

**STUDIES ON HETEROSIS, COMBINING ABILITY AND STABILITY
ANALYSIS OF HYBRID FORAGE SORGHUM (*sorghum bicolor* (L.)
Moench) FOR MULTICUT HABIT**

Thesis submitted in part fulfillment of the requirements for the degree of
Doctor of Philosophy in Plant Breeding and Genetics
to the Tamil Nadu Agricultural University, Coimbatore.

BY

K. IYANAR

I.D.NO. 98-810-004

**CENTRE FOR PLANT BREEDING AND GENETICS
AGRICULTURAL COLLEGE AND RESEARCH INSTITUTE
TAMIL NADU AGRICULTURAL UNIVERSITY
COIMBATORE – 641 003**

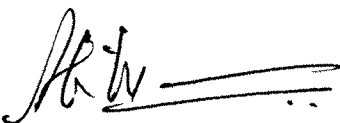
2001

CERTIFICATE

This is to certify that the thesis entitled "STUDIES ON HETEROSIS, COMBINING ABILITY AND STABILITY ANALYSIS OF HYBRID FORAGE SORGHUM (*Sorghum bicolor* (L.) Moench) FOR MULTICUT HABIT" submitted in part fulfillment of the award of the requirements for the degree of Doctor of Philosophy (Agriculture) in Plant Breeding and Genetics to the Tamil Nadu Agricultural University, Coimbatore is a record of *bonafide* research work carried out by Mr. K. IYANAR under my supervision and guidance and that no part of this thesis has been submitted for the award of any other degree, diploma, fellowship or other similar titles or prizes and that the work has not been published in part or full in any scientific or popular journal or magazine.

Place : Coimbatore

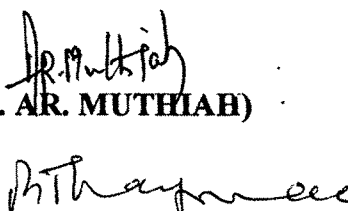
Date : 4-7-2001


(Dr. A.K. FAZLULLAH KHAN)
CHAIRMAN

Approved by

Chairman : (Dr. A.K. FAZLULLAH KHAN)

Members : (Dr. AR. MUTHIAH)


(Dr. B. THAYUMANAVAN)

Date : 30-1-2002


(Dr. V. KRISHNASAMY)


External Examiner

Acknowledgement

ACKNOWLEDGEMENT

I wish to express my deep sense of gratitude and indebtedness to Dr.A.K.Fazlullah Khan, Professor and Head, Department of Millets and Chairman of the advisory committee for his inspiring guidance, encouragement, kind treatment, sustained interest and constant encouragement through out the course of the investigation and preparation of this manuscript. It was a great experience to work under a man personified with professional attributes.

I humbly express my gratitude and profound thanks to Members of the Advisory committee, Dr. A.R. Muthiah, Professor and Head, Department of Pulses, Dr.B.Thayumanavan, Professor and Head (Biochemistry) and Dr. V. Krishnasamy, Professor (Seed Technology) for their advice, guidance and useful suggestion in the present study.

I am greartful to Dr. Surendran, Director, Centre for Plant Breeding and Genetics for his valuable help during the course of study.

I owe my sincere thanks to Dr. A. Gopalan, Professor and Head, Department of Forages, Dr. M. Maheswaran, Dr. K. Kumar and Dr. Vanniarajan for their sustained encouragement, useful suggestions and critical comments during the course of study.

I^{am} equally indebted to Dr. Manivannan, Dr. Arumugasamy and Dr.R. Ravikesavan for their valuable suggestions and benevolent assistance in the preparation of manuscript, their encouragement and useful suggestions during the course of study. I acknowledge the help rendered by Mrs. Jaibunisa, Field Assistant (Forages) and Mrs. Santha (Field Worker) during the course of field study.

I would like to place on record the love, affection and timely criticism rendered by Mr. Justin Mohan, Mr. Jayakumar, Mr. Tamilselvam, Mr.Rave, Mr. Anbumani, Mr. Sathyan and Mr. Ezhil kumar.

*The unsolicited assistance rendered by my friends **Mr. Sassikumar** and **Mr. Thangaraj** for their carrying company during my study at college is memorable.*

*I express my sincere gratitude to **Mr. Senthilvel** for his help in carrying out the statistical analysis of the experimental data. The help rendered by **Mr. Sathish** and **Mr. Sudhagar** are also greatly acknowledged.*

On the personal ground, I wish to accord my whole hearted thanks to my parents, sisters, brother and relatives for their blessing.


(K. NYANAR)

Abstract

ABSTRACT

STUDIES ON HETEROSIS, COMBINING ABILITY AND STABILITY ANALYSIS OF HYBRID FORAGE SORGHUM (*SORGHUM BICOLOR* (L.) MOENCH.) FOR MULTICUT HABIT

By

K. IYANAR

Degree : Doctor of Philosophy in Plant Breeding and Genetics.

Chairman: Dr. A. K. FAZLULLAH KHAN,
Professor and Head,
Department of Millets,
Centre for Plant Breeding and Genetics,
Tamil Nadu Agricultural University,
Coimbatore - 641 003.

2001

An investigation was undertaken to develop hybrids with multicut habit having multitillering nature and perenniality. The hybrids were obtained by crossing in Line (4) x tester (21) fashion during summer '99. The hybrids (84 cross combinations) and their parents were evaluated from January 2000. Eleven metric traits were considered in addition to three-quality characters (HCN, TSS and crude protein) for assessing their performance in four harvests.

The results of the pooled combining ability studies through Line x Tester analysis indicated the predominance of additive gene action for all the traits except number of tillers, crude protein and green fodder yield per plot.

The genotypes 111 A, 2077 A, 68726, 68786, SS 032 and 68814 possessed high *per se* with significant *gca* effects for most of the traits under study.

Based on the *per se* performance, *sca* effects and standard heterosis seven hybrids viz., 111 A x 68726, 111 A x 68724, 111 A x 68814, 2077 A x 68814, 111 A x SS 032, 111A x FS 9605 and 2219 A x 68716 were identified as the best hybrids for green fodder yield per plot and will be useful for direct exploitation.

The results of the genotypic correlation and path analysis revealed that due importance has to be to plant height, number of tillers, leaf breadth, leaf stem ratio and stem thickness, since they had recorded significant correlation for green fodder yield and had high direct effect.

Stability analysis of data from all the four environments (cuts) was also carried out. The ratio of non-linear to linear component of variance for different characters showed that a major portion of contribution was of linear type except for green fodder yield per plant where non-linearity exceeded the linear component. Highly significant nature of mean square deviation for green fodder yield per plant was observed.

Among the four environments studied environment 3 (3rd cut) had the highest favourable effect for all the characters.

A simultaneous consideration of the three parameters (mean, b_i and S^2_{di}) of the individual genotypes, indicated that the hybrids 2219 A x 68786 and 111 A x FS 9401 were the best for green fodder yield per plot as they recorded high mean and average responsiveness to the environment with high stability. 111 A x Co 27 also recorded high mean with high responsiveness to the environment with high stability for green fodder yield

Positive correlation between mean and b_i , mean vs S^2_{di} and b_i vs S^2_{di} for number of tillers, green fodder yield per plant and green fodder yield per plot indicated that selection for higher mean values for these traits would simultaneously increase the b_i and S^2_{di} values, thereby resulting in low stability.

AMMI analysis I indicated that 111 A x FS 211, 2219 A x 68786 and 111 A x Co 27 could be selected as the best hybrids for their average performance in each cut for green fodder yield per plot.

Sixteen hybrids had good ratooning ability even upto five cuts and their stability was assessed over five cuts. It indicated that 111 A x 68724 was the best hybrid for green fodder yield per plot as it recorded high mean with high responsiveness and high stability.

AMMI analysis II indicated that 2219 A x FS F401, 2219 A x SS 003 and 111 A x FS9401 could be selected (among the 16 hybrids) as the stable genotypes with average yield (at the maximum of five cuts) throughout the year.

By comparing the two stability models (linear regression model and AMMI) 2219 A x 68786 and 111 A x CO 27 were selected as the best hybrids for higher fodder yield.

CONTENTS

CHAPTER	TITLE	PAGE NO.
I	INTRODUCTION	1
II	REVIEW OF LITERATURE	3
III	MATERIALS AND METHODS	25
IV	RESULTS	46
V	DISCUSSION	144
VI	SUMMARY	180
	REFERENCES	
	PLATES	
	APPENDICES	

LIST OF TABLES

Table No.	Title	Page No.
1	Details of the experimental materials	26
2	Analysis of variance for parents and hybrids for different characters in individuals environments and pooled data	47
3	Mean performance of parents and hybrids in pooled data for different characters	50
4	Analysis of variance for combining ability in individual environments and pooled data for different characters in Line x Tester design	57
5	Combining ability variances and interaction variances in individual environments and pooled data for different characters	59
6	Proportional contribution of lines, testers and their interaction to total variance in individual environments and pooled data for different characters	61
7	General combining ability effects of parents in pooled data for different characters	62
8	Specific combining ability effects of parents in pooled data for different characters	67
9	Relative heterosis (di), Heterobeltiosis (dii) and Standard heterosis (diii) in pooled data for days to 50 % flowering, plant height, No. of tillers, No. of leaves and leaf length	73
10	Relative heterosis (di), Heterobeltiosis (dii) and Standard heterosis (diii) in pooled data for leaf breadth, leaf stem ratio, stem thickness, hydrocyanic acid and total soluble solids	76
11	Relative heterosis (di), Heterobeltiosis (dii) and Standard heterosis (diii) in pooled data for crude protein, dry fodder yield, green fodder yield per plant and per plot	79
12	Correlation co efficient of green fodder yield and yield components in individual environments and pooled data	82

13	Path coefficient analysis of different characters with green fodder yield in individual environments and pooled data	85
14	Analysis of variance for stability for different characters	88
15	Environmental indices for seven different characters	89
16	Stability parameters of parents and hybrids for to 50 per cent flowering	91
17	Stability parameters of parents and hybrids for to plant height	94
18	Stability parameters of parents and hybrids for to number of tillers	98
19	Stability parameters of parents and hybrids for to dry fodder yield	101
20	Stability parameters of parents and hybrids for to green fodder yield per plant	104
21	Stability parameters of parents and hybrids for to green fodder yield per plot	108
22	Stability parameters of parents and hybrids for to crude protein	111
23	Correlation between stability parameters of seven characters	114
24	Analysis of variance for the AMMI model for green fodder yield per plant	116
25	Analysis of variance for the AMMI model for green fodder yield per plot	116
26	ANOVA for stability parameters for different characters (5 cuts)	124
27	Environmental indices for seven different characters (5 cuts)	125
28	Stability parameters of parents and hybrids for to 50 per cent flowering and plant height (5 cuts)	126
29	Stability parameters of parents and hybrids for number of tillers and dry fodder yield (5 cuts)	128

30	Stability parameters of parents and hybrids for green fodder yield per plant and green fodder yield per plot (5 cuts)	129
31	Stability parameters of parents and hybrids for crude protein (5 cuts)	130
32	Correlation between stability parameters of seven characters (5 cuts)	131
33	Analysis of variance for the AMMI model for green fodder yield per plant (5 cuts)	133
34	Analysis of variance for the AMMI model for green fodder yield per plot (5 cuts)	133
35	Score chart of mean and <i>gca</i> values for parents and mean, <i>sca</i> and standard heterosis values for hybrids for pooled data over environments	140
36	Stable genotypes with high mean and non significant S^2_{di} values for different characters	171

LIST OF FIGURES

FIG. NO.	TITLE	PAGE NO.
1	AMMI 1 biplot of main effects and interactions for green fodder yield per plant (4 cuts)	118
2	Interaction biplot for the AMMI 2 model for green fodder yield per plant (4 cuts)	119
3	AMMI 1 biplot of main effects and interactions for green fodder yield per plot (4 cuts)	120
4	Interaction biplot for the AMMI 2 model for green fodder yield per plot (4 cuts)	121
5	AMMI 1 biplot of main effects and interactions for green fodder yield per plant (5 cuts)	135
6	Interaction biplot for the AMMI 2 model for green fodder yield per plant (5 cuts)	136
7	AMMI 1 biplot of main effects and interactions for green fodder yield per plot (5 cuts)	137
8	Interaction biplot for the AMMI 2 model for green fodder yield per plot (5 cuts)	138

LIST OF PLATES

PLATE NO.	TITLES
1	The Experimental Plot – Field view
2	Best hybrid of sorghum with their parents – Hybrid 1
3	Best hybrid of sorghum with their parents – Hybrid 2
4	Best hybrid of sorghum with their parents – Hybrid 3
5	Best hybrid of sorghum with their parents – Hybrid 4

LIST OF APPENDICES

Appendix No.	Title
1	Mean performance of parents and hybrids in individual environments and pooled data for days to 50 per cent flowering and plant height (cm)
2	Mean performance of parents and hybrids in individual environments and pooled data for number of tillers and number of leaves
3	Mean performance of parents and hybrids in individual environments and pooled data for leaf length (cm) and leaf breadth (cm)
4	Mean performance of parents and hybrids in individual environments and pooled data for leaf stem ratio and stem thickness (cm)
5	Mean performance of parents and hybrids in individual environments and pooled data for Hydrocyanic acid (ppm) and total soluble solids (per cent)
6	Mean performance of parents and hybrids in individual environments and pooled data for crude protein (per cent) and dry fodder yield (g)
7	Mean performance of parents and hybrids in individual environments and pooled data for green fodder yield per plant (g) green fodder yield per plot (kg)
8	General combining ability effects of parents in individual environments and pooled data for days to 50 per cent flowering
9	General combining ability effects of parents in individual environments and pooled data for plant height
10	General combining ability effects of parents in individual environments and pooled data for number of tillers
11	General combining ability effects of parents in individual environments and pooled data for number of leaves
12	General combining ability effects of parents in individual environments and pooled data for leaf length
13	General combining ability effects of parents in individual environments and pooled data for leaf breadth
14	General combining ability effects of parents in individual environments and pooled data for leaf stem ratio

15	General combining ability effects of parents in individual environments and pooled data for stem thickness
16	General combining ability effects of parents in individual environments and pooled data for hydrocyanic acid
17	General combining ability effects of parents in individual environments and pooled data for total soluble solids
18	General combining ability effects of parents in individual environments and pooled data for crude protein
19	General combining ability effects of parents in individual environments and pooled data for dry fodder yield
20	General combining ability effects of parents in individual environments and pooled data for green fodder yield per plant
21	General combining ability effects of parents in individual environments and pooled data for green fodder yield per plot
22	Specific combining ability effects of hybrids in individual environments and pooled data for days to 50 per cent flowering
23	Specific combining ability effects of hybrids in individual environments and pooled data for plant height
24	Specific combining ability effects of hybrids in individual environments and pooled data for number of tillers
25	Specific combining ability effects of hybrids in individual environments and pooled data for number of leaves
26	Specific combining ability effects of hybrids in individual environments and pooled data for leaf length
27	Specific combining ability effects of hybrids in individual environments and pooled data for leaf breadth
28	Specific combining ability effects of hybrids in individual environments and pooled data for leaf stem ratio
29	Specific combining ability effects of hybrids in individual environments and pooled data for stem thickness
30	Specific combining ability effects of hybrids in individual environments and pooled data for hydrocyanic acid

31	Specific combining ability effects of hybrids in individual environments and pooled data for total soluble solids
32	Specific combining ability effects of hybrids in individual environments and pooled data for crude protein
33	Specific combining ability effects of hybrids in individual environments and pooled data for dry fodder yield
34	Specific combining ability effects of hybrids in individual environments and pooled data for green fodder yield per plant
35	Specific combining ability effects of hybrids in individual environments and pooled data for green fodder yield per plot
36	Relative heterosis (di), heterobeltiosis (dii) and standard heterosis (diii) in individual environments and pooled data for days to 50 per cent flowering
37	Relative heterosis (di), heterobeltiosis (dii) and standard heterosis (diii) in individual environments and pooled data for plant height
38	Relative heterosis (di), heterobeltiosis (dii) and standard heterosis (diii) in individual environments and pooled data for number of tillers
39	Relative heterosis (di), heterobeltiosis (dii) and standard heterosis (diii) in individual environments and pooled data for number of leaves
40	Relative heterosis (di), heterobeltiosis (dii) and standard heterosis (diii) in individual environments and pooled data for leaf length
41	Relative heterosis (di), heterobeltiosis (dii) and standard heterosis (diii) in individual environments and pooled data for leaf breadth
42	Relative heterosis (di), heterobeltiosis (dii) and standard heterosis (diii) in individual environments and pooled data for leaf stem ratio
43	Relative heterosis (di), heterobeltiosis (dii) and standard heterosis (diii) in individual environments and pooled data for stem thickness
44	Relative heterosis (di), heterobeltiosis (dii) and standard heterosis (diii) in individual environments and pooled data for hydrocyanic acid
45	Relative heterosis (di), heterobeltiosis (dii) and standard heterosis (diii) in individual environments and pooled data for total soluble solids
46	Relative heterosis (di), heterobeltiosis (dii) and standard heterosis (diii) in individual

	environments and pooled data for crude protein
47	Relative heterosis (di), heterobeltiosis (dii) and standard heterosis (diii) in individual environments and pooled data for dry fodder yield
48	Relative heterosis (di), heterobeltiosis (dii) and standard heterosis (diii) in individual environments and pooled data for green fodder yield per plant
49	Relative heterosis (di), heterobeltiosis (dii) and standard heterosis (diii) in individual environments and pooled data for green fodder yield per plot
50	Number of days accounted by different cuts
51	Weekly weather during experimental period (2000 – 2001)

Introduction

I. INTRODUCTION

Livestock play an important role in agricultural economy of our country as they account for 32-34 per cent to the total agricultural output. For raising the livestock successfully and for economic management of livestock industry, the feeding of animals with required quantity of quality forage is necessary as it provides the nutritional requirements for both maintenance and production. Since, feeding alone accounts for 60 per cent of the total cost of animal production, green fodder availability at cheaper rate is important.

The projected demand for fodder in 2000 is estimated to be 950 million tones of dry fodder and 1,135 million tones of green fodder. However the present availability is short by 50 per cent of green fodder and 25 per cent of dry fodder (Prabaharan, 2000). The gap between demand and supply of fodder is likely to widen further due to more pressure to grow food grains and other crops. There is no possibility to increase area under forage, which is about 8.3 million ha under cultivated forages (Lodhi and Arora, 1997).

Obviously there is an urgent need to improve productivity of fodders and pasture lands by introducing improved fodder crops and increased use of wasteland for fodder production. The improvement of forage productivity through genetic amelioration is the most efficient, cheap and durable approach. In that context, an attempt has been made to develop required type of cultivars for enhancing forage production.

Majorities of varieties bred so far in most of the cereal fodders are single cut types and their average forage yield is not high. Even the multi cut types released so far in India hardly yield 140-180 q/ha of dry matter. In order to achieve the target yields of 1000-1200 q per ha fresh and 300-400 q/ha dry forage we must give priority for breeding profusely tillering, quick regenerating, faster growing varieties or hybrids having a minimum of 4-5 cuttings per year

Among the cereals, sorghum plays an important role in India, as a major grain cum fodder crop. It is extensively grown as a major source of fodder and is preferred over maize in kharif because of its high tolerance to various stresses. It is superior to pearl millet in having lower oxalate and fiber content. Quick profuse tillering, high drymatter content, leafiness, high palatability, hardiness and suitability for silage making makes it an ideal fodder crop.

However, significant improvement with reference to high fodder production has not been achieved so far mostly due to inadequacy of information on the genetics of green and dry fodder yields and associated traits. Only a few fodder sorghum varieties have been evolved through inter-varietal hybridization and selection. Most of these varieties are annuals that can stand one or two cuts at the best. In this context, an approach has been made to develop hybrids with multicut habit having multitillering nature and perenniality with the following objectives.

1. To identify good combining parents with desirable traits for developing fodder sorghum hybrids.
2. To select the hybrids with high heterotic vigour for the important fodder qualities.
3. To evaluate and identify hybrids with multicut habit combined with high fodder yield.
4. To determine the association of characters between fodder yield and other vegetative plant attributes besides quality traits at the genotypic level.
5. To evaluate the performance of hybrids over seasons to ascertain their stability for yield and its parameters.

Review of literature

II. REVIEW OF LITERATURE

The objectives of breeding forage crops are different from other crops and the foremost objective is to develop genotypes capable of producing more biomass (green and dry) rather than specific economic traits like grain yield, fiber and oil content etc. The forage should be nutritionally superior such as better in palatability, high in protein, digestibility and low in toxic constituents in order to obtain better animal performance. In addition, the genotypes should have faster growth, wider adoption, resistance to biotic and abiotic factors, responsiveness to input, suitability for various cutting management and conservation practices. Reasonable high seed yield is quite important for faster spread of forage cultivars in areas of their adaptation. The perennial forage crops should have good persistency and regeneration. Hybrid development is the only way to solve most of these problems.

In Sorghum (*Sorghum bicolor* (L) Moench) exploitation of hybrid vigour has been considered as one of the important breeding strategy for maximising the yield potential. The utilization of cytoplasmic male sterility for exploiting heterosis can obviate the limitations of large scale production of hybrid seeds. Knowledge on the pre potency in the parents of the hybrid is an essential requirement which is obtained through the use of several biometrical and biochemical techniques.

2.1. Studies on combining ability and gene action:

Combining ability is a useful biometric tool to the plant breeders for formulating an efficient breeding program to evolve superior genotypes in crop plants. The concept of combining ability in terms of genetic variation was put forward by Sprague and Tatum (1942) using single crosses in maize. They used the term general combining ability (GCA) to denote the average performance of a line or population in several hybrid combinations and specific combining ability (SCA) was used to designate those effects in certain combinations which significantly departed from what would be expected on the basis of the average performance of the lines involved. They attributed general combining ability to additive effect of genes and specific combining ability to dominant deviation and epistatic interaction.

Henderson (1952) defined SCA as the deviation of the average of an infinitely large number of progenies of two individual lines from the value which would be expected on the basis of known GCA of these individuals or lines and the maternal ability of the female parent. Sprague and Federer (1951) and Rojas and Sprague (1952) examined the combining ability over years in corn and found that SCA not only involved dominance and epistasis but also a considerable amount of genotype environmental interaction. Griffing (1956) expressed that GCA involved both additive effects as well as additive x additive interaction.

Kempthorne (1957) precisely defined the GCA and SCA as σ^2 GCA and σ^2 SCA respectively in terms of covariance of half sibs (HS) and full sibs (FS) in random mating population where σ^2 GCA is Cov. HS and σ^2 SCA is Cov.FS-2 (Cov. HS). Allard (1960) classified the combining ability into general combining ability (GCA) and specific combining ability (SCA). He defined the GCA as average performance of a strain in a series of crosses and SCA as the deviation from the performance on the basis of GCA.

Studies on combining ability carried out by different workers recently in sorghum are summarized hereunder.

Dangi *et al.* (1980) in a line x tester analysis involving five pollinators with 17 lines observed preponderance of additive gene action for fodder yield.

Monk *et al.* (1985) studied six diverse lines of *S. bicolor* and F_1 progenies of their diallele crosses and observed that additive component was significant for starch, total sugars and cell wall percentages and IVDMD, while dominance component was significant for number of vascular bundles and rind thickness. There were significant maternal effects for IVDMD and starch percentage. Partial dominance was demonstrated in seven characters and of overdominance in four others.

Cheng *et al.* (1986) in two 5 x 5 diallele crosses involving 10 male sterile and maintainer lines of sorghum observed that general combining ability values for stem sugar content were considerably higher than specific combining ability values indicating that additive gene effects were more important than dominance effects. Dominance was in the

direction of low sugar content. Genetic control appeared to be by a major gene with unevenly distributed minor genes for stem sugar content.

Chandrashekharappa (1987) studied 16 components of fodder and grain yield in crosses of eight male sterile lines with four local cultivars of sorghum and observed that the additive genetic variance was predominant for plant height, days to 50 per cent flowering, number of leaves, internode length, stem girth, dry stem weight, fresh leaf weight and panicle length. Non-additive genetic variance was observed to be important for other characters.

El-Shouny *et al.* (1990) observed significant GCA and SCA estimates for all traits except crude protein content. Variances for GCA were 6 to 20 times higher than those for SCA. GCA for fresh and dry forage yield, crude fiber and protein contents were more stable for year than location. Female parent Texas 624 and the male parent Piper gave high GCA estimates for fresh and dry forage yields and the later parent was also good for low fiber content and stem sugar content.

Kishan *et al.* (1990) studied nineteen restorers with four lines differing in cytoplasmic male sterility (milo, caudatum, durra and guinea) in a line x tester mating design. Considerable variation among cytoplasmic lines for total soluble solid (TSS) content of stem was found. Hybrids of those other than milo cytoplasm had high *gca* effects for TSS. When breeding for high TSS, sorghum with caudatum, durra or guinea cytoplasm was recommended. Indian restorers showed significant positive *gca* effects whereas exotic restorers exhibited negative *gca* effects for TSS.

Nandanwankar and Chandan (1990) studied six generations viz., parents, F₁, F₂, B₁ and B₂ developed from five male sterile lines and four restorers of sorghum. The estimates of gene effects showed that additive, dominance as well as epistasis had played an important role for plant height at maturity. Dominance gene effects had shown major contribution and were positive. Amongst epistatic effects, additive x additive was prominent in 296A x PVR-12 and 2219A x PVK 9 suggesting the possibility of direct selection of transgressive sergeants from F₂ as well as further generations. In respect of dry fodder yield, magnitude of

dominance effects was generally high in all crosses for dry fodder yield indicating the possibility of obtaining transgressive variation in fodder yield expression.

Jagadeshwar and Shinde (1992) observed that mean squares due to GCA and SCA were highly significant in individual environments as well as pooled data over environments for all the traits. The estimate of interaction components GCA x environment and SCA x environment were significant for all the traits except days to flowering. However, the interaction component due to GCA x environment variances showed higher values as compared to the SCA X environment variances indicating the additive variance X environment interaction. The parents SPV 438, SPV 86 and SPV 41 were good general combiners for grain yield and green fodder yield.

Pathak and Sanghi (1992) studied six CMS lines and 18 diverse pollinators in line x tester fashion at 2 locations. Combining ability, separately and on a pooled basis, was evaluated for 9 quantitative leaf traits. They observed that CMS lines 2077A, 36A and M 31-2A and pollinators C10-2, Vidisha, Rio, PC6, IS 685, IS 3287 and IS 4776 showed high *gca* effects for most of the characters. Of the hybrids CK 60A X PC 6, 2219A x IS 612, 36A X IS 3301, 36A X IS 662 and M 31-2A X IS 612 gave significant *sca* effects on a pooled basis for majority of the traits. The *gca* effect was stable for dry leaves per plant, leaf weight, leaf: stem ratio and leaf area, where as *sca* was unstable for all characters.

Shaug (1992) observed that mean square of GCA for HCN at 60 (HCN60) days and HCN at maturity (HCNM) was highly significant in males but not in females. SCA was only significant for HCN 60. GCA for HCN 60 and HCN M exceeded SCA. He reported that those traits in males with higher genotypic components also had higher combining ability effects and might be used as breeding materials for reducing HCN potential in forage sorghum.

Shivanna *et al.* (1992) reported that SPV 346 and IS 24996 were the best general combiners for the majority of the traits. IS 24996 and SB 1066 were found to be good combiners for maturity traits. The pattern of difference in combining ability effects remained the same across both the environments studied.

Bassnayaka *et al.* (1994) observed genetic variation for osmotic adjustment among the lines and reported that both GCA and SCA were significant indicating that the trait (adaptation to water stress) was controlled by more than one gene.

Manickam and Vijendra Das (1994a) recorded the GCA: SCA variance ratio for eleven forage characters and found that there was predominance of non-additive gene action for all the traits except number of tillers and number of leaves. The line TNAU MS1B was the best combiner among the lines and K 10 the best among the testers.

Manickam and Vijendra Das (1994b) reported that TNAU MS 1A X SSG 59-1, TNAU MS1A X CO 4, 2219A X K 10 and 2219 A X MP chari recorded the maximum specific combining ability effects for green fodder yield, dry matter production, total soluble solids and crude protein content respectively.

Sankarapandian *et al.* (1994) observed non-additive gene action for number of leaves, leaf stem ratio, total soluble solids at maturity, crude protein and dry matter yield per plant where as plant height was observed to be controlled by additive gene action. Among the different combinations, 2077 A X FS 35-1, 2077 A X FS 1, 2219 A X FS 1 were the best combiners having high *sca* effects.

Manickam and Vijendra Das (1995) observed non-additive gene action for plant height, stem girth, leaf area per plant and green fodder yield in contrast to additive gene action for number of tillers and number of leaves. TNAU MS1A and SSG 59-3 were the best parents based on general combining ability effects and the hybrid TNAU MS1A X SSG 59-3 was having highest *sca* effects.

Shaug Suepea and Lo Kuoduhng (1995) reported that the mean squares of GCA and SCA of potassium and hydrocyanic acid at heading and maturity were all significantly different. The additive variances of chemical components were higher than the dominant variances at heading, however, similar variances were observed between additive and dominant components at maturity. The SCA of crude protein was highly significant at heading and maturity.

Oosterom *et al.* (1996) reported that inheritance of the onset of senescence (stay-green trait) was additive, but slow senescence rate (Green leaf area duration-GLAD) was dominant over a fast rate. Consequently a large relative GLAD (slow senescence) was partially dominant over a small relative GLAD. Because of the dominance of a large leaf area at flowering, the partial dominance in relative GLAD translated into over dominance for a large absolute GLAD. In spite of significant genotype x environment interactions for the component traits, the expression of heterosis for non-senescence as related to the stay green trait was stable across environments. These results offered an opportunity for improving drought tolerance of sorghum in environments with post-flowering drought stress in case of dual-purpose sorghum.

Shah and Joshi (1996) studied ten derivatives of Exotic x Indian crosses, their 45 F1s and 45 F2's planted in three environments. They reported both additive and non-additive gene effects for fodder yield, plant height and days to 50 per cent bloom. The parents SPV 474, IS 508 and SPV 394 emerged as good combiners for fodder yield and plant height while SPV 96 and SPV 297 were the best for days to bloom. The hybrids SPV 474 X IS 508, SPV 394 X IS 508 and SPV 45 X IS 508 were found to show high *sca* effects for fodder yield.

Bazzocchi *et al.* (1997) observed high *gca* effects for time to emergence, time to flowering, tillering, plant height, dry matter yield and dry matter content at harvest. Bhadouriya and Saxena (1997) reported both additive and dominant gene action for number of leaves, plant height and days to 50 per cent flowering.

Katsuba *et al.* (1998) found that line 2098-2-4-4 (Sudangrass restorer) had very high *gca* effects for all forage quality characters than the early maturing parents 744, piper and green leaf. The hybrid 378A X 2098-2-4-4 produced high *sca* effects and was more vigorous than the other hybrid cultivars.

Khatri *et al.* (1998) reported the presence of additive and dominance component of variance with preponderance of dominance component for the content of total sugars, reducing sugars and non-reducing sugars in forage sorghum. A high frequency of dominant

alleles in parents with over dominance was recorded for all the three traits. An unequal distribution of positive and negative alleles, with more dominant genes, was observed among parents.

Kumar and Kumar (1998) studied interspecific hybrids between sorghum and sudan grass (*Sorghum sudanense*) in a line x tester design and reported predominance of SCA variance for all the characters except leaf area and number of nodes per plants. ICSA 101 and ICSR 93014 were found to be good general combiners for most of the characters studied. Among the hybrids ICSA 101 X SSG 59-3 and ICSA 75 X SSG 59-3 were found to have high *sca* effects.

2.2.Studies on Heterosis:

Plant breeders have extensively explored and utilized heterosis in enhancing the yield in a number of crops like corn, sorghum, pearl millet, cotton, sunflower, rice, red gram etc. Heterosis defined as the deviation of F_1 hybrid over its mid parent, the better parent and standard parental value, is the consequence of hybridization.

Heterosis in common sense represents percentage increase or decrease in mean value of F_1 hybrids over mid parental value. The heterobeltiosis represents the increase or decrease in mean value of F_1 hybrid over its better parent. The classical term heterosis coined by Shull (1914) implies excellence of F_1 hybrid over strictly homozygous parents involved in its formation. Conner and Karper (1927) reported heterosis in sorghum first. Since then, several workers have reported heterosis for many of the characters in sorghum.

Hybrid forage sorghums can be developed using several combinations. For example:

1. Male sterile grain type x male fertile grain type yielding dual purpose or silage hybrids with high grain: stover ratio.
2. Male sterile grain type x male fertile sudangrass yielding Sorghum-Sudan grass hybrids.
3. Male sterile sudangrass (Alam and Sandal, 1967) x male fertile sudangrass resulting in hybrid sudangrass. Type 2 and 3 are generally used as green chop, hay and pasture grazing types.

Based on the above considerations, the recent reports on heterosis of fodder yield and fodder yield components in sorghum are briefly reviewed here under.

Boora and Lodhi (1981) crossed 17 diverse lines with five diverse testers of sorghum and the resulting 85 F_1 hybrids were studied for their hybrid vigor. During summer, heterosis of the order of 189.05 and 347.33 per cent over the better parent was recorded for green fodder yield and dry matter yield respectively whereas during kharif, heterosis was upto 121.95 and 202.92 per cent for green fodder and dry matter yield respectively.

Muhammad *et al.* (1981) studied F_1 hybrids of four cytoplasmic male sterile sorghum varieties with four sudangrass varieties. The hybrids showed improved vigour for fodder yield and seven yield related and quality traits. Like sudangrass, the hybrids could be ratooned.

Shekar and Ahluwalia (1981) crossed eight male sterile lines with 15 pollinators of sorghum in a line x tester fashion and observed a significant heterosis and heterobeltiosis in the desirable direction for many of the characters except leaf breadth and stem girth. Maximum heterobeltiosis (75 to 197 per cent) was observed for green fodder yield. Protein content and leaf to stem ratio exhibited negative heterosis.

Torres-Cardana *et al.* (1983) studied five single crosses and five three way cross hybrids of sorghum. The single cross hybrids were better in yield and other related characters than the three way cross hybrids and single cross hybrids had higher HCN contents.

Bhagmal and Mishra (1985a) studied 11 F_1 hybrids and 16 parents of forage sorghum and observed that the mid parental heterosis ranged from 34 to 124 per cent for plant height, -27 to 25 per cent from culm thickness, -18 to 18 per cent for leaf number, -24 to 43 per cent for leaf length and -36 to 45 per cent for leaf breadth. The range of variation for heterobeltiosis was from -37 to 54 per cent for plant height, -38 to 30 per cent for leaf length and -41 to 32 per cent for leaf breadth. The maximum range of variation for mid parent and better parent heterosis was recorded for plant height.

Bhagmal and Mishra (1985b) crossed F_1 hybrids of *S. bicolor* with *S. sudanense* line. Three way cross hybrids showed significant positive transgressive segregation for plant height, culm thickness, leaf breadth and both positive and negative transgression for number of leaves and leaf length. Highest percentage of significant heterosis for plant height (68.96 per cent) was followed by leaf length (62.67 per cent), leaf number (48.27 per cent), culm thickness (27.58 per cent) and leaf breadth (24.14 per cent)

Girko (1985) crossed inbred sudangrass lines with CMS forms of grain sorghum and reported that relative heterosis was 93.3 per cent, for plant height and 53.3 per cent for number of internodes. Heterosis was negative (-13.93 per cent) for per cent of leaf area in the first cut. Partial dominance was most frequently observed for the duration of the emergence of the head, leaf width, degree of tillering and panicle length.

Semenova (1986) studied F_1 and F_2 generations involving ten varieties of sorghum including one variety of Sudanense. Nine out of 12 F_1 hybrids showed heterosis for leaf number, the rest being intermediate between their parents, six out of 10 F_2 hybrids showed transgressive segregation for leaf number.

Lazanyi and Bajaj (1986) studied F_1 hybrids involving five cytoplasmic male sterile lines and their five maintainer lines in a diallel fashion and reported that heterosis was limited to plant height, leaf length and leaf breadth.

✓ Rathore and Singhania (1985) studied eight F_1 populations involving six varieties of *S. bicolor* and their F_2 s for 14 characters. The magnitude of heterosis and inbreeding depression was high for plant height, number of intact leaves, stem diameter, leaf width and green and dry forage yields. The absence of significant residual heterosis in F_2 populations suggested the limited commercial feasibility of exploiting heterosis at F_2 level.

✓ El-Shouny *et al.* (1990) studied 30 hybrids involving ten male steriles and three restorer lines and observed that Piper x Texas 624, Piper x Atlas and Green leaf x Texas 662 gave the highest fresh yield as well as dry matter yield. Their average surpassed the best control, sordan by 79, 34 and 43 per cent respectively. They were also superior to the best

male parent Oena, by 18 per cent and 24 per cent for fresh and dry yields. Green leaf x New Mexico 10495 was found to have higher protein (10 per cent) than parents other hybrids and the controls. In general, mean heterosis over better parent was positive for all the traits except crude fibre content.

Patil and Bapat (1991) noticed significant positive heterosis for forage yield in partial dialle crosses of seven varieties of sorghum.

Pathak and Sanghi (1992) observed highly significant heterosis for green fodder yield and varying degrees of heterosis for all the characters studied.

Mehndiratta *et al.* (1993) studied heterosis for green and dry fodder yield in interspecific forage sorghum by line x tester analysis. Among the hybrids, six had significantly exceeded the control hybrid Pioneer x 988.

Antohe *et al.* (1994) observed heterosis for green matter and silage from sorghum x sudan grass hybrids. Sankarapandian *et al.* (1994) found high positive standard heterosis for high juice yield and brix. Manickam and Vijendra Das (1995) observed positive heterosis for green fodder yield, dry matter content, total soluble solids and crude protein content. Raveendran *et al.* (1996a) reported significantly positive standard heterosis in a cross between *S. bicolor* (Co-27, 2n=20) and *S. halepense* (2n=40).

Sankarapandian *et al.* (1997) observed that there is positive but varying degrees of heterosis for forage yield related and quality traits in a 3 x 15 line x tester cross as well as in 45 three way cross hybrids obtained from crosses between three male sterile single crosses and the fifteen testers.

Jayamani and Dorairaj (1997) observed a positive highly significant heterosis for green fodder yield in the main fodder crop as well as ratoon crop in five out of 30 hybrids of inter specific crosses involving *Sorghum bicolor* and *S. halapense*.

Desai *et al.* (1999) reported that crosses involving ICSA 77 as female parent, especially ICSA 77 X IS 3332 exhibited high heterobeltiosis as well as standard heterosis for most of the characters in both first and second cuts. These hybrids can serve as potential multicut hybrids for commercial exploitation to boost net forage production.

Sun *et al.* (1999) compared 15 *Sorghum bicolor*-sudangrass (*S.sudanense*) hybrids with sweet sorghum hybrids. They reported that production capacity of sorghum sudangrass hybrids used as fodder was lower than sweet sorghum hybrids, but better in some aspects, such as early maturity, high quality etc. Diurnal production capacity of dry matter and green parts of sorghum sudangrass hybrids was greater than that in Tianza-Z.

2.3.Studies on character association:

The breeder is always concerned with the selection of superior genotypes which is dependent on the phenotypic expression. Often, selection based on phenotypic performance does not lead to the expected genetic advance, mainly due to the presence of genotype x environment interaction as well as due to undesirable association between the component characters at genotypic level.

Thus a knowledge of the correlation between complex characters like fodder yield and its component characters will be useful in designing efficient selection criteria for isolating ideal plant types. Genetic correlation between quantitative characters is one of the determinants of the rate and direction of evolution of the average phenotype in a population in response to multivariate patterns of natural selection (Falconer, 1981)

The existence of correlation may be attributed to the presence of linkage or pleiotropic effects of genes or physiological and developmental relationships or environmental effects or a combination of all. The recent reports on the correlation studies of different fodder yield characters of sorghum are reviewed here under.

Vijay Singh *et al.* (1983) studied five varieties of *S. bicolor* and reported a high positive correlation between green fodder yield and crude protein, sugar, fat and mineral constituents but a negative correlation with HCN and crude fiber.

Ful Pagare *et al.* (1983) reported that IVDMD of sorghum was positively correlated with crude protein content and negatively correlated with acid detergent fibre, neutral detergent fiber, cellulose, hemicellulose, lignin and silica contents.

Hiremath and Parvatikar (1985) studied 83 cultivars of sorghum and reported that high leaf area index at flowering was associated with high dry matter accumulation.

Selvi and Palanisamy (1987) examined 28 hybrids by crossing seven high juice, high sugar lines with four high yielding grain lines in a line x tester design. Total sugars, reducing sugars, green stalk yield and sucrose percentage were significantly and positively associated with sucrose content at both genotypic and phenotypic levels. Brix was positively and significantly associated with both extractable juice and green stalk weight at genotypic level.

Kaushik and Grewal (1988) studied 54 diverse genotypes of fodder sorghum for 11 component characters and reported that except for early vigor and days to 50 per cent flowering all the other components studied had significant and positive correlation with green as well as dry matter yields.

Bangarwa *et al.* (1989) evaluated 48 genotypes of sorghum for 10 characters and found that, green and dry fodder yields were positively correlated with stem girth and weight, leaves per plant and leaf weight. Dry fodder yield was also positively correlated with plant height and leaf breadth. It was suggested that selection for dry matter should be based on plant height and number of broad leaves.

Sood and Ahluwalia (1989) studied 26 cultivars of forage sorghum and observed that the green and dry matter yields were significantly and positively correlated with each other as well as with other characters, such as stem girth, leaves per plant, days to 50 per cent flowering and leaf breadth. The fodder yield in general was observed to be negatively associated with plant height and leaf stem ratio.

Bakhert (1990) studied mass and family selection for fresh forage in F_3 of *Sorghum bicolor*-sudangraas hybrids (Surdand) continuously for 3 generations upto F_6 . He concluded that there was a positive correlation between plant height and seasonal fresh and dry forage yield.

Jayamani and Dorairaj (1993) reported the presence of positive association between green biomass yield with plant height, leaf breadth, number of leaves, tillers per plant and stem diameter, whereas there was a negative correlation between days to 50 per cent flowering and leaf stem ratio.

Manickam and VijendraDas (1994 b) observed a positive correlation of green fodder yield with plant height, number of leaves, number of tillers, leaf area per plant, dry matter yield and crude protein. They also reported that there was a direct contribution of dry matter yield and number of leaves towards green fodder yield.

Patil *et al.* (1995) observed a significant positive correlation of fodder yield with days to 50 per cent flowering, brix at 50 per cent flowering and leaf area. The inter relationship between brix and leaf area at physiological maturity was also observed.

Mohamed Alikkhan *et al.* (1995) reported that straw yield was significantly and positively correlated with plant height, number of leaves, leaf length and leaf breadth. Plant height was correlated with number of leaves and leaf length but not with stem thickness and leaf breadth. They suggested that selection programme keeping plant height at a desirable level and making selection for number of leaves and leaf breadth is ideal for improving both grain yield and straw yields in the yellow grained sorghum.

Maiti *et al.* (1995) reported that crude protein content was significantly and negatively correlated with flag leaf area and positively with stem diameter and there was an inter correlation between lipid and days to 50 per cent flowering.

Raveendran *et al.* (1996 b) found that green fodder yield had significant positive correlation with days to flowering, number of tillers, leaf length breadth ratio and HCN content. They also observed a negative association between number of tillers and stem girth.

Sun *et al.* (1996) found that increased brix value in hybrids is associated with secondary tillers rather than main tillers and also observed a positive correlation between dry matter yield and plant height.

Jeyapraksh *et al.* (1997) reported the presence of a positive correlation between grain yield and dry fodder yield. Bazzocchi *et al.* (1997) observed a negative correlation between earliness, plant height and dry fodder yielding ability.

Desai *et al.* (1999) observed that fodder yield was significantly and positively correlated with plant height, number of leaves per plant, leaf length, total leaf area and basal tillering.

2.4. Stability and genotype x environment interaction:

Stability analysis helps in understanding the adaptability of crop varieties over a wide range of environmental conditions and in the identification of the most adaptable genotypes. The use of adaptable genotypes for general cultivation over a wide range of environmental conditions helps in achieving stabilization in crop production over locations and years.

The genotype x environment interaction is the interplay of genetic and non-genetic effects on the phenotypic expression and will be indicated by the failure of a genotype to give the same response in different environments (Frey and Horner, 1966). Verma and Gill (1975) were also of the opinion that failure of a genotype to give the same performance when grown under different environments is the reflection of the genotype x environmental interaction. G x E interaction was observed to be present in purelines and different types of hybrids. (Eberhart and Russel, 1966).

Stability analysis is done from the data of replicated trials conducted over several locations or for several years on the same location or both. When G X E interaction is found significant, the stability analysis can be carried out using one or different models proposed by different workers viz., Finley and Wilkinson (1963), Eberhart and Russel (1966), Perkins and Jinks (1968), Freeman and Perkins (1971) and Westcott (1986).

Lewis (1955) measured the phenotypic stability in terms of a stability factor (SF) as follows:

$$SF = \frac{\text{Mean performance in the highest yielding environment}}{\text{Mean performance in the lowest yielding environment}}$$

Generally, a variety having $b=1$ and high mean yield would be considered as the most widely adapted, while $b<1$ and a low mean yield would indicate a poorly adapted genotype. Thus Finlay and Wilkinson (1963) suggested linear regression as a measure of stability.

Eberhart and Russel (1966) made further improvement by partitioning the genotype-environmental interaction of each variety into two parts as:

1. The variation due to regression of phenotype on environmental indices measured in terms of deviations from overall mean, and
2. The unexplainable deviations from the regression. They emphasized on both linear and deviation from linear components of genotype-environmental interaction while judging stability of genotypes. Thus a stable variety is the one with high mean performance, average or above responsiveness to environment ($b=1$) and high stability ($S^2_d=0$). This model does not provide independent estimation for mean performance and environmental index. The stability can also be determined by the genotype grouping technique proposed by Francis and Kannenberg (1978).

Perkins and Jinks (1968) proposed a different model for stability analysis. Here also, three parameters as in Eberhart and Russel's model are calculated. But, variation is divided into three fractions i.e, genotypes, environments and G x E. The G x E is subdivided into heterogeneity due to regression and SS due to remainder. In this model also regression co-

efficient and deviation from the regression are used as the parameters of stability. This model also does not provide independent estimation for mean performance and environmental index.

Freeman and Perkins (1971) presented a better method for partitioning the sum of squares in stability analysis. In this model, the total variance is first divided into three components viz., 1. Genotypes 2. Environments 3. Interaction $G \times E$. The environmental SS is subdivided into two components namely (a) combined regression and (b) residual. The interaction variance is also subdivided into two parts viz., (a) homogeneity of regression and (b) residual 2. The residual SS form the pooled deviation in this model. It provides an opportunity to know about independent estimation of mean performance and environmental index.

Gupta *et al.* (1977) reported that the environmental and genotype - environmental interaction components of variance were the lowest in the populations derived from the combinations of highly stable parents. The phenotypic stability being seemingly under separate genetic control involving gene systems similar to those for other quantitative traits, it would be feasible to develop phenotypically stable and high potential genotypes by hybridization.

Despite the availability of different models, the model proposed by Eberhart and Russel (1966) is in common use as it is comparatively simple (Singh and Chaudhary, 1985). The recent studies on the performance of sorghum genotypes at varied environments have been made mostly through Eberhart and Russel's model and they are reviewed hereunder.

Diaz and Viera (1987) studied stability of sorghum cultivars over 14 locations and reported no correlation between yield and stability parameters. Some of the cultivars were found to be adapted to poor environments and some were most stable.

Mathur and Patil (1989) studied different sorghum varieties at four sites and found that some of the genotypes were well adapted to high yielding environments and low yielding genotypes showed best response to environmental variability.

Partition analysis of variance and regression of four hybrids in 18 environments by Wade *et al.* (1989) revealed the contribution of environmental effects up to 92 per cent of the total variance.

Kim *et al.* (1989) studied *Sorghum bicolor* X *S. sudanense* hybrid (GW 9110 G) at varying degrees of temperature for 10 days before cutting and after cutting plants from each temperature were transferred to the same temperatures for 20 days to study their regeneration. A temperature of 27°C before or after cutting gave the greatest plant height, tiller number, stem diameter, leaf area and shoot: root ratio in the regrowth. Increasing temperature increased dry weight and digestible dry matter weight but decreased IVDMD.

Bakhert (1990) studied the phenotypic and genotypic stability for green fodder and leafiness of 15 grain sorghum genotypes under different nitrogen fertilization levels. Phenotypic stability parameters revealed that the local introduction from Tahta was stable for total fresh forage yield. Genotypic stability parameters indicated that Dradow, 2723, 3541, local 29, hybrid 113 and local introductions from different places were highly stable for total fresh forage yield, while local commercial and Giheina were highly stable for leafiness percentage.

El-Shouny *et al.* (1990) studied 30 F₁ hybrids generated in a 10 x 3, L x T mating design at three locations. There were significant differences among the locations with respect to fresh and dry forage yield, protein and ash content.

Patel and Desai (1990) studied 110 sorghum hybrids generated in a 5 x 22, L x T mating system at four locations. There were significant differences among the locations with respect to plant height, panicle length, days to 50 per cent flowering and grain yield per plant and the trait 100-grain weight did not show significant differences among the locations. Fluctuating results were obtained for the interaction of *gca* and *sca* with locations.

Patil (1990) in his studies on the stability of sorghum hybrids over environments reported that variances due to genotypes and location x genotypes were highly significant. However, variances due to location x genotypes were comparatively less influenced by environments. The GCA x location, SCA x location interactions and variances due to GCA,

SCA and locations were highly significant for panicle weight and grain yield while the SCA x location interaction for 1000 grain weight was not significant. The *gca* effects were more stable for panicle weight, while *sca* effects were more stable for grain yield and 1000 grain weight.

Youngquist *et al.* (1990) observed significant genotype x environment interactions for grain yield and stover yield and they reported that cultivars that had been identified as stable in environments where rainfall was >400 mm/year were not the most stable in low rainfall environments. The results suggested that specific cultivars can be developed that has high stability in low yielding environments.

Yue and Liang (1990) compared three statistical models (proposed by Eberhart and Russel, Tai and Shukla respectively) to assess the yield stability of 10 hybrids grown in 17 environments. The Shukla model appeared to be less sensitive or more conservative than the other two models because of fewer hybrids showing significant stability estimates.

Patil *et al.* (1991) studied ten genotypes of sorghum at five different environments with respect to six yield and growth characters. Analysis of pooled data revealed a significant genotype x environment interaction for all traits. Stability parameter indicated that the best adapted genotype was SPV 346 for all characters and RSV 6 for fodder yield.

Rameshpal Singh *et al.* (1991) studied 66 F₁ hybrids from twelve varieties of forage sorghum involved in a partial diallele mating system. They observed a significant genotype x environment interaction for grain yield and 100 grain weight.

Khan (1992) in his studies on the stability of single, three way and double cross sorghum hybrids found that single crosses were higher yielding but generally unstable than the other two group of hybrids.

Ombakho and Miller (1994) studied single cross hybrids and three way cross hybrids of sorghum in eight environments in Texas. The regression coefficient of three way crosses

was greater than 1.0 indicating their responsiveness to better environments, and their above average mean yield made them the most stable group.

Sanjari and Redai (1994) found that varieties Jabo and Speed feed had average fresh weight yields of 82.64 and 80.24 t/ha respectively and showing regression co-efficients very close to unity. They gave significantly better yields than the average yields of the seven new sorghum varieties and hybrids.

Santes *et al.* (1995) reported that year was a significant source of variation for all yield components and rainfall distribution play a major role for year x hybrid interactions.

Chisi *et al.* (1996) studied one-hundred full-sib families derived from a broad based population of sorghum evaluated at three locations over two years. The interaction of full sib families with the individual environments was high. The use of mean productivity, rank summation and selection index using a sub set of the environments to select for genotypes with consistent high yield across the environments or stability were predicted to be ineffective. The score from principle component analysis of the G x E matrix was found to be the best method for identifying stable genotypes in full sib families.

McCaughey *et al.* (1996) studied the effects of genotype and environment on dry matter yield of seven forage sorghum genotypes evaluated in six different environments. Genotype, environment and G x E interaction accounted for 3.9, 84.8 and 3.3 per cent respectively of the total variation in dry matter yield and the relative rankings of varieties differing across environments indicated that yield is unstable.

Oosterom *et al.* (1996) observed significant genotype x environment interaction for stay green trait (a component for post flowering drought tolerance), in a nine parents in a complete diallele experiment evaluated over two years in post rainy season.

Sarhan *et al.* (1996) studied eight imported sorghum (*Sorghum bicolor* x Sudangrass - *S. sudanense*) hybrids at five locations. Average fresh weight and dry matter yields were highest in hybrid PSS 079 although differences were not significant at all sites.

Narkhede *et al.* (1997) studied 18 kharif sorghum hybrids for their grain and fodder yield stability at five locations. They observed that the variance due to environment was significant for both grain and fodder yield and there was considerable interaction between cultivars and environment. The hybrid SPH 821 was the most stable for grain yield and SPH 792 was the most stable for fodder.

Kim *et al.* (1998) studied 11 sorghum sudangrass hybrids at five sites in the Korean Republic. They reported that Cv. NC + 855 gave the highest fodder yield at three of the sites averaged over sites and year.

Narkhede *et al.* (1998a) studied eleven hybrids along with a variety M 35-1, for grain and fodder yield during rabi at three locations. Both linear and non-linear components of genotype environment interaction played an important role for the expression of both traits. Hybrid SPH 634 was found to be the most stable for fodder yield and possessed good general adaptability.

Narkhede *et al.* (1998b) studied twelve kharif sorghum varieties for grain and fodder yield performance over five locations. They observed that linear and non-linear components played an important role in the expression of both grain and fodder yield traits. The variety CSV 15 had both high grain and fodder yield with good stability. Narkhede *et al.* (1998 c) observed significant G x E interaction for grain and fodder yield in seven genotypes evaluated over five environments. Among the different varieties SPV 489 was the most stable for fodder yield.

Kumar *et al.* (1999) studied 21 sorghum genotypes grown over three years to identify dual purpose varieties suitable for low rainfall alfisols. Grain equivalent was considered as a better index than grain or fodder for identifying the best dual purpose variety. Based on stability parameters SPV 669 and IS 6992 were found to be the best suitable varieties for unfavorable environmental conditions.

Chapman *et al.* (2000) studied the characteristics that confound interpretation of hybrid yield by analysing three data sets for G x E interaction over 9-17 years and upto 30 locations. They reported that trial means varied 2-3 fold across seasons and a greater range was observed for variance components like trial error (range of 0.05-0.5), genotype (0->0.3) and G x L interaction (0.05->1.0). There was substantial seasonal variation in the ratio of σ^2_g to $\sigma^2_g + \sigma^2_{gl}$ and in two data sets, 73 per cent of the seasonal variation was accounted by σ^2_{gl} due to poor genetic correlations among locations. It implied that any given set of hybrids in a random set of locations would be ranked differently from season to season. Analysis of locations over years detected 90 percentage of the total G x E interaction as G x L x Y, rather than G x L or G x Y, although this was reduced by accounting for genotype maturity. They concluded that to achieve repeatability of >80 per cent, trials would need to be conducted over at least five years and 20 locations per year. The variable and unpredictable nature of much of the G x E interaction in the region implies that broad adaptation to different water regimes is required, unless prior knowledge of the seasonal weather can be used to choose narrowly adapted cultivars. With current approaches, a large sample of environments is needed to identify such hybrids and testing across locations and year is equally important.

Additive Main and Multiplicative Interaction (AMMI) Analysis:

The AMMI model is essentially a combination of ANOVA and Principal Component Axis (PCA) analysis. It applies PCA to the GE interaction part of the ANOVA. Because of this, the AMMI model is also called IPCA (interaction PCA). Although PCA and ANOVA were developed in 1901 and 1918, respectively, they were not combined to form AMMI until 1952. Kempton (1984) seems to have been the first to apply AMMI to the study of GE interaction.

AMMI is theoretically the most effective model to account for the GE interaction sum of squares with a minimum number of degrees of freedom. A full AMMI model (AMMI-F) equates to the ANOVA model, since all the sum of squares due to GE interaction are explained by the axes. AMMI with one axis is most effective, since it frequently gives the minimum predictive errors. Following the analysis of a soybean multilocation trial by Zobel *et al.*

(1988), the AMMI model has become popular for quantifying the GE interaction for yield (Gauch and Zobel, 1996 and Yan and Hunt, 1998).

In addition to its effectiveness in accounting for the GE interaction, the AMMI model has several important features. First, it quantifies both the contributions to the GE interaction sum of squares for each genotype and each environment simultaneously. Second, the hypothesized variables can be easily related to the real environment and /or genotypic variables, thus facilitating biological interpretation of the GE interaction. Third, the AMMI quantified environmental and genotypic scores can be conveniently displayed in the form of a "biplot". Using the biplot technique, the genotypes and the environments can be mutually classified at the same time. An AMMI biplot with the main effects plotted against the IPCAI scores of both the genotypes and the environments can usually explain > 90 per cent of the total sum of squares of a two-way table.

In general, by examining an AMMI biplot the genotypes that gave the highest average yield across the environments, the environments that gave the highest average yield across the genotypes, the positive and negative GE combinations, the best (worst) genotypes for a given environment, genotypes that are most (or least) responsive to the environment and environment (s) that best (least) differentiate the genotypes are known.

Materials and methods

•

III. MATERIALS AND METHODS

3.1. MATERIALS:

The experimental materials consisted of four male sterile lines and their maintainers and twenty-one restorers of *Sorghum bicolor* (L.) Moench. The details of the materials are presented in Table-1.

The present investigation was carried out at the Forage Crops Department farm, Center for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore.

3.2. Crossing programme:

The four lines (female parents) and twenty one testers (male parents) were raised in rows of 3 m length with a spacing of 45 cm x 15 cm during summer 1999. Three staggered sowings were taken up to effect maximum number of crosses by getting synchrony in flowering to produce sufficient crossed seeds. Each of the four lines were crossed with each of twenty-one testers in line x tester fashion and 84 cross combinations were produced.

Male sterile lines were bagged just after the tip of the head began to flower. The flowering tips were cut off and the head was bagged. The date was written on all head bags to simplify the search of receptive heads. It took 3 to 5 days for a head to flower fully. In case of restorer, the panicle was covered with Kraft paper bags just before anthesis and pollination was effected by collecting pollen from the chosen male parents and dusting on the panicle of the female parents, which were receptive. Dusting of pollen was repeated for three consecutive days for each panicle. Contamination from foreign pollen was prevented by covering the panicle of the female with kraft paper cover immediately after pollination. At maturity, the crossed seeds were collected carefully and stored in paper bags after proper drying.

3.3. Study of F₁ hybrids:

The eighty four F₁ hybrids along with their twenty five parents (four lines and twenty one testers) and one ruling check variety Co 27 were raised in a randomized block design

Table 1. Details of the experimental materials

Sl.No	Genotypes	Attributes	Source
1	296A/B	Grain sorghum types	Millet Breeding station Tamil Nadu Agricultural University Coimbatore
2	2219A/B		
3	2077A/B		
4	111A/B		
5	68716	Stay green types from ICRISAT derivatives of <i>S. sudanense</i> with <i>S. bicolor</i>	International Crop Research Institute for Semi Arid Tropics Hyderabad
6	68740		
7	68918		
8	68786		
9	68814		
10	FS211	Sweet sorghum types Sweet sorghum types Sweet sorghum types Sweet sorghum types SSV74 / SSV 84 CO 27 / <i>S. halepense</i> SPV881 / <i>S. arundinaceum</i> CO 22 / <i>S. arundinaceum</i>	Department of Forages Tamil Nadu Agricultural University Coimbatore
11	FS205		
12	FS9401		
13	SS003		
14	SS012		
15	SS020		
16	SRV605		
17	FS9604		
18	FS9605		
19	FS9601		
20	FS9603		
21	68710	Stay green types from ICRISAT derivatives of <i>S. sudanense</i> with <i>S. bicolor</i>	International Crop Research Institute for Semi Arid Tropics Hyderabad
22	68724		
23	68726		
24	SS032	Sweet sorghum types CO 11 / <i>S. halepense</i>	Department of Forages Tamil Nadu Agricultural University Coimbatore
25	Co27		

with three replications by adopting 30 cm x 15 cm spacing during winter 2000. All the agronomic practices were followed to maintain the crop stand.

The biometrical observations on fodder yield and other related yield components were recorded on five randomly selected plants from each variant per replication at the time of 50 per cent flowering. The replication wise mean values of the genotypes were subjected to statistical analysis.

After the completion of first cut the same experimental materials were allowed to grow as a ratoon crop. Similar package of practices was followed as that of first crop and at the time of 50 per cent flowering biometrical observations were taken and tabulated. In the same way third, fourth and fifth cuts were allowed to study the ratooning ability / multicut habit of the experimental materials. Observations were taken on each cut and were tabulated for further statistical analysis.

3.4. Observations recorded:

The following observations were recorded on the plants at 50 per cent flowering for fodder characteristics.

3.4.1. Days to 50 per cent flowering:

Days taken from sowing to flowering when anthesis was half way down the ear in 50 per cent of population was recorded.

3.4.2. Plant height:

Height of the plant from ground level to the tip of the ear of the main stem in centimeters was recorded.

3.4.3. Number of tillers:

Total number of tillers per plant was counted and recorded.

3.4.4. Number of leaves:

Number of leaves on the main tiller were counted.

3.4.5. Leaf length:

Length of the fourth leaf from top from its base to the tip was recorded in centimeters.

3.4.6. Leaf breadth:

Breadth of the fourth leaf blade at its widest point was expressed in centimeters.

3.4.7. Stem thickness:

Diameter or width of the fourth internode from the top, was measured with the help of Calipers and recorded in centimeters.

3.4.8. Leaf stem ratio:

Weight of leaves of a single plant, divided by weight of the stem of the same plant was expressed as leaf stem ratio.

3.4.9. Total soluble solids (TSS):

Juice was extracted from the fourth internode of the main stem below the panicle. (Monk *et al*, 1985). Standard Brix hygrometer was used to determine the brix value of the extracted juice and suitable temperature corrections were made to obtain the corrected TSS value in percentage.

3.4.10. HCN content:

HCN content was determined according to the methodology adopted by Hogg and Ahlgren (1942) and was expressed in parts per million (ppm).

3.4.11. Crude protein:

The crude protein content was estimated using the methodology adopted by Humphires (1956). The total nitrogen was multiplied by factor 6.25 to get crude protein estimate and was expressed in percentage.

3.4.12. Dry fodder yield:

Dry matter content was determined according to the method given in AOAC (1970) and was expressed in percentage and dry fodder yield was estimated from green fodder yield by using dry matter content and was recorded in grams.

3.4.13. Green fodder yield per plant:

Total weight of the entire plant immediately after harvest was expressed in grams.

3.4.14. Green fodder yield per plot:

Green fodder yield per plant was multiplied with the total number of plants present at each cut and green fodder yield per plot was expressed in kg per plot (4.88m²).

3.5. STATISTICAL PROCEDURE:

3.5.1. Unit Analysis :

Data obtained from individual environments (cuts) were subjected to analysis of variance as per Panse and Sukhatme (1961).

The pooled analysis of variance was carried out using the average data from all the four environments (cuts).

Analysis of variance for individual environments (cuts)

Source	df	MS	Expectation of MS
Replication	(r-1)		
Genotypes	(g-1)	M_g	$V_e + rV_g$
Error	(r-1)(g-1)	M_e	V_e
Total	(rg-1)		

r = number of replications

g = number of genotypes

M_g = mean squares for genotypes

M_e = mean squares of error

V_e = error variance

V_g = genotypic variance

Pooled analysis of variance over the environments(cuts)

Source	df	MS	Expectation of MS
Replications within environment	$s(r-1)$	-	
Environments	(s-1)	M_s	$\sigma^2_e + r\sigma^2_{gs} + r\sigma^2_s$
Genotypes	(g-1)	M_g	$\sigma^2_e + r\sigma^2_{gs} + r\sigma^2_g$
Genotypes x Environments	(g-1)(s-1)	M_{gs}	$\sigma^2_e + \sigma^2_{gs}$
Pooled error	$s(r-1)(g-1)$	M_e	σ^2_e

The estimates of genotypic variance (σ^2_g) and Genotype x Environmental interaction variance (σ^2_{gs}) were obtained as given below.

$$\sigma^2_g = M_g - M_{gs}/rs$$

$$\sigma^2_{rgs} = M_{gs} - M_s/r$$

Where,

r = number of replications

s = number of environments or situations

3.5.2. Line x Tester analysis:

3.5.2.1. Line x Tester analysis for individual environments (cuts)

The combining ability analysis was carried out individually for all the four environments as per the method suggested by Kempthorne (1957). The mean squares due to different sources of variation in each environment as well as the genetic expectations were estimated as indicated in ANOVA table given below.

ANOVA for Line x Tester analysis including parents for individual environments

Source	Degrees of Freedom	Means square	Expectation of mean square
REPLICATION	r-1	M_r	
GENOTYPES	g-1	M_g	
Parents	l+t-1	M_p	
Lines	l-1	$M_l = M_1$	$\sigma^2_e + r(\text{Cov.FS} - 2\text{Cov.HS}) + rt(\text{Cov.HS})$
Testers	t-1	$M_t = M_2$	$\sigma^2_e + r(\text{Cov.Fs} - 2\text{Cov.HS}) + rl(\text{Cov.HS})$
Lines vs Testers	1	$M_{l \times t}$	
Hybrids	lt-1	M_h	
Lines effect	l-1	M_{leff}	
Tester effect	t-1	M_{teff}	
Lines x testers effect	(l-1)(t-1)	$M_{l \times t} = M_3$	$\sigma^2_e + r(\text{Cov.FS} - 2\text{Cov.HS})$
Parents vs Hybrids	1	$M_{p \text{ vs } h}$	
ERROR	(r-1)(lt-1)	$M_e = M_4$	σ^2_e
TOTAL	rlt-1		

Where,

r = number of replications

l = number of lines

t = number of testers

g =number of genotypes (lines +testers)

Estimation of combining ability variances and genetic components:

From the genetic expectations of mean squares, the covariances of full sibs (Cov. FS) and half sibs (Cov.HS) were estimated as given below.

$$\begin{aligned} \text{Cov. (HS)} &= \frac{(M_1 - M_{bt}) + (M_r - M_{bt})}{r(l+t)} = \frac{(M_1 - M_3) + (M_2 - M_3)}{r(l+t)} \\ \text{Cov. (FS)} &= \frac{(M_1 - M_e) + (M_t - M_e) + (M_{bt} - M_e) + 6r(\text{Cov.HS}) - r(l+t)(\text{Cov.HS})}{3r} \\ &= \frac{(M_1 - M_4) + (M_2 - M_4) + (M_3 - M_4) + 6r(\text{Cov.HS}) - r(l+t)(\text{Cov.HS})}{3r} \end{aligned}$$

From the above parameters, variance due to general combining ability (GCA) and variance due to specific combining ability (SCA) were estimated as follows

Variance due to general combining ability (σ^2_{GCA}) = Cov.HS

Variance due to specific combining ability (σ^2_{SCA}) = Cov.FS- 2(Cov.HS)

The narrow sense heritability and genetic advance were calculated from the estimates of general combining ability (GCA) and specific combining ability (SCA) variances as given below (Singh and Narayanan, 1993).

Heritability (Narrow sense) $H = [V_{gca} / (V_{gca} + V_{sca} + V_e)] \times 100$

Where, V_e is Error variance

Genetic Advance $= H \times \sqrt{\sigma^2 p} \times k$

Where,

H = percentage of heritability in narrow sense,

k = selection differential (2.06) at 5 per cent level of significance

$\sigma^2 p$ = phenotypic standard deviation (square root of phenotypic variance)

The variances of epistasis, additive, dominance and degree of dominance components were estimated as per the method suggested by Singh and Narayanan (1993).

Estimation of *gca* and *sca* effects:

The model used to estimate the combining ability effects was as follows:

$$X_{ijk} = \mu + g_i + g_j + s_{ij} + e_{ijk}$$

Where,

μ = population mean

g_i = *gca* effect of i^{th} line

g_j = *gca* effect of j^{th} tester

s_{ij} = *sca* effect of ij^{th} hybrid

e_{ijk} = error associated with ijk^{th} observation

i = number of lines

j = number of testers and

k = number of replications

The individual effects were estimated as indicated below:

$$\text{Mean } (\mu) = \frac{\sum x \dots}{r \cdot l \cdot t}$$

$$gca \text{ effects of lines } (g_i) = \frac{x_{i..}}{rt} - \frac{x_{...}}{rlt}$$

$$gca \text{ effects of lines } (g_j) = \frac{x_{.j.}}{rl} - \frac{x_{...}}{rlt}$$

$$sca \text{ effects of hybrids } (s_{ij}) = \frac{x_{ij.}}{r} - \frac{x_{i..}}{rt} - \frac{x_{.j.}}{rl} + \frac{x_{...}}{rlt}$$

Where,

- $x_{...}$ = Total number of hybrid combinations over 'r' replications
- $x_{i..}$ = total of i^{th} line over all testers and replications
- $x_{.j.}$ = total of j^{th} tester over all lines and replications
- $x_{ij.}$ = total of hybrid between i^{th} line and j^{th} tester over all replications

The standard error pertaining to *gca* effects of lines and testers and *sca* effects of hybrids were calculated as follows.

$$SE (g_i) (\text{lines}) = \sqrt{\sigma^2 e / rt} = \sqrt{M_e / rt}$$

$$SE (g_j) (\text{testers}) = \sqrt{\sigma^2 e / rl} = \sqrt{M_e / rl}$$

$$SE (s_{ij}) (\text{hybrids}) = \sqrt{\sigma^2 e / r} = \sqrt{M_e / r}$$

't' value was calculated by using the formula,

$$t = \text{parameter} / SE$$

The calculated 't' value was compared with table 't' value at error degrees of freedom to test the significance.

The ratio of σ^2_{gca} : σ^2_{sca} was worked out for each character to find out the predominance of additive or non additive gene action.

3.5.2.2. Pooled Line x Tester analysis

To understand the real picture of genetic architecture of hybrids and their parents in different environments, the data from four environments (cuts) were subjected to pooled analysis (Eli-itriby *et al.*, 1981)

The model used for analysis was

$$X_{ijk_r} = \mu + l_i + t_j + (lt)_{ij} + s_k + (ls)_{ik} + (ts)_{jk} + (lts)_{ijk} + e_{ijk_r}$$

Where,

X_{ijk_r}	=	value of the ijk_r^{th} observation
μ	=	Overall mean
l_i	=	<i>gca</i> effect of the i_{th} line
t_j	=	<i>gca</i> effect of the j_{th} tester
$(lt)_{ij}$	=	<i>sca</i> effect of the hybrid
s_k	=	effect of the k_{th} environment
$(ls)_{ik}$	=	i_{th} line and k_{th} environment interaction effect
$(ts)_{jk}$	=	j_{th} tester and k_{th} environment interaction effect
$(lts)_{ijk}$	=	hybrids x environment interaction effect
e_{ijk_r}	=	random error effects associated with ijk_r^{th} observation
l	=	number of lines
t	=	number of testers
s	=	number of environments/situations
r	=	number of replications

The mean squares due to different sources of variation in each experiment as well as the genetic expectations were estimated as indicated in the pooled ANOVA table given below.

Pooled ANOVA for Line x tester analysis including parents over environments

Source	Degrees of freedom	Mean square	Expectation of mean square
REPLICATIONS	$r-1$	M_r	-
ENVIRONMENTS(ENV)	$s-1$	M_s	-
REPLICATIONS X ENV	$(r-1)(s-1)$	M_{sr}	-
GENOTYPES	$l+t+lt-l=g-1$	M_g	-
Parents	$l+t-1$	M_p	-
Lines	$l-1$	$M_l = M_1$	$\sigma^2_e + r\sigma^2_{ls} + r\sigma^2_{ts} + r\sigma^2_{lt} + r\sigma^2_l$
Testers	$t-1$	$M_t = M_2$	$\sigma^2_e + r\sigma^2_{ls} + r\sigma^2_s + r\sigma^2_{lt} + r\sigma^2_t$
Lines vs Testers	1	$M_{l \text{ vs } t}$	-
Hybrids	$l+t-1$	M_h	-
Lines effect	$l-1$	M_{leff}	-
Testers effect	$t-1$	M_{teff}	-
Lines x Testers effect	$(l-1)(t-1)$	$M_{ld} = M_3$	$\sigma^2_e + r\sigma^2_{ls} + \sigma^2_{lt}$
Parents vs Hybrids	1	$M_{p \text{ vs } h}$	-
GENOTYPES x ENV.	$(s-1)(g-1)$	M_{gs}	-
Parents x Environments	$(s-1)(l+t-1)$	M_{ps}	-
Lines x Environments	$(s-1)(l-1)$	M_{ls}	-
Testers x Env	$(s-1)(t-1)$	M_{ts}	-
Lines vs Testers x Env.	$(s-1)$	$M_{(l \text{ vs } t)s}$	-
Hybrids x Environments	$(s-1)(l+t-1)$	M_{hs}	-
Lines effect x Env.	$(s-1)(l-1)$	$M_{(leff)s} = M_4$	$\sigma^2_e + r\sigma^2_{ls} + r\sigma^2_{ls}$
Testers effect x Env.	$(s-1)(t-1)$	$M_{(teff)s} = M_5$	$\sigma^2_e + r\sigma^2_{ls} + r\sigma^2_{ts}$
Lines x Test.eff. x Env.	$(s-1)(l-1)(t-1)$	$M_{(lxs)s} = M_6$	$\sigma^2_e + r\sigma^2_{ls}$
Parents vs Hybrids x Env.	$(s-1)$	$M_{(p \text{ vs } h)s}$	-
ERROR	$s(g-1)(r-1)$	$M_e = M_7$	σ^2_e
TOTAL	$grs-1$		

Where,

s = number of environments

σ^2_l = variance due to lines

σ^2_t = variance due to testers

σ^2_{lt} = variance due to Lines x Testers interaction

σ^2_{ls} = variance due to Lines x Environments interaction

σ^2_{ts} = variance due to Testers x Environments interaction

σ^2_{lts} = variance due to (Lines x Testers) x Environments interaction

Estimation of variance components was done by equating mean squares to expectations and sorting out for the appropriate components.

$$\begin{aligned}
 \sigma^2_l &= \frac{M_l - M_{lxt} - M_{(leff)s} + M_{(lxt)s}}{rts} = \frac{(M_1 - M_3 - M_4 + M_6)}{rts} \\
 \sigma^2_t &= \frac{M_t - M_{lxt} - M_{(teff)s} + M_{(lxt)s}}{rls} = \frac{(M_2 - M_3 - M_5 + M_6)}{rls} \\
 \sigma^2_{lt} &= \frac{M_{lxt} - M_{(lxt)s}}{rs} = \frac{(M_3 - M_6)}{rs} \\
 \sigma^2_{ls} &= \frac{M_{(leff)s} - M_{(lxt)s}}{rt} = \frac{(M_4 - M_6)}{rt} \\
 \sigma^2_{ts} &= \frac{M_{(teff)s} + M_{(lxt)s}}{rl} = \frac{(M_5 - M_6)}{rl} \\
 \sigma^2_{lts} &= \frac{M_{(lxt)s} - M_s}{r} = \frac{(M_6 - M_7)}{r}
 \end{aligned}$$

Likewise variance components for GCA, SCA and their respective interactions with the environment were calculated as below.

$$\begin{aligned}
 \sigma^2_{GCA} &= \frac{M_l + M_t - 2M_{lxt} - M_{(leff)s} - M_{(teff)s} + 2M_{(lxt)s}}{rs(l+t)} = \frac{(M_1 + M_2 - 2M_3 - M_4 - M_5 + 2M_6)}{rs(l+t)} \\
 \sigma^2(GCA \times E) &= \frac{M_{(leff)s} - M_{(teff)s} + 2M_{(lxt)s}}{r(l+t)} = \frac{(M_4 + M_5 + 2M_6)}{r(l+t)} \\
 \sigma^2_{SCA} &= \sigma^2_{lt} \\
 \sigma^2(SCA \times E) &= \sigma^2_{lts}
 \end{aligned}$$

Estimation of general and specific combining ability effect of ijk_{th} observation in case of combined estimate was carried out as was done for the individual environment, except that

the total of all replications over the four environments was used for two way table of Lines vs Testers and the denominator in all cases was $rlts$ instead of rlt .

For calculation of standard error effects, the same treatments were used as in case of individual environment except the denominator which increase by multiplication of number of environments.

3.5.3. Estimation of heterosis:

Heterosis values were worked out by utilizing the overall mean of each parent or hybrid in all three replications for each character. Relative heterosis was estimated as per cent deviation of the F_1 hybrid from its mid parental value. Heterobeltiosis for each character, in each hybrid combination was expressed as per cent increase or decrease of F_1 value over better parental value. Standard heterosis was estimated as a difference between the mean of the F_1 and that of the standard commercial varietal check CO 27. The three types of heterosis were estimated using the following formulae

$$\text{Relative heterosis (d)} = \frac{\overline{F_1} - \overline{MP}}{\overline{MP}} \times 100$$

$$\text{Heterobeltiosis (dii)} = \frac{\overline{F_1} - \overline{BP}}{\overline{BP}} \times 100$$

$$\text{Standard heterosis (diii)} = \frac{\overline{F_1} - \overline{SP}}{\overline{SP}} \times 100$$

Where,

$\overline{F_1}$ = mean of the hybrid

$\overline{MP}$ = mean of the two parents involved in the hybrid combination

$\overline{BP}$ = mean of better parent hybrid combination

$\overline{SP}$ = mean of the standard parent, CO 27

The significance of heterosis was estimated by 't' test using the formulae (Wynne *et al*, 1970)

$$\text{SE of Relative heterosis (di)} = \frac{\overline{F_{ij}} - \overline{MP_{ij}}}{\sqrt{(3/2)(\sigma^2 e/r)}}$$

$$\text{SE of Heterobeltiosis(dii)} = \frac{\overline{F_{ij}} - \overline{BP_{ij}}}{\sqrt{2 \sigma^2 e/r}}$$

$$\text{SE of standard heterosis (diii)} = \frac{\overline{F_{ij}} - \overline{SP}}{\sqrt{2 \sigma^2 e/r}}$$

where,

$\overline{F_{ij}}$ = mean of the ij^{th} cross

$\overline{MP_{ij}}$ = mean of mid parent value for ij^{th} hybrid

$\overline{BP_{ij}}$ = mean of better parent value for ij^{th} hybrid

$\overline{SP}$ = mean of standard heterosis

$\sigma^2 e$ = estimate of variance

3.5.4. Score chart:

Score chart based on mean performance and gca effects of parents, and mean performance, standard heterosis and sca effects of hybrids was prepared as follows (Thenmozhi, 1983).

Score 1 = Positive significant performance over general mean , or gca or sca effects or standard heterosis

Score 0 = Non-significant values for the above parameters

Score -1 = Negative significant values for the above parameters

The total score for each parent or hybrid over the characters was worked out and utilized to classify the parents as high (H) or low (L) combines, and the hybrids as the high (H) or Low (L) combinations. Parents or hybrids receiving a zero total score due to

cancellation of + and - effects over component characters were also classified as H, since the final score was neutral.

In the case of characters like days to 50 per cent flowering and hydrocyanic acid, parents or hybrids recording negative significance were given a +1 score and vice versa, since earliness and low HCN content respectively are desirable traits in a breeding programme.

3.5.5. Association analysis

The genotypic correlation coefficients among all the combinations of characters for each environment were computed using variance and covariance components as per the formula suggested by Robinson *et al.*, (1951)

$$r_g(x_1, x_2) = \frac{\text{CoV}_g(x_1, x_2)}{\sqrt{\sigma^2_g(x_1) \times \sigma^2_g(x_2)}}$$

Where,

$r_g(x_1, x_2)$ = correlation co-efficient between characters x_1 and x_2 in each environment.

CoV_g = genotypic covariance of the characters x_1 and x_2 in the corresponding environment.

$$= (\text{MSP}_g - \text{MSP}_e) / r$$

Where,

MSP_g = genotype mean sum of products for x_1 and x_2

MSP_e = error mean sum of products for x_1 and x_2

r = number of replications

$\sigma^2_g(x_1)$ and $\sigma^2_g(x_2)$ = genotypic variance of x_1 and x_2 in the corresponding environment

$$= (M_g - M_e) / r \text{ for } x_1 \text{ or } x_2$$

where,

M_g = genotype mean square for x_1 or x_2

M_e = error mean square for x_1 or x_2

r = number of replications

The significance of correlation co-efficient was tested with reference to the 't' table given by Snedecor and Cochran (1967) with n-2 degrees of freedom.

3.5.6. Path coefficient analysis

Path coefficient analysis was done for different characters to findout direct and indirect effects using the correlation coefficients in individual environments as suggested by Wright (1921) and Dewey and Lu (1959).

By keeping fodder yield as dependent variable and other characters as independent variables, simultaneous equations, which expressed the basic relationship between path co-efficients, were solved to estimate the direct and indirect effects. The direct and indirect effects were classified based on the following scale (Lenka and Mishra, 1973)

> 1.0	-	very high
0.30 - 0.99	-	high
0.20 - 0.99	-	moderate
0.10 - 0.19	-	low
0.00 - 0.09	-	negligible

3.5.7. STABILITY ANALYSIS

3.5.7.1. Eberhart and Russell's model

The stability parameters namely (i) overall mean of each variety over a range of environments/situations, (ii) regression coefficient (b_i) and (iii) mean squared deviation from resression (S^2_{di}) for each genotype were estimated based on the model proposed by Eberhart and Russel (1966) as detailed below.

$$Y_{ij} = \mu_i + b_i I_j + \delta_{ij} \quad (i = 1, 2, \dots, g \text{ and } j = 1, 2, \dots, s)$$

Where,

Y_{ij} = mean performance of i^{th} genotype in j^{th} environment

μ_i = mean performance of i^{th} genotype over all environment

b_i = regression coefficient that measures the response of the i^{th} genotype to varying environments

δ_{ij} = deviation from regression of the i^{th} genotuype at j^{th} environment

I_j = environmental index as the deviation of the mean of all genotypes in j^{th} environment from grand mean.

Analysis of variance of stability

The analysis of variance as proposed by Eberhart and Russel (1966) is given below:

ANOVA for stability

source	Df	Sum of squares	Mean squares
Total	(gs-1)	$\sum_{ij} Y_{ij}^2 - CF$	
Genotype	(g-1)	$1/s \sum_i Y_i^2 - CF$	M_g
Environment+(GxE)	g(s-1)	$\sum_{ij} Y_{ij}^2 - \sum_i Y_i^2 / s$	M_{gs+s}
Environment (linear)	1	$1/g (\sum_j Y_{.j} I_j)^2 / \sum_j I_j^2$	M_s
Genotype xEnv.(linear)	g-1	$\sum_i [(\sum_j Y_{ij})^2 / \sum_j I_j^2] - [1/g (\sum_j Y_{.j} I_j)^2 / \sum_j I_j^2]$	M_{gs}
Pooled deviation	g(s-2)	$\sum_{ij} \delta_{ij}^2$	M_{pd}
Deviation due to individual genotype	s-2	$(\sum_j Y_{ij})^2 e - (Y_i^2 / g) - [(\sum_j Y_{.j} I_j)^2 / \sum_j I_j^2]$	M_{gi}
Pooled error	s(r-1)(g-1)	$\sigma^2 e$	M_e
G =genotype		S = environment/situation	r =replication

Estimation of stability parameters

The regression coefficient (b_i) and mean square deviation from the linear regression (S^2_d) were estimated as given below.

a) Computation of regression coefficient

The regression coefficient is the regression of the performance of each genotype under different environments on the environmental means of overall genotypes. This was estimated as detailed below:

$$b_i = \sum_j Y_{ij} I_j / \sum_j I_j^2$$

Where,

$\sum Y_{ij}I_j$ = the sum of products of environment index (I_j) with corresponding mean of that genotype at each environment (Y_i)

$\sum I_j^2$ = the sum of the squares of the environmental index (I_j)

Y_{ij} = Mean of i^{th} variety in j^{th} environments

$I_j = \sum Y_{ij}/g - \sum \sum Y_{ij}/gs$ with $\sum I_j = 0$

b) Computation of mean square deviation

Computation of mean square deviation (S^2_{di}) from linear regression was done as given below.

$$S^2_{di} = \frac{\sum \delta_{ij}^2}{s-2} - \frac{M_e}{r}$$

where,

$$\sum \delta_{ij}^2 = (\sum Y_{ij}^2 - (Y_i^2/g) - [(\sum Y_{ij} I_j)^2 / \sum I_j^2])$$

= variance due to deviation from the regression for a genotype

where,

$(\sum Y_{ij}^2 - (Y_i^2/g))$ = variance due to dependent variable

$$[(\sum Y_{ij} I_j)^2 / \sum I_j^2] = [(\sum Y_{ij} I_j) (\sum Y_j I_j)] / \sum I_j^2 = b_i \sum Y_{ij} I_j$$

= variance due to regression

and $M_e = \frac{\sigma^2_e}{s(r-1)(g-1)} = \text{Mean square for pooled error from ANOVA table}$

Where,

s = number of environments / situations

g = number of genotypes

r = number of replications

c) Tests of significance

The following tests of significance were carried out

1. To test the significance of the difference among genotype means namely, $H_0 = \mu_1 = \mu_2 = \mu_3 \dots \mu_{109}$, the F test used was,

$$F = \frac{\text{MS due to genotypes}}{\text{MS due to pooled deviation}} = \frac{M_g}{M_{pd}}$$

2. To test that the genotypes did not differ due to regression on environmental index i.e., $H_0 = b_1 = b_2 \dots b_{109}$, the 'F' test used was,

$$F = \frac{\text{MS due to genotypes x Environments (linear)}}{\text{MS due to pooled deviation}} = \frac{M_{gs}}{M_{pd}}$$

3. Individual deviation from linear regression was tested as below,

$$F = \frac{\sum_j \delta_{ij}^2 / (s-2)}{\text{pooled error}}$$

4. The hypothesis that any regression coefficient does not differ from unity was tested by the appropriate 't' test at (s-2) df using the formula,

$$t = \text{parameter} / \text{SE}(b_i)$$

$$\text{SE}(b) = \sqrt{\frac{\text{MS due to pooled deviation}}{\sum_j I_j^2}} = \sqrt{\frac{\sum_i \sum_j \delta_{ij}^2 / s-2}{\sum_j I_j^2}}$$

$$\text{SE}(b_i) = \sqrt{\frac{\text{MS due to pooled deviation of } i^{\text{th}} \text{ variety}}{I_j^2}} = \sqrt{\frac{\sum_j \delta_{ij}^2 / s-2}{I_j^2}}$$

5. Population mean (μ) and standard error were calculated as

$$\text{Population mean } (\mu) = \frac{\text{Grand total}}{\text{Number of observations}}$$

$$\text{SE of Mean} = \sqrt{\frac{\text{MS due to pooled deviation}}{\text{Number of environments}-1}}$$

Association of stability parameters

Association between stability parameters viz., mean ($\bar{x}$), regression coefficients (b_i) and deviation from regression (S^2_{di}) were worked out by using the method suggested by Goulden (1952).

Stable genotype

A genotype with deviation not significantly differing zero ($S^2_{di} = 0$) was taken to be a stable genotype.

3.5.8. Additive Main effects and Multiplicative Interaction (AMMI) (Zobel *et al.*, 1988) analysis:

The AMMI statistical model is a hybrid model. It makes use of standard analysis of variance (ANOVA) procedures to separate the additive variance from the multiplicative variance (G x E interaction) and then uses a multiplicative procedure. Principal components Analysis (PCA) is to extract the pattern from the G x E portion of the ANOVA analysis. This results in a least squares analysis, which with further graphical representation of the numerical results (Biplot analysis) often allows a straight forward interpretation of the underlying causes of G x E. The Mathematical statement of the hybrid model is :

$$Y_{ge} = \mu + \sigma g + \sigma e + \sum_{N=1}^N \lambda_n \gamma_{gn} \delta_{en} + \rho_{ge} + E_{ge}$$

Where g = genotypes

e = environments

Y_{ge} = the yield of genotypes g in environment e

μ = the grand mean

σg = genotype mean deviations

σe = environment mean deviations.

N is the number of IPCAs (Interaction Principal Component Axis) retained in the model

λ_n = is the singular value for IPCA axis 'n'

- γ_{gn} = are the genotype eigen values for IPCA axis 'n'
- δ_{en} = are the environment eigen vector values for IPCA axis 'n' and
- ρ_{ge} = are the residuals
- E_{ger} = random error

The AMMI biplot is developed by placing both genotype and environment means on the x - axis and the respective PCA axis eigen vectors on the y - axis.

Results

IV. EXPERIMENTAL RESULTS

In the present investigation, the observations recorded on green fodder yield and yield attributes in the 25 parents and 84 hybrids raised in randomized block design with three replications in four environments (cuts) were statistically analysed for combining ability, heterosis, character association, and stability. The results are presented here under.

4.1. Analysis of variance for line x tester analysis.

Analysis of variance for line x tester mating design for fourteen characters in individual and in pooled environments is presented in Table 2. Variances due to genotypes and parents were highly significant for all the fourteen characters in all the four environments and for pooled data over environments. The differences within the parental variances due to lines were significant for all the characters in all the environments and for pooled data over environments except for number of tillers; numbers of leaves and leaf length in E₂. Variances for stem thickness in E₁, E₂ and E₃ were non-significant for lines. Among the tester variances except for stem thickness (E₁, E₂, E₃ and E₄) all other characters in all the environments and the pooled analysis over environments for all the fourteen characters were found to be significant.

Line vs tester variances were significantly different for all the characters in all the environments and in pooled analysis except for leaf breadth in E₂ and E₄, stem thickness in E₂ and E₃, Hydrocyanic acid and total soluble solids in E₂. Parent vs crosses for single degrees of freedom was found to be highly significant for all the characters except for number of tillers (E₁, E₂ and E₄), number of leaves (E₄), leaf length (E₄), stem thickness (E₂) and hydrocyanic acid (pooled analysis).

The variances due to environments in pooled analysis were found to differ significantly for plant height, number of leaves, leaf length, leaf breadth, leaf stem ratio, stem thickness, crude protein, dry fodder yield, green fodder yield per plant and green fodder yield per plot. The variances due to environment vs genotypes significantly differed for all the

Table (contd...)

Source	df	Env	Plant height	Days to 50 per cent flowering	No.tillers	Noleaves	Leaf length	Leaf breadth	Leaf ratio	Stem thickness	Hydrocyanic acid	Total soluble solids	Crude protein	Dry Fodder yield	Green Fodder yield/plant	Green Fodder yield/plot
PARENT vs CROSSES																
		E ₁	21316.95**	7.07**	0.070	2.84*	917.47**	7.06**	0.1259**	4.267**	1101.73**	5.26**	27.22**	11449.14**	548991**	198.22**
		E ₂	21399.33**	377.94**	0.205	22.66**	1110.25**	36.15**	0.0327**	0.304	6373.94**	16.81**	73.86**	24285.37**	1193215**	1038.94**
	1	E ₃	60716.03**	278.70**	14.155**	6.30**	2371.76**	81.71**	0.0906**	10.080**	10862.66**	17.80**	125.86**	80428.63**	1559229**	1557.67**
		E ₄	18442.11**	2.77*	0.392	0.21	38.61	27.25**	0.0468**	2.225**	100.78**	34.86**	68.17**	31060.86**	618609**	282.30**
	P		113736.31**	308.73**	3.712**	18.07**	3512.02**	131.43**	0.2772**	9.550**	0.38	68.20**	277.00**	130566.0**	3741307**	2630.69**
Environments	3	P	133.04**	1.96	0.536	3.82*	242.74**	1.42*	0.0015**	0.44**	36.65	1.962	0.134**	264.16**	172.59**	3.21*
EnV *	324	P	930.30**	40.120**	0.876**	2.534**	71.31**	0.848**	0.0039**	0.151	1466.17**	9.039**	0.820**	1460.51**	22081.50*	31.190**
Genotypes																
EnV * Parents	72	P	1298.41**	44.860**	1.074**	6.083**	101.24**	0.929**	0.0056**	0.158**	1724.76**	12.615*	0.507**	1327.70**	18407.71*	27.170**
EnV Parents(L)	9	P	234.33**	45.280**	0.088	3.754**	77.76**	0.940	0.0138**	0.262**	1031.71**	5.306**	0.378**	291.34**	8432.97**	19.230**
EnV * Parents(T)	60	P	1515.59**	43.310**	1.273**	5.528**	103.33**	0.768**	0.0039**	0.120	1829.35**	11.978*	0.525**	1496.95**	19295.12*	24.560**
EnV * Parents (L*T)	3	P	147.06**	74.610**	0.063**	24.172**	129.88**	4.119**	0.0167**	0.589**	1712.05**	47.286*	0.542**	1051.78**	30583.70*	103.210**
EnV * Parents Vs crosses	3	P	2712.70**	119.250**	3.703**	4.646**	308.69**	6.913**	0.0063**	2.442**	6146.24**	2.177	6.036**	5552.63**	59579.37*	148.810**
Error																
		E ₁	35.37	1.15	0.18	0.55	26.69	0.83	0.0004	0.09	13.40	0.6	0.03	14.38	34.84	1.03
	216	E ₂	35.28	0.96	0.32	3.65	34.05	0.35	0.0004	0.08	106.21	1.33	0.04	51.03	32.4	0.54
		E ₃	35.71	0.92	0.55	0.42	31.78	0.41	0.0004	0.14	13.09	1.57	0.05	204.16	63.67	2.57
		E ₄	36.35	0.83	0.45	0.76	30.97	0.49	0.0004	0.09	8.88	1.02	0.03	39.28	49.44	0.45
	864	P	35.513	0.96	0.38	1.33	30.76	0.52	0.0004	0.1	35.36	1.13	0.04	77.13	44.93	1.15

characters except stem thickness, while the variances due to environment vs parents, environment vs parents (LvsT), and environment vs (Parent vs crosses) were found to be significant for all the fourteen characters.

For environment vs Lines significant differences were observed for all the characters except number of tillers and leaf breadth while the variances due to Environment vs testers were significant for all the characters except stem thickness.

4.2. Mean performance of parents and hybrids:

The mean performance of parents and hybrids in the four environments and the over all pooled mean values for the fourteen characters is presented in Appendices 1 to 7.

4.2.1. Days to 50 per cent flowering:

The mean of parents for days to 50 per cent flowering ranged from 58.75 (2077A) to 64.17 (111 A) among lines and from 58.75 (FS 211) to 75.50 (68710) among testers. Among the hybrids, the range was from 56.92 (2219A x FS 9601) to 71.00 (2077 A x 68786) in pooled data (Table.3).

4.2.2. Plant height:

The mean of parents for plant height ranged from 80.93 (2219 A) to 102.63 cm (111A) among the lines, and from 169.39 (FS 9604) to 253.55 cm (68786) among the testers. Mean of the hybrids for plant height ranged from 172.06 (296 A x SS 012) to 253.21 cm (2077 A x SS020) in the pooled data (Table3.) Generally lower values were non-significant and higher values were significant from their respective line mean, tester mean and hybrid means in individual environments and in pooled data.

4.2.3. Number of tillers:

With regard to parental mean, 111 A recorded a high mean (1.34) among lines and in the testers the range was from 1.42 (68918) to 3.81 (68726) (Table 3). Among the different

Table 3. Mean performance of parents in pooled data for different characters

Parents	Days to 50% flowering	Plant height	No. of tillers	No. of leaves	Leaf length	Leaf breadth	Leaf/stem ratio	Stem thickness	Hydrocyanic acid	Total soluble solids	Crude protein	DFY/plot	Green fodder yield/plant	Green fodder yield/plot
296A	63.00	84.49	1.09	8.87	59.71	6.08	0.40*	2.13	51.28	6.33	7.66	29.84	171.44	7.17
2219A	60.42	80.93	1.17	7.13	47.57	5.11	0.35	1.85	99.36*	9.67	7.92	20.94	131.25	2.65
2077A	58.75	98.42	1.29	7.74	56.30	4.93	0.35	1.89	99.60*	8.54	8.62*	41.76	219.31**	6.34
111A	64.17*	102.63	1.34	8.96	56.58	6.70	0.35	2.35	80.43	9.46	7.92	36.26	212.68**	11.05*
Lines Mean	61.59	91.62	1.22	8.18	55.04	5.71	0.36	2.06	82.67	8.50	8.03	32.20	183.67	6.80
68716	64.58	221.54**	2.19	8.24	64.23	4.60	0.26	1.61	56.67	6.83	8.10	58.57	262.59	7.62
68740	65.42*	230.16**	2.81	8.63	62.88	4.57	0.28	1.63	50.38	6.83	7.85	82.97*	325.80**	9.54
68918	65.83*	186.63	1.42	9.04	56.47	5.83	0.30**	2.05	49.17	8.92	7.57	54.25	269.88	5.19
68786	65.25	253.55**	2.55	9.69	67.91	5.67	0.28	1.82	64.58	7.25	7.84	130.85**	477.91**	15.67**
68814	70.42**	238.09**	1.58	8.86	63.53	4.62	0.30**	1.74	53.33	7.33	8.10	54.66	234.16	9.86
FS211	58.75	184.53	1.73	11.27**	60.65	5.52	0.24	1.81	65.78	11.33**	7.40	65.49	283.19	7.79
FS205	62.75	206.60	2.16	8.78	57.40	5.45	0.27	1.79	68.76	9.71	7.76	69.68	262.72	7.35
FS9401	62.42	224.54**	2.29	9.02	66.93	5.39	0.26	1.81	49.16	10.17*	7.22	73.86	291.20	7.73
SS003	63.42	185.41	1.75	8.10	65.09	5.36	0.27	1.77	52.08	6.75	8.19	44.99	229.47	7.60
SS012	60.50	173.51	1.45	8.23	58.53	5.54	0.24	1.78	52.92	6.92	8.01	35.87	192.27	5.95
SS020	61.67	238.64**	2.29	9.50	66.75	4.94	0.22	1.79	79.58	7.67	7.57	59.53	248.16	12.04**
SRV605	66.33**	210.53*	2.14	8.74	63.08	4.94	0.24	1.90	67.92	8.29	8.01	67.56	254.03	10.13
FS9604	59.67	169.39	1.92	7.73	57.39	5.33	0.24	1.66	85.42**	10.13*	8.10	56.89	243.27	8.08
FS9605	63.00	220.48*	2.34	8.19	69.18	4.45	0.26	1.81	67.92	8.63	8.36**	55.75	244.17	7.92
FS9601	59.50	217.89	2.51	8.25	60.50	4.72	0.23	1.73	88.74**	8.08	7.75	63.45	266.00	7.40
FS9603	63.08	198.02	3.04	7.95	64.04	4.98	0.27	1.73	107.92**	7.33	8.49**	77.71	296.08*	8.23
68710	75.50**	191.54	1.63	8.50	68.86	5.43	0.32**	1.91	89.59**	8.42	7.57	61.12	276.96	9.04
68724	63.83	207.18	3.12	8.28	62.85	4.27	0.28	1.65	82.50*	9.13	8.10	81.70	324.00**	11.87**
68726	61.17	221.69**	3.81**	8.44	69.79	4.04	0.25	1.62	107.92**	8.83	7.48	86.79*	354.17**	15.23**
Co27	61.67	203.62	2.43	8.26	62.17	5.03	0.27	1.88	94.58**	7.79	8.27*	71.00	258.06	9.24
SS032	63.83	201.87	2.25	9.21	63.86	5.67	0.27	2.07	51.22	8.46	8.29**	89.44**	397.00**	13.86**
Testers Mean	63.82	208.82	2.26	8.71	63.43	5.06	0.26	1.79	70.76	8.32	7.9	68.67	285.28	9.39
Parental Mean	63.48	190.01	2.09	8.62	62.09	5.17	0.28	1.83	72.67	8.35	7.92	62.84	269.03	9.98
SE(d)	0.802	4.866	0.501	0.942	4.529	0.589	0.016	0.260	4.856	0.867	0.155	7.171	5.473	0.874
CD at 5%	1.572	9.537	0.981	1.846	8.876	1.154	0.032	0.509	9.517	1.700	0.305	14.055	10.727	1.713
CD at 1%	2.066	12.534	1.289	2.426	11.666	1.517	0.042	0.669	12.508	2.234	0.401	18.472	14.099	2.251

Table 3 (contd.). Mean performance of hybrids in pooled data for different characters

Hybrids	Days to 50% flowering	Plant height	No. of tillers	No. of leaves	of	Leaf length	Leaf breadth	Leaf/stem ratio	Stem thickness	Hydrocyanic acid	Total soluble solids	Crude protein	DFY/plot	Green fodder yield/plant	Green fodder yield/plot
296A x 68716	64.17*	178.70	1.81	8.17		61.14	5.68	0.24	1.93	101.68**	6.71	9.94**	59.04	312.71	8.55
296A x 68740	61.33	199.49	2.19	8.37		64.65	5.78	0.27	2.05	126.66**	8.25	9.15	85.36	355.49	11.58
296A x 68918	61.17	172.97	1.75	9.13		64.76	7.21*	0.25	2.27	84.16*	7.29	9.32	64.37	338.50	10.57
296A x 68786	68.58**	203.58	1.80	8.51		65.36	5.87	0.25	2.12	90.33**	7.25	8.45	71.78	377.65	5.00
296A x 68814	65.42**	208.29	1.88	9.23		69.31	6.21	0.30**	2.14	85.41**	8.92	9.50**	75.96	310.17	9.33
296A x FS211	63.33	191.33	1.92	8.47		66.00	6.26	0.25	2.16	82.50*	9.25	9.06	69.66	357.89	11.89
296A x FS205	64.08*	204.64	2.06	8.89		63.15	6.64	0.24	2.07	73.32	7.92	8.36	71.69	308.95	9.26
296A x FS9401	61.83	205.75	2.17	8.77		65.14	6.00	0.25	2.01	99.16**	6.58	9.50**	74.51	319.70	12.98
296A x SS003	61.00	193.19	1.98	8.44		64.71	6.12	0.25	2.00	70.42	7.92	8.53	66.74	293.61	10.64
296A x SS012	60.25	172.06	1.57	8.13		61.40	6.12	0.22	1.98	100.84**	7.17	9.41*	49.84	256.77	8.48
296A x SS020	61.75	221.77*	1.98	8.37		71.18	6.31	0.24	2.24	55.42	8.83	8.62	76.62	340.10	7.43
296A x SRV605	64.42**	183.19	2.23	8.26		65.88	5.71	0.29**	2.09	112.92**	8.00	9.06	72.65	299.20	2.74
296A x FS9604	66.67**	186.15	2.17	9.29		64.29	6.61	0.27	2.34	99.58**	6.92	8.97	91.53	449.86**	4.14
296A x FS9605	62.00	199.65	2.04	7.90		66.56	5.35	0.24	1.84	62.08	8.42	7.75	67.12	320.75	11.51
296A x FS9601	61.08	204.34	2.32	8.22		66.56	5.79	0.24	1.99	83.34*	10.25**	9.41*	88.26	338.75	14.54**
296A x FS9603	61.00	189.71	2.49	7.81		65.70	5.79	0.25	1.91	115.84**	8.67	8.54	81.72	354.28	6.90
296A x 68710	62.17	201.94	2.90	8.36		72.18	6.26	0.24	1.98	51.58	9.58*	7.22	87.74	440.39**	10.95
296A x 68724	59.75	208.81	2.61	8.12		69.12	5.70	0.23	1.89	87.92**	9.75*	9.15	104.88*	429.21**	12.33
296A x 68726	59.25	195.91	4.79**	7.69		62.41	5.11	0.22	1.76	72.09	8.50	8.18	127.84**	561.78**	4.88
296A x Co27	60.42	188.49	1.93	8.00		66.89	5.94	0.25	1.92	104.58**	9.00	9.50**	82.94	334.09	12.41
296A x SS032	61.00	183.04	2.72	8.45		61.22	6.26	0.23	2.10	79.58	8.42	8.80	92.50	437.43**	9.79
2219A x 68716	59.50	224.47*	2.80	8.96		68.37	5.45	0.27	2.05	78.33	7.58	8.97	102.03*	479.44**	20.71**
2219A x 68740	60.33	219.38	2.44	8.78		63.77	5.67	0.26	1.91	94.59**	7.17	9.76**	78.76	353.28	13.63
2219A x 68918	58.25	182.79	2.02	8.31		64.33	5.59	0.27	2.04	93.35**	7.17	10.11**	69.18	345.45	14.37*
2219A x 68786	60.92	215.72	2.03	9.19		68.32	5.53	0.27	1.98	62.09	6.00	9.50**	89.82	413.50**	15.18**
2219A x 68814	58.50	209.48	2.69	8.34		67.14	4.97	0.25	1.84	46.25	8.50	9.85**	82.08	376.39	16.80**
2219A x FS211	57.00	188.96	1.98	8.14		61.68	5.34	0.24	1.91	106.26**	8.08	9.59**	71.18	314.34	12.46
2219A x FS205	58.42	212.38	2.07	8.79		63.50	5.44	0.27	1.87	67.08	8.75	10.11**	60.86	281.24	10.01
2219A x FS9401	57.67	204.67	2.44	8.56		63.99	5.60	0.28*	1.86	74.17	7.67	9.85**	82.71	320.65	15.00**
2219A x SS003	57.83	214.60	1.88	8.72		67.11	5.54	0.27	1.93	67.92	8.67	8.62	67.44	283.86	13.23
2219A x SS012	57.92	194.94	2.05	8.27		58.82	5.36	0.23	1.99	72.08	9.67*	9.59**	57.36	286.68	11.43
2219A x SS020	59.25	222.76*	2.01	8.63		66.48	5.49	0.26	1.89	72.92	7.83	9.76**	77.85	315.22	16.15**
2219A x SRV605	62.00	204.25	1.67	8.23		63.09	5.57	0.24	1.92	65.42	6.67	9.50**	59.86	257.08	11.79
2219A x FS9604	63.42	188.35	1.58	8.52		64.50	5.80	0.26	1.91	64.17	8.92	10.37**	45.41	251.84	10.01

Table 3 (contd..)

Hybrids	Days to 50% flowering	Plant height	No. of tillers	No. of leaves	Leaf length	Leaf breadth	Leaf/stem ratio	Stem thickness	Hydrocyanic acid	Total soluble solids	Crude protein	DFY/plot	Green fodder yield/plant	Green fodder yield/plot
2219A x FS9605	59.58	208.50	2.23	8.00	64.97	5.14	0.28*	1.82	39.17	9.42	9.41**	76.17	295.82	11.94
2219A x FS9601	56.92	208.61	2.25	7.90	62.28	5.02	0.24	1.88	58.34	8.50	8.36	80.54	329.31	13.89
2219A x FS9603	57.92	187.55	2.19	8.04	61.66	5.17	0.24	1.80	101.67**	7.08	9.24	67.20	271.47	11.92
2219A x 68710	59.50	200.83	2.16	8.46	65.91	5.28	0.24	1.95	55.59	8.67	10.11**	76.44	329.39	8.90
2219A x 68724	60.17	218.14	2.05	9.16	68.61	5.10	0.24	1.98	45.83	9.50*	9.41*	76.16	335.51	14.91**
2219A x 68726	57.92	216.96	2.70	8.37	65.69	4.83	0.24	1.82	59.17	9.75*	9.50**	79.86	350.25	18.76**
2219A x Co27	58.50	200.72	2.33	8.41	64.90	4.92	0.26	1.93	63.34	8.33	9.32	65.54	283.34	14.81**
2219A x SS032	58.42	186.86	2.29	8.02	61.30	5.52	0.25	2.17	64.56	9.58*	9.76**	81.40	349.55	14.72**
2077A x 68716	64.42**	248.64**	2.13	9.31	70.36	6.39	0.23	2.17	69.59	5.50	8.89	118.43**	584.15**	5.73
2077A x 68740	64.83**	243.91**	2.63	9.43	65.80	6.23	0.25	2.22	87.81**	7.00	9.85**	118.34**	528.61**	12.96
2077A x 68918	62.08	203.61	1.55	9.83	64.77	6.90	0.28*	2.29	63.75	5.67	9.15	78.36	429.69**	7.89
2077A x 68786	71.00**	239.69**	1.85	10.19	70.31	6.10	0.24	2.37	55.41	5.00	8.45	123.36**	674.89**	13.10
2077A x 68814	70.08**	250.24**	2.51	10.43	74.26	6.31	0.26	2.16	48.33	7.58	10.02**	128.48**	593.93**	14.48*
2077A x FS211	60.17	212.36	2.20	9.25	69.27	6.29	0.24	2.12	77.91	8.17	8.88	83.31	417.54**	13.73
2077A x FS205	64.67**	241.62**	2.14	9.23	64.55	6.05	0.25	2.05	42.08	5.58	9.50**	94.51	419.37**	10.18
2077A x FS9401	61.25	233.82**	2.42	8.78	65.10	5.92	0.22	2.07	44.58	6.58	7.75	94.48	402.26	12.58
2077A x SS003	62.42	204.99	1.93	9.41	65.55	5.97	0.23	1.94	60.83	7.00	9.41*	82.02	402.38	10.28
2077A x SS012	63.50	215.73	1.68	9.13	60.48	5.89	0.24	2.03	66.66	6.50	9.76**	75.03	421.87**	10.53
2077A x SS020	63.17	253.21**	2.16	9.81	74.13	6.08	0.26	2.00	45.42	7.33	7.75	77.59	375.81	12.04
2077A x SRV605	65.83**	226.75**	1.74	9.40	63.55	5.67	0.22	2.10	50.44	6.25	7.14	76.49	377.23	12.57
2077A x FS9604	67.25**	205.93	1.55	9.19	60.38	6.01	0.25	1.95	80.84	8.25	8.71	81.72	422.73**	9.67
2077A x FS9605	62.50	235.15**	2.00	9.58	71.87	5.81	0.24	1.99	64.14	8.17	9.59**	90.72	408.99*	14.38*
2077A x FS9601	61.58	226.87**	2.27	8.58	66.33	5.54	0.25	2.10	47.92	7.67	8.97	88.91	371.81	12.60
2077A x FS9603	62.25	226.68**	2.22	9.10	65.13	5.84	0.23	2.23	73.33	7.17	8.18	96.11	422.08**	9.79
2077A x 68710	66.75**	230.35**	2.70	9.42	73.25	6.04	0.25	2.08	60.83	6.58	8.71	123.83**	545.15**	9.81
2077A x 68724	67.25**	238.99**	2.58	9.63	71.56	5.69	0.23	2.05	72.92	6.67	8.97	117.97**	487.07**	13.75
2077A x 68726	59.42	249.15**	3.13	9.52	69.90	5.38	0.22	1.96	50.41	7.92	8.16	150.11**	634.90**	10.94
2077A x Co27	59.58	230.76**	2.42	9.17	67.11	6.13	0.23	2.38	54.58	8.50	8.68	107.14**	516.15**	8.19
2077A x SS032	59.08	228.98**	1.69	9.18	60.80	6.06	0.22	2.17	43.33	6.75	8.27	53.01	251.88	1.39
111A x 68716	67.17**	223.84*	2.18	9.55	68.21	6.09	0.24	2.04	79.37	7.08	8.18	84.05	456.03**	12.06
111A x 68740	66.58**	243.54**	1.78	10.07	69.11	6.24	0.26	2.02	85.83**	6.67	9.58**	96.98	373.57	12.58
111A x 68918	68.58**	200.26	1.74	9.66	63.52	6.63	0.24	2.13	75.82	7.25	8.71	75.53	366.20	12.45

Table 3 (Contd.)

Hybrids	Days to 50% flowering	Plant height	No. of tillers	No. of leaves	Leaf length	Leaf breadth	Leaf/stem ratio	Stem thickness	Hydrocyanic acid	Total soluble solids	Crude protein	DFY/plot	Green fodder yield/plant	Green fodder yield/plot
111A x 68786	69.42**	224.38*	2.29	9.40	67.41	6.76	0.25	2.25	51.65	6.42	9.15	100.49	506.83**	15.64**
111A x 68814	68.92**	231.03**	2.69	9.59	75.72*	6.14	0.23	2.02	58.33	6.00	8.60	122.40**	592.48**	21.71**
111A x FS211	59.50	196.27	2.11	9.23	65.88	6.56	0.21	2.15	63.32	7.50	8.60	91.45	421.95**	14.00
111A x FS205	63.42	226.21**	2.03	9.67	63.93	6.65	0.24	2.03	39.33	8.33	8.45	86.87	376.58	14.30*
111A x FS9401	61.00	225.43**	2.23	9.01	65.98	6.44	0.23	1.98	77.93	7.83	7.31	87.60	388.27	14.73**
111A x SS003	59.25	177.48	1.78	8.82	62.56	6.50	0.24	2.17	65.83	7.42	8.97	69.95	327.57	13.93
111A x SS012	60.92	198.09	1.58	10.18	60.50	6.30	0.22	2.13	77.08	7.50	8.97	73.57	373.70	13.32
111A x SS020	66.42**	235.88**	1.71	9.66	68.04	6.09	0.26	2.04	80.72	6.58	10.11**	77.11	369.33	13.39
111A x SRV605	65.92**	208.81	2.21	8.79	61.17	5.80	0.24	1.95	92.08**	7.50	8.36	85.91	387.72	20.26**
111A x FS9604	64.58**	192.84	2.20	9.21	65.22	6.05	0.27	2.06	71.25	9.33	10.37**	91.95	434.87**	14.51*
111A x FS9605	61.92	236.11**	2.70	9.30	68.50	6.26	0.23	1.91	59.58	9.67*	9.41*	108.61**	486.41**	18.10**
111A x FS9601	60.75	242.84**	2.07	9.62	60.71	6.26	0.23	2.02	70.83	7.67	7.22	89.81	403.84	15.56**
111A x FS9603	62.08	209.02	3.21*	8.31	62.82	6.27	0.25	2.04	123.34**	8.33	8.10	120.73**	501.69**	7.39
111A x 68710	64.50**	210.04	2.83	8.38	70.80	6.41	0.21	2.08	93.28**	9.00	8.71	104.02**	504.64**	6.84
111A x 68724	66.08**	230.93**	2.42	9.86	73.07	6.22	0.23	2.14	86.25**	7.83	9.24	100.01	517.89**	22.63**
111A x 68726	61.42	230.26**	3.16*	9.41	72.03	5.59	0.24	1.92	60.41	8.50	9.32	118.52**	532.20**	23.94**
111A x Co27	64.42**	217.38	2.02	9.21	67.17	6.16	0.24	2.03	54.58	8.17	9.24	89.39	373.22	14.73**
111A x SS032	62.75	217.46	2.85	9.07	62.11	6.53	0.24	2.17	88.33**	8.42	9.24	118.10**	540.00**	22.59**
Hybrids Mean	62.32	212.25	2.22	8.90	65.99	5.93	0.25	2.03	72.71	7.81	9.02	86.60	396.24	12.35
SE(d)	0.802	4.866	0.501	0.942	4.529	0.589	0.016	0.260	4.856	0.867	0.155	7.171	5.473	0.874
CD at 5%	1.572	9.537	0.981	1.846	8.876	1.154	0.032	0.509	9.517	1.700	0.305	14.055	10.727	1.713
CD at 1%	2.066	12.534	1.289	2.426	11.666	1.517	0.042	0.669	12.508	2.234	0.401	18.472	14.099	2.251

hybrids, only two viz., 296 A x 68726 (4.79) and 111 A x FS 9603 (3.21) recorded significant values in pooled data over environment and in E₂, E₃ and E₃, E₄ respectively.

4.2.4. Number of leaves:

Among the parents none of the lines recorded significant values and among the testers only FS 211 (11.27) had significant difference over tester mean and eight parents were on par with overall tester mean. The range for hybrids was from 7.69 (296 A x 68726) to 10.43 (2077 A x 68814). Though some of the hybrids recorded significant values in individual environments, none differed significantly from hybrid mean in the pooled data over seasons (Table 3).

4.2.5. Leaf length:

Among the lines and testers none differed significantly from their respective parental mean. Only one hybrid 111 A x 68814 (75.72 cm) recorded significant difference from hybrid mean in the pooled data over environments (Table 3).

4.2.6. Leaf breadth:

The maximum value of leaf breadth was recorded by 111 A (6.70 cm) among lines and the lowest by 2077 A (4.93 cm). Among the testers none had significant mean in pooled data over environments. In hybrids, the range for leaf breadth was from 4.83 cm (2219 A x 68726) to 7.21 cm (296 A x 68918). While considering the deviation, only one hybrid (maximum value recorded) had significant mean in the pooled data (Table 3).

4.2.7. Leaf stem ratio:

296 A (0.40) among lines recorded the maximum leaf stem ratio. The range for leaf stem ratio in testers was from 0.22 (SS020) to 0.32 (68710). Three of the testers, viz., 68918 (0.30), 68814 (0.30) and 68710 (0.32) recorded a highly significant difference from tester mean in pooled data. Among the hybrids only two, [296 A x 68814 (0.30) and 296 A x SRV 605 (0.29)] had significant mean values (Table 3).

4.2.8. Stem thickness:

Among the parents and hybrids none of the genotypes recorded significant difference over the parental mean or hybrid mean in pooled data over environments. Among the lines 111 A recorded high mean in E₄ and among the testers SRV 605 recorded high mean in E₃. Among the hybrids nine recorded significant values in E₁ (Table 3).

4.2.9. Hydrocyanic acid:

The lowest value among the lines was recorded by 296 A (51.28 ppm). Among the testers, the range was from 49.16 ppm (68918 and FS 9401) to 107.92 ppm (FS 9603 and 68726). Among the hybrids it was from 39.17 (2219 A x FS 9605) to 123.34 ppm (111 A x FS 9603). A total of forty-six hybrids were found to be non-significant for hydrocyanic acid in the pooled data. Maximum values for hydrocyanic acid were observed in E₂ (Table 3).

4.2.10. Total soluble solids:

The range of total soluble solids was from 6.33 per cent (296 A) to 9.67 per cent (2219 A) among lines and from 6.75 (SS 003) to 11.33 per cent (FS 211) among testers. The maximum value was recorded by 296 A X FS 9601 (10.25 per cent) among the hybrids and the lowest value was recorded by 2077A x 68786 (5.00 per cent) in the pooled data. The genotypes showing maximum values were significantly different in individual environments (Table 3).

4.2.11. Crude protein:

In the pooled data over environments, the maximum value was 8.62 per cent recorded by 2077A among the lines and among the testers FS 9605 (8.36 per cent) recorded the highest value. The range for hybrids was from 7.14 per cent (111 A x FS 9601 and 2077 A x SRV 605) to 10.37 per cent (2219 A x FS 9604). Among the parents and hybrids thirty-nine genotypes recorded significant mean values (Table 3).

4.2.12. Dry fodder yield:

Among the parents, none of the lines had significant mean and among the testers four parents recorded a significant mean. The range for testers was from 35.87 g (SS012) to 130.85 g (68786). Among the hybrids 2077A x 68726 (150.1 g) recorded the maximum value and 2219 A x FS 9604 (45.41g) recorded the lowest value in the pooled data. (Table 3).

4.2.13. Green fodder yield per plant:

Among the lines, the range was from 131.25 g (2219 A) to 219.31g (2077 A) and from 192.27 g. (SS 012) to 477.91g (68786) among the testers. In the hybrids, the range was from 251.84 (2219 A x FS 9604) to 674.89g. (2077 A x 68786) in the pooled data. Among the parents and hybrids out of 109 genotypes, forty-three had significant mean values in the pooled data (Table 3).

4.2.14. Green fodder yield per plot:

In pooled data over environments the range for green fodder yield per plot was from 2.65 kg (196 A) to 11.05 kg (111 A) among lines and from 5.19 (68918) to 15.23kg (68726) among testers. The maximum value among hybrids was recorded by 111 A x 68724 and 111 A x 68726 (23.94 kg) and the lowest value was recorded by 2077 A x SS 032 (1.39 kg). Among the different genotypes thirty-two recorded significant mean values of which 12 hybrids were 111 A derivatives (Table 3).

4.3. Analysis of variances for combining ability:

Since, the genotypic differences were found to be significant the combining ability was estimated by line x tester analysis for the fourteen characters. Significant differences among hybrids were observed for all the characters (Table 4). except stem thickness (E_3 and E_4) in all the environments and pooled data. Within the hybrid variances, the variance due to line effect was significant for all the characters except number of tillers in all the environments. Non-significant differences were observed for leaf length in E_3 , for leaf stem ratio and total soluble solids in E_2 .

Table 4. Analysis of variance for combining ability in individual environments and pooled data for different characters in Line x Tester design

Source	Df	Env	Plant height	Days to 50 per cent flowering	No.tillers	Notleaves	Leaf length	Leaf breadth	Leaf stem ratio	Stem thickness	Hydrocyanic acid	Total soluble solids	Crude protein	Dry yield	Fodder yield/plant	Green Fodder yield/plot
CROSSES		E ₁	1389.54**	75.87**	0.308**	1.91**	87.16**	1.821**	0.0021**	0.222**	2464.84**	12.80**	2.47**	1628.45**	22083.0**	57.75**
		E ₂	2025.04**	105.32**	1.403**	2.21	67.15**	1.219**	0.0028**	0.121*	2748.43**	12.55**	1.65**	1428.43**	41228.3**	85.60**
	83	E ₃	1227.51**	41.39**	2.086**	1.67**	67.54**	1.160**	0.0046**	0.146	1952.38**	7.41**	3.27**	2857.72**	47392.1**	121.24**
		E ₄	2507.42**	23.54**	1.313**	3.48**	122.53**	0.875**	0.0044**	0.085	1559.45**	6.73**	1.64**	3363.45**	64224.32**	42.92**
	P		4742.36**	132.71**	2.756**	4.83**	165.00**	2.821**	0.0036**	0.210**	4720.09**	15.24**	6.49**	4929.24**	106851.8**	214.72**
Line Effect		E ₁	12307.64**	814.86**	0.355	12.57**	232.57**	31.029**	0.0093**	2.309**	15913.54**	34.42*	10.33**	7885.86**	144191.2**	244.74**
		E ₂	22523.60**	711.67**	1.849	24.09**	113.31*	10.094**	0.0061	0.783**	6745.24*	10.03	8.70**	5022.97**	224697.4**	568.10**
	3	E ₃	11465.44**	150.76**	2.862	7.53**	83.57	9.605**	0.0080*	0.611**	13333.75**	78.47**	8.87*	13505.88**	340757.3**	1088.37**
		E ₄	34315.80**	111.09**	1.663	49.05**	299.71*	5.112**	0.0102*	0.247*	8524.35**	60.76**	8.65**	31684.47**	690379.7**	428.31**
	P		61126.22**	1336.86**	0.704	73.52**	347.83**	40.344**	0.0170**	1.577**	33269.78**	97.74**	32.44**	36573.82**	1059359.5**	1969.25**
Tester Effect		E ₁	2870.56**	122.17**	0.529**	4.20**	244.57**	1.383**	0.0024	0.227*	3190.50**	10.45	2.75	2488.84**	42018.1**	67.77
		E ₂	3382.55**	166.72**	2.884**	2.17*	139.19**	1.976**	0.0031	0.101	3800.73*	29.59**	1.38	2628.87**	71563.12**	101.43*
	20	E ₃	1881.08**	94.77**	4.272**	2.87**	128.94**	1.973**	0.0093**	0.217**	2795.82**	9.24**	3.62	3053.24	39848.58	79.00
		E ₄	2579.99**	51.08**	2.143**	1.90	174.09*	0.830	0.0051	0.098	2239.03**	9.72**	1.37	3832.83**	66775.78**	48.95**
	P		7712.22**	233.66**	6.787**	3.77**	443.21**	3.500**	0.0051**	0.288**	7704.40**	25.38**	5.71	7758.38**	147410.3**	172.94
Line * Tester Effect		E ₁	349.96**	23.49**	0.232	0.61	27.43	0.507	0.0016**	0.116	1550.52**	12.50**	1.99**	1028.78**	9332.66**	45.06**
		E ₂	547.61**	54.54**	0.886**	1.13	40.83	0.523**	0.0026**	0.094	2197.83**	7.00**	1.39**	848.56**	21943.31**	56.20**
	60	E ₃	497.76**	18.12**	1.319**	0.97**	46.27*	0.467	0.0029**	0.099	1102.16**	3.25**	2.88**	2260.14**	35238.38**	86.97**
		E ₄	892.82**	9.99**	1.019**	1.73**	96.48**	0.678*	0.0039**	0.072	984.68**	3.04**	1.38**	1790.94**	32066.06**	21.65**
	P		933.22**	38.86**	1.515**	1.74	63.12**	0.718*	0.0025**	0.116	2297.84**	7.73**	5.46**	2403.96**	45706.94**	140.92**
ENV * Crosses	249		802.38**	37.80**	0.785**	1.482	59.79**	0.752**	0.0034**	0.121*	1335.01**	8.087**	0.847**	1449.60**	22692.02**	30.930**
ENV * Lines effects	9		6495.42**	150.510**	2.008**	6.577**	127.11**	5.166**	0.0055*	0.791**	3749.03**	28.651**	1.368*	7175.12**	113555.41**	120.090**
ENV * Tester effects	60		1000.66**	67.030**	1.013**	2.458**	81.19**	0.888**	0.0049**	0.119	1440.56	11.209**	1.133**	1415.13	24265.10*	41.400**
ENV * Lines Tester effects	180		451.64**	22.430**	0.647**	0.901	49.29**	0.486	0.0028**	0.089	1179.12**	6.018**	0.726**	1174.82**	17624.49**	22.990**
ERROR	166	E ₁	35.63	1.26	0.19	0.54	28.68	0.95	0.0004	0.09	13.35	0.62	0.03	15.26	35.14	1.13
		E ₂	35.44	1.15	0.36	0.91	39.2	0.41	0.0004	0.09	103.44	1.48	0.04	43.46	33.41	0.62
		E ₃	35.71	1.1	0.64	0.47	33.77	0.44	0.0004	0.15	12.98	1.98	0.05	247.6	63.53	2.88
		E ₄	36.45	0.99	0.51	0.77	34.17	0.59	0.0004	0.11	8.94	1.28	0.03	27.48	49.57	0.51
	664	P	35.81	1.13	0.43	0.67	33.96	0.6	0.0004	0.11	34.68	1.34	0.04	83.45	45.41	1.29

The variance due to tester effect was significant for plant height, days to 50 per cent flowering, number of tillers, leaf length and hydrocyanic acid in all the environments. However, it was not significant for number of leaves and leaf breadth in E_4 , for leaf stem ratio in E_1 , E_2 and E_4 , for stem thickness in E_2 and E_4 , for total soluble solids in E_1 , for dry fodder yield and green fodder yield per plant in E_3 , and for green fodder yield per plot in E_1 , E_3 and E_4 . The variance due to crude protein content was not significant in any of the environments.

The variance due to line x tester effect was significant for plant height, days to 50 per cent flowering, leaf stem ratio, hydrocyanic acid, total soluble solids, crude protein and dry fodder yield per plot in all the environments and in pooled data over environments. However, these variances were not significant for number of tillers and leaf breadth in E_1 , for number of leaves and leaf length in E_1 and E_2 and that of stem thickness was not significant in any of the environments.

While considering the combining ability variances with environments, there were highly significant differences in environment vs crosses, and environment vs line effect. The interaction variances of environment vs (line x tester effect) were significant for all characters except number of leaves, leaf breadth and stem thickness. While considering the environment vs tester effect the variances were not significant for stem thickness, hydrocyanic acid and dry fodder yield.

4.3.1. Combining ability variances:

General and specific combining ability variances and their interaction variances in individual and pooled data over environments for all the characters are presented in Table 5]. The relative estimates of variances due to *GCA* and *SCA* revealed that *GCA* variances were predominant for plant height, number of leaves, leaf length, leaf breadth, stem thickness, hydrocyanic acid and dry fodder yield in pooled data and for total soluble solids in E_3 , E_4 and pooled data, for dry fodder yield and green fodder yield per plant in pooled data.

Table 5. Combining ability variances and interaction variances in individual environments and pooled data for different characters

source	Enviro nt	Plant height	Days to 50 per cent flowering	No.tillers	No.leaves	Leaf length	Leaf breadth	Leaf stem ratio	Stem thickness	Hydro cyanic acid	Total soluble solids	Crude protein	Dry Fodder yield	Green Fodder yield/plant	Green Fodder yield/plot
GCA	E ₁	193.04	11.87	0.0056	0.207		0.42	0.0001	0.031	213.37	0.264	0.121	110.895	2233.92	2.965
	E ₂	330.813	10.26	0.0395	0.320	2.28	0.15	0.0001	0.0093	82.00	0.342	0.097	79.40	3364.98	7.43
	E ₃	164.68	2.79	0.0599	0.113	1.60	0.142	0.0002	0.0084	185.67	1.083	0.089	160.52	4135.06	13.24
	E ₄	468.136	1.896	0.024	0.633	3.745	0.061	0.0001	0.003	117.254	0.859	0.097	425.806	9240.312	5.786
	P	201.264	4.400	0.009	0.222	1.850	0.124	0.0000	0.003	111.824	0.266	0.087	110.946	3375.948	5.816
SCA	E ₁	104.78	7.41	0.0139	0.024	-0.42	-0.15	0.0004	0.009	512.39	3.962	0.652	337.839	3099.17	14.642
	E ₂	170.72	17.80	0.1749	0.074	0.54	0.04	0.0007	0.0001	698.13	1.841	0.450	268.37	7303.3	18.53
	E ₃	154.02	5.67	0.2270	0.167	4.17	0.009	0.0008	-0.0180	363.06	0.422	0.942	670.85	11724.95	28.03
	E ₄	285.456	2.999	0.169	0.321	20.769	0.029	0.0012	-0.012	325.247	0.584	0.453	587.818	10672.165	7.046
	P	40.132	1.369	0.072	0.070	1.152	0.019	0.0000	0.002	93.227	0.143	0.394	102.429	2340.204	9.828
GCA/SCA	E ₁	1.843	1.602	0.401	8.533	-13.416	-2.806	0.2853	3.114	0.416	0.067	0.186	0.328	0.721	0.203
	E ₂	1.938	0.576	0.226	4.312	4.193	4.021	0.0762	76.421	0.118	0.186	0.216	0.296	0.461	0.401
	E ₃	1.069	0.492	0.264	0.675	0.384	16.055	0.1893	-0.467	0.511	2.565	0.095	0.239	0.353	0.473
	E ₄	1.640	0.632	0.139	1.971	0.180	2.109	0.0870	-0.234	0.361	1.470	0.214	0.724	0.866	0.821
	P	5.015	3.214	0.126	3.167	1.606	6.413	-1.4644	1.339	1.200	1.865	0.221	1.083	1.443	0.592
Var. Env	P	0.104	0.005	0.000	0.003	0.426	0.002	0.0000	0.001	0.015	-0.001	0.000	0.210	0.269	0.006
Var. Env * LINE	P	95.933	2.033	0.022	0.090	1.235	0.074	0.0000	0.011	40.792	0.359	0.010	95.243	1522.713	1.541
Var. Env * TESTERS	P	45.751	3.717	0.031	0.130	2.658	0.034	0.0002	0.003	21.787	0.433	0.034	20.026	553.384	1.535
Var. LINE	P	214.878	4.643	-0.009	0.262	0.821	0.139	0.0000	0.003	112.706	0.267	0.105	111.784	3641.753	6.870
Var. TESTER	P	129.791	3.129	0.102	0.010	7.254	0.050	0.0000	0.003	107.190	0.260	-0.003	106.544	1980.474	0.284
Var. Env * GCA	P	87.904	2.302	0.023	0.096	1.463	0.068	0.0001	0.010	37.751	0.371	0.014	83.208	1367.620	1.540
Var. Env * L * T(SCA)	P	138.611	7.100	0.074	0.077	5.112	-0.038	0.0008	-0.007	381.480	1.560	0.230	363.789	5859.693	7.233

Number of tillers, crude protein and green fodder yield per plot recorded higher *SCA* variances than the *GCA* variances. The *SCA* x Environment interaction was significant and greater than *GCA* x Environment interaction for all the characters studied. Leaf breadth, plant height and number of leaves recorded higher heritability values (above 50 per cent) and number of tillers and leaf stem ratio had the lowest values.

4.4. Proportional contribution of lines, testers and their interaction.

The proportional contribution of lines, testers and their interaction to total variance in individual environments and pooled data for different characters are presented in Table 6).

Plant height, number of leaves, leaf breadth and green fodder yield per plant recorded higher contributions by lines (>40%). Days to 50 per cent flowering, number of tillers, leaf length, hydrocyanic acid, total soluble solids and dry fodder yield recorded greater contribution (> 40%) by the testers.

The proportion of line x tester interaction to the total variance was greater for leaf stem ratio, stem thickness, crude protein and green fodder yield per plot in the pooled data. A similar trend was observed in individual environments also except in a few cases, where the contribution by line x tester interaction variances was more as seen in total soluble solids in E₁.

4.5. Combining ability effects of parents:

The estimates of *gca* effects of parents in individual and pooled environments for different characters are presented in Appendices 8 to 21.

4.5.1. Days to 50 per cent flowering:

Among the parents, the line 2219 A had maximum negative *gca* effect in pooled data over environments as well as in all the individual environments. The tester 68726 also showed maximum negative *gca* effect followed by FS 211 (Table 7).

Table 6. Proportional contribution of lines, testers and their interaction to total variance in individual environments and pooled data for different characters

source	ENV	Plant height	Days to 50 per cent flowering	No.tiller	No.leaves	Leaf length	Leaf breadth	Leaf ratio	Leaf stem thickness	Hydro cyanic acid	Total soluble solids	Crude protein	Dry Fodder yield	Green Fodder yield/plant	Green Fodder yield/plot
LINE	E ₁	32.01	38.82	4.16	23.78	9.64	61.59	16.34	37.58	23.34	9.72	15.1	17.5	23.6	15.32
	E ₂	40.2	24.42	4.76	39.37	6.1	29.93	7.85	23.42	8.87	2.89	19.08	12.71	19.7	23.99
	E ₃	33.76	13.17	4.96	16.33	4.47	29.92	6.32	15.12	24.68	38.27	9.79	17.08	25.99	32.45
	E ₄	49.47	17.05	4.58	50.94	8.84	21.11	8.42	10.56	19.76	32.62	19.02	34.05	38.85	36.07
	P	46.59	36.41	0.92	55.07	7.62	51.69	16.97	27.14	25.48	23.18	18.05	26.82	35.83	33.15
TESTER	E ₁	49.78	38.8	41.33	53.03	67.61	18.3	27.78	24.65	31.19	19.66	26.77	36.83	45.85	28.28
	E ₂	40.25	38.14	49.55	23.67	49.95	39.06	26.71	20.2	33.32	56.81	20.11	44.35	41.83	28.55
	E ₃	36.93	55.18	49.34	41.45	46.01	40.96	48.79	35.79	34.51	30.05	26.63	25.75	20.26	15.7
	E ₄	24.79	52.28	39.32	13.15	34.24	22.86	27.84	28.05	34.6	34.8	20.13	27.46	25.05	27.48
	P	39.19	42.43	59.35	18.83	64.73	29.89	34.06	33.09	39.33	40.14	21.2	37.93	33.24	19.41
L * T	E ₁	18.21	22.38	54.51	23.19	22.75	20.11	55.87	37.77	45.47	70.62	58.12	45.67	30.55	56.4
	E ₂	19.55	37.43	45.68	36.95	43.95	31.01	65.43	56.38	57.81	40.31	60.81	42.94	38.48	47.46
	E ₃	29.31	31.65	45.7	42.21	49.52	29.12	44.89	49.09	40.81	31.68	63.58	57.17	53.75	51.85
	E ₄	25.74	30.67	56.1	35.91	56.92	56.03	63.74	61.39	45.65	32.58	60.86	38.49	36.09	36.45
	P	14.23	21.17	39.73	26.1	27.65	18.41	48.96	39.77	35.19	36.68	60.75	35.26	30.92	47.44
HERITABILITY (NS) %	E ₁	76.797	75.197	12.590	66.985	55.193	83.220	29.9370	61.367	45.226	11.275	26.812	39.275	58.952	28.307
	E ₂	78.377	53.016	21.084	62.942	25.081	62.772	11.5043	37.127	18.292	22.656	29.642	35.955	47.919	44.228
	E ₃	66.500	48.024	21.429	40.995	17.182	64.559	24.5800	33.676	50.268	66.669	15.748	29.880	41.317	47.749
	E ₄	75.881	53.250	12.189	68.724	18.889	35.099	13.5037	18.366	41.673	62.934	29.549	58.789	63.356	61.596
	P	52.960	40.061	7.413	52.878	23.540	59.865	8.1339	20.144	28.793	17.233	21.043	25.757	38.166	36.486
GENETIC ADVANCE %	E ₁	35.472	8.703	0.077	1.086	5.136	1.720	0.0169	0.400	28.618	0.503	0.526	19.226	105.722	2.669
	E ₂	46.910	6.794	0.266	1.308	2.202	0.885	0.0073	0.171	11.283	0.811	0.495	15.565	116.985	5.281
	E ₃	30.487	3.373	0.330	0.626	1.527	0.882	0.0180	0.155	28.145	2.475	0.346	20.176	120.417	7.327
	E ₄	54.908	2.927	0.156	1.922	2.450	0.427	0.0107	0.065	20.364	2.142	0.493	46.093	222.906	5.500
	P	30.0773	3.868	0.0757	0.998	1.9226	0.7951	0.0053	0.0717	16.5307	0.6239	0.3949	15.5734	104.5729	4.2439

Table 7. General combining ability effects of parents in pooled data for different characters

Parents	Days to 50% flowering	Plant height	No. of tillers	No. of leaves	Leaf length	Leaf breadth	Leaf/stem ratio	Stem thickness	Hydrocyanic acid	Total soluble solids	Crude protein	DFY/plot	Green fodder yield/plant	Green fodder yield/plot
Lines														
296A	0.088	-17.349**	0.034	-0.495**	-0.387	0.115*	0.010**	0.004	14.877**	0.457**	-0.144**	-7.292**	-37.215**	-3.025**
2219A	-3.281**	-6.974**	-0.036	-0.438**	-1.395**	-0.571**	0.008**	-0.108**	-3.557**	0.453**	0.536**	-12.764**	-70.405**	1.484**
2077A	1.441**	18.575**	-0.054	0.504**	1.368**	0.093	-0.008**	0.080**	-12.661**	-0.864**	-0.221**	11.620**	63.594**	-1.565**
111A	1.751**	5.748**	0.056	0.429**	0.415	0.363**	-0.009**	0.025	1.341**	-0.047	-0.171**	8.436**	44.026**	3.105**
SE (g)	0.067	0.377	0.041	0.052	0.367	0.049	0.0012	0.021	0.371	0.073	0.012	0.576	0.424	0.071
Testers														
68716	1.488**	6.658**	0.011	0.095	1.034	-0.018	-0.003	0.011	9.530**	-1.090**	-0.025	4.418**	62.347**	-0.591**
68740	0.946**	14.324**	0.041	0.257*	-0.157	0.060	0.012**	0.017	26.009**	-0.538**	0.565**	8.389**	7.001**	0.333*
68918	0.196	-22.347**	-0.456**	0.327**	-1.642	0.661**	0.012**	0.148**	6.558**	-0.965**	0.303**	-14.611**	-27.855**	-1.033**
68786	5.155**	8.588**	-0.228*	0.419**	1.862*	0.144	0.006*	0.144**	-7.841**	-1.642**	-0.136**	9.893**	97.463**	-0.123
68814	3.405**	12.502**	0.224*	0.492**	5.621**	-0.015	0.013**	0.005	-13.132**	-0.059	0.470**	15.757**	72.506**	3.225**
FS211	-2.324**	-15.024**	-0.164	-0.132	-0.281	0.192	-0.014**	0.051	9.786**	0.441**	0.012	-7.571**	-17.808**	0.668**
FS205	0.321*	8.957**	-0.144	0.241*	-2.206**	0.275*	0.002	-0.031	-17.261**	-0.163	0.084**	-7.991**	-49.201**	-1.416**
FS9401	-1.887**	5.163**	0.095	-0.126	-0.937	0.071	-0.006*	-0.057	1.246	-0.642**	-0.420**	-1.645	-38.018**	1.466**
SS003	-2.199**	-14.689**	-0.326**	-0.056	-1.006	0.112	-0.003	-0.028	-6.465**	-0.059	-0.135**	-14.932**	-66.799**	-0.335*
SS012	-1.679**	-17.052**	-0.503**	0.021	-5.686**	-0.005	-0.019**	-0.002	6.452**	-0.100	0.412**	-22.519**	-60.981**	-1.417**
SS020	0.321*	21.149**	-0.256**	0.214	3.970**	0.073	0.009**	0.008	-9.096**	-0.163	0.040	-9.181**	-45.618**	-0.105
SRV605	2.217**	-6.505**	-0.260**	-0.232*	-2.564**	-0.233*	-0.001	-0.021	7.499**	-0.704**	-0.506**	-12.743**	-65.426**	-0.513**
FS9604	3.155**	-18.939**	-0.344**	0.149	-2.391**	0.201	0.016**	0.030	6.246**	0.546**	0.586**	-8.818**	-5.912**	-2.773**
FS9605	-0.824**	7.595**	0.024	-0.210	1.988*	-0.280*	0.001	-0.146**	-16.469**	1.108**	0.018	-0.815	-17.743**	1.627**
FS9601	-2.241**	8.410**	0.006	-0.325**	-2.017*	-0.267*	-0.008**	-0.038	-7.608**	0.712**	-0.530**	0.410	-34.810**	1.792**
FS9603	-1.512**	-9.012**	0.309**	-0.588**	-2.158*	-0.152	-0.004	-0.039	30.831**	0.004	-0.507**	4.969**	-8.354**	-3.354**
68710	0.905**	-1.465	0.426**	-0.247*	4.548**	0.078	-0.013**	-0.014	-7.393**	0.650**	-0.332**	11.536**	59.158**	-3.23**
68724	0.988**	11.960**	0.194*	0.287*	4.604**	-0.241*	-0.014**	-0.020	0.513	0.629**	0.171**	13.285**	46.681**	3.552**
68726	-2.824**	10.813**	1.226**	-0.156	1.520	-0.693**	0.029**	-0.168**	-12.195**	0.858**	-0.229**	32.609**	124.049**	2.278**
Co27	-1.595**	-2.918**	-0.043	-0.204	0.531	-0.136	-0.004	0.030	-3.444**	0.691**	0.164**	-0.219	-29.659**	0.182
SS032	-2.012**	-8.169**	0.168	-0.225	-4.631**	0.174	-0.011**	0.120*	-3.765**	0.483**	-0.004	-0.221	-1.021	-0.233
SE (g)	0.153	0.864	0.094	0.118	0.841	0.112	0.0029	0.048	0.850	0.167	0.028	1.319	0.973	0.164

* Significant at 5 per cent level

** Significant at 1 per cent level

4.5.2. Plant height:

The *gca* effect of plant height ranged from 37.287 (SS 020) in E₄ to -39.412(FS9604) in E₁. The tester SS 020 had maximum positive significant effect in all the environments, while the tester 68918 had maximum negative significant effect in all the four environments and also in pooled data. Among the line 2077 A had the highest positive significant *gca* effect and among the testers SS 020, 68740, 68724 and 68726 had very high positive significant *gca* effects in all the environments and in pooled data over environments (Table 7)..

4.5.3. Number of tillers:

The maximum positive significant *gca* effect (1.226) was recorded by 68726 in all the environments and also in pooled data over environments followed by 68710 (0.426). Among the lines none had significantly differed in pooled data over environments (Table 7).

4.5.4. Number of leaves:

The *gca* effect of parents for number of leaves ranged from -0.405 (296 A) to 0.492 (68814) The line 2077 A and testers viz., 68814, 68786, 68918, 68724 68740 and FS 205 recorded significant positive effects while the others recorded non-significant and negative *gca* effects in pooled data (Table 7)..

4.5.5. Leaf length:

The range of *gca* effects for leaf length in pooled data over environments was from -2.564 (SRV 605) to 5.621 (68814). The tester 68814 had maximum positive significant *gca* effect in three (E₁, E₂ and E₃) of the environments followed by 68724 which differ in (E₁, E₂ and E₄) three environments and also in pooled data over environments. Among the lines 2077 A (1.368) differed significantly in E₁, E₂ and pooled data (Table 7)..

4.5.6. Leaf breadth:

Among the parents, maximum positive *gca* effect of 0.785 was recorded by 68918 in E_3 , followed by FS 205 in two (E_2 and E_3) environments and pooled data. Among the lines 111 A recorded significant value in pooled as well as in individual environments (Table 7).

4.5.7. Leaf stem ratio:

Among the parents, the tester 68726 had maximum positive significant *gca* effect (0.029) followed by FS 9604 (0.016) in pooled data over environments. FS9604 also differed significantly in two (E_2 and E_3) environments while 68726 had maximum *gca* effect in E_2 alone. Among the lines 296 A had significant values both in individual environments and pooled data (Table 7).

4.5.8. Stem thickness:

Maximum *gca* effect for stem thickness was recorded by 68918 (0.148) followed by 68786 (0.144) in pooled data in addition to significant differences in two environments. Among the lines 2077 A had recorded maximum *gca* effect (0.080) in pooled data and significantly differed in two (E_1 and E_2) environments (Table 7).

4.5.9. Hydrocyanic acid:

The range of *gca* effect for hydrocyanic acid was from -3.444 (Co 27) to 30.831 (FS 9603). Among the testers FS 205 (-17.261) recorded the highest negative significant *gca* effect followed by FS 9605 (-16.469) in pooled data over environments and also differed significantly in other environments in the desirable direction. Among the lines, 2077A (-12.661) differed significantly in pooled data as well as in individual environments (Table 7).

4.5.10. Total soluble solids:

The maximum *gca* effect in pooled data was recorded by FS 9605 (1.108) and it significantly differed in three (E_2 , E_3 and E_4) environments in the desirable direction followed by 68726 which was significant only in two (E_1 and E_2) environments in addition to

that in pooled data. Among the lines 296 A and 2219 A differed significantly in pooled data as well as in individual environments (Table 7).

4.5.11. Crude protein:

The *gca* effects of parents ranged from -0.135 (SS 003) to 0.586 (FS 9604) in pooled data. Among the testers FS 9605 (0.586) had maximum positive significant *gca* effect in addition to being significantly different in three individual (E_2 , E_3 and E_4) environments. The next best tester 68740 had *gca* effect on par with FS 9604 and significantly differed in all the environments. Among the lines 2219 A was significant in individual environments and in pooled data (Table 7).

4.5.12. Dry fodder yield:

For dry fodder yield, maximum *gca* effects was noticed in 68726 (32.609) in pooled data as well as in all the other environments followed by 68724 (13.285). Among the lines 2077 A recorded significant *gca* effect in individual environments and pooled data (Table 7).

4.5.13. Green fodder yield per plant:

The *gca* effects of parents ranged from -70.405 (2219 A) to 63.594 (2077 A) among the lines, and from -66.790 (SS 003) to 124.049 (68726) among the male parents. The tester 68726 had maximum positive *gca* effects followed by 68786 (97.463). A total of two lines (2077 A and 111 A) and seven male parents (68726, 68786, 68814, 68716, 68710, 68724 and 68740) recorded significant positive *gca* effects. Other parents recorded either non-significant or negative *gca* effects (Table 7).

4.5.14. Green fodder yield per plot:

The green fodder yield per plot ranged from -3.025 (296 A) to 3.105 (111 A) among the lines and from -3.354 (FS 9603) to 3.552 (68724) among the testers in the pooled data. Among the lines 111 A recorded the highest positive significant *gca* effects followed by 2219A, both in pooled data and in individual environments. The values were positive and significant for 68724, 68814 and 68726 in pooled data as well as in individual environments.

The parents FS 9601, FS 9605, FS 9401, FS 211 and 68740 had significant positive *gca* effects in pooled data and their effects in individual environments were either negative or non-significant atleast in two environments (Table 7).

4.6. Combining ability effects of hybrids:

The *sca* effects of eighty-four hybrids for the fourteen character studied are presented in Appendices 22 to 35.

4.6.1. Days to 50 per cent flowering:

The *sca* effects of hybrids for days to 50 per cent flowering ranged from -3.948 (2219 A x 68814) to 4.312 (111 A x 68918) in pooled data. The hybrid 2219 A x 68814 recorded the highest negative *sca* effect in pooled data as well as in individual environments followed by 296 A x 68724 and 2219 A x 68786 (Table 8).

4.6.2. Plant height:

The *sca* effects of hybrids for plant height ranged from -25.833 (111 A x SS 003) to 24.08 (2219 A x SS 003) in pooled data. These hybrids also recorded significant values in individual environment and in pooled data in their respective direction. Among the hybrids twenty-three had recorded significantly negative *sca* effects (Table 8).

4.6.3. Number of tillers:

The *sca* effects of hybrids for number of tillers ranged from -0.71 (2219 A x 68726) to 1.308 (296 A x 68726). Among the different hybrids 296 A x 68726 had recorded maximum positive *sca* effects in pooled data and in two individual (E_2 and E_4) environments. A total of six hybrids had registered positive significant *sca* effects in pooled data (Table 8).

4.6.4. Number of leaves:

The range of *sca* effects for number of leaves in pooled data over environments was from -0.704 (111 A x 68710) to 0.825 (111 A x SS 012). The hybrid 111 A x SS 012 was highly

Table 8. Specific combining ability effects of hybrids in pooled data for different characters

Hybrids	Days to 50% flowering	Plant height	No. of tillers	No. of leaves	Leaf length	Leaf breadth	Leaf/stem ratio	Stem thickness	Hydrocyanic acid	Total soluble solids	Crude protein	DFY/ plot	Green fodder yield/ plant	Green fodder yield/ plot
296A x 68716	0.266	-22.860**	-0.453*	-0.330	-5.492**	-0.340	-0.007	-0.118	4.556**	-0.468	1.086**	-24.554**	-108.049**	-0.184
296A x 68740	-2.026**	-9.736**	-0.108	-0.298	-0.798	-0.317	0.010	-0.007	13.057**	0.522	-0.294**	-2.203	-9.924**	1.917**
296A x 68918	-1.442**	0.412	-0.047	0.390	0.797	0.515*	-0.010	0.086	-9.985**	-0.009	0.143**	-0.194	5.868**	2.277**
296A x 68786	1.016**	0.090	-0.229	-0.314	-2.105	-0.312	-0.005	-0.058	10.583**	0.626*	-0.294**	-17.293**	-78.227**	-4.209**
296A x 68814	-0.401	0.878	-0.593**	0.325	-1.907	0.191	0.036**	0.094	10.954**	0.709*	0.150**	-18.977**	-120.747**	-3.222**
296A x FS211	3.245**	11.449**	-0.166	0.196	0.681	0.028	0.008	0.073	-14.875**	0.543	0.173**	-1.946	17.284**	1.896**
296A x FS205	1.349**	0.776	-0.048	0.242	-0.248	0.331	-0.010	0.059	2.992	-0.187	-0.599**	0.498	-0.266	1.351**
296A x FS9401	1.308**	5.684**	-0.175	0.485*	0.472	-0.102	0.005	0.024	10.326**	-1.041**	1.041**	-3.029	-0.698	2.185**
296A x SS003	0.787*	12.975**	0.057	0.090	0.119	-0.022	-0.003	-0.011	-10.706**	-0.291	-0.207**	2.488	4.076*	1.644**
296A x SS012	-0.484	-5.796**	-0.183	-0.301	1.483	0.091	-0.011*	-0.058	6.798**	-0.999**	0.121*	-6.819**	-40.657**	0.563
296A x SS020	-0.984**	5.716**	-0.018	-0.255	1.607	0.204	-0.017**	0.198*	-23.079**	0.730*	-0.295**	6.619*	27.309**	-1.795**
296A x SRV605	-0.213	-5.207**	0.232	0.085	2.847	-0.094	0.036**	0.077	17.829**	0.438	0.689**	6.216*	6.214**	-6.072**
296A x FS9604	1.099**	10.187**	0.263	0.736**	1.084	0.377	0.001	0.270**	5.748**	-1.895**	-0.491**	21.171**	97.356**	-2.412**
296A x FS9605	0.412	-2.850	-0.235	-0.298	-1.025	-0.401	-0.011*	-0.053	-9.043**	-0.957**	-1.147**	-11.241**	-19.921**	0.551
296A x FS9601	0.912**	1.021	0.057	0.134	2.977	0.024	-0.005	-0.007	3.356*	1.272**	1.065**	8.674**	15.145**	3.416**
296A x FS9603	0.099	3.820*	-0.067	-0.009	2.257	-0.089	0.006	-0.087	-2.582	0.397	0.167**	-2.423	4.220*	0.924**
296A x 68710	-1.151**	8.500**	0.218	0.198	2.028	0.147	0.000	-0.045	-28.619**	0.668*	-1.322**	-2.979	22.828**	4.851**
296A x 68724	-3.651**	1.945	0.165	-0.577*	-1.082	-0.090	-0.012*	-0.127	-0.185	0.855**	0.099	12.417**	24.118**	-0.550
296A x 68726	-0.338	-9.812**	1.308**	-0.564*	-4.706**	-0.231	-0.009	-0.108	-3.309	-0.624*	-0.464**	16.049**	79.320**	-6.723**
296A x Co27	-0.401	-3.496*	-0.276	-0.201	0.764	0.036	0.003	-0.145	20.432**	0.043	0.456**	3.982	-5.287**	2.898**
296A x SS032	0.599	-3.694*	0.296	0.267	0.249	0.053	-0.007	-0.056	-4.249*	-0.332	-0.076	13.542**	80.038**	0.694*
2219A x 68716	-1.032**	12.530**	0.607**	0.396	2.748	0.116	0.011*	0.110	-0.353	0.411	-0.559**	23.906**	92.668**	7.462**
2219A x 68740	0.343	-0.229	0.220	0.056	-0.665	0.264	-0.011*	-0.031	-0.572	-0.558	-0.359**	-3.340	21.852**	-0.539
2219A x 68918	-0.990**	-0.140	0.294	-0.482*	1.384	-0.425	-0.004	-0.033	17.638**	-0.130	0.253**	10.085**	46.793**	1.567**
2219A x 68786	-3.282**	1.854	0.075	0.305	1.862	0.034	0.002	-0.095	0.777	-0.620*	0.076	6.221*	-8.390**	1.469**
2219A x 68814	-3.948**	-8.306**	0.283	-0.619**	-3.071	-0.368	-0.020**	-0.088	-9.772**	0.297	-0.180**	-7.389**	-20.545**	-0.267
2219A x FS211	0.281	-1.299	-0.036	-0.195	-2.634	-0.199	-0.003	-0.065	27.316**	-0.620*	0.018	5.047	7.716**	-2.046**
2219A x FS205	-0.948**	-1.855	0.032	0.082	1.114	-0.182	0.013*	-0.022	15.188**	0.651*	0.471**	-4.861	6.016**	-2.416**
2219A x FS9401	0.510	-5.776**	0.161	0.217	0.335	0.183	0.024**	-0.011	3.766*	0.047	0.711**	10.653**	34.236**	-0.309
2219A x SS003	0.989**	24.008**	0.021	0.308	3.524*	0.076	0.013*	0.028	5.224**	0.463	-0.799**	8.67**	28.315**	-0.274
2219A x SS012	0.552	6.709**	0.365	-0.220	-0.082	0.013	-0.005	0.069	-3.526*	1.505**	-0.382**	6.173*	23.229**	-0.993**
2219A x SS020	-0.115	-3.674*	0.078	-0.046	-2.085	0.069	-0.003	-0.042	12.857**	-0.266	0.165**	13.321**	36.414**	2.412**
2219A x SRV605	0.739*	5.475**	-0.257	0.000	1.061	0.457*	-0.013*	0.011	-11.241**	-0.891**	0.449**	-1.106	-1.919	-1.537**
2219A x FS9604	1.218**	2.004	-0.261	-0.097	2.296	0.253	-0.010	-0.044	-11.234**	0.109	0.229**	-19.480**	-66.676**	-1.058**

Table 8 (contd..)

Hybrids	Days to 50% flowering	Plant height	No. of tillers	No. of leaves	Leaf length	Leaf breadth	Leaf/stem ratio	Stem thickness	Hydrocyanic acid	Total soluble solids	Crude protein	DFY/ plot	Green fodder yield/ plant	Green fodder yield/ plot
2219A x FS9605	1.364**	-4.381*	0.020	-0.257	-1.612	0.067	0.023**	0.035	-13.515**	0.047	-0.165**	3.276	-10.863**	-3.523**
2219A x FS9601	0.114	-5.081**	0.060	-0.240	-0.292	-0.061	-0.011*	-0.010	-3.213	-0.474	-0.67**	6.427*	39.688**	-1.745**
2219A x FS9603	0.385	-8.716**	-0.302	0.161	-0.771	-0.028	-0.012*	-0.085	1.679	-1.183**	0.187**	-11.474**	-44.603**	1.435**
2219A x 68710	-0.448	-2.991	-0.455*	0.244	-3.227	-0.142	-0.002	0.037	-6.176**	-0.245	0.888**	-8.804**	-54.198**	-1.710**
2219A x 68724	0.135	0.894	-0.329	0.403	-0.585	-0.003	-0.001	0.069	-23.844**	0.609	-0.316**	-10.828**	-35.604**	-2.480**
2219A x 68726	1.697**	0.866	-0.710**	0.057	-0.419	0.173	0.000	0.065	2.207	0.630*	0.171**	-26.46**	-98.224**	2.646**
2219A x Co27	1.052**	-1.640	0.193	0.150	-0.219	-0.293	0.002	-0.027	-2.375	-0.620*	-0.399**	-7.947**	-22.053**	0.794**
2219A x SS032	1.385**	-10.252**	-0.060	-0.223	1.337	-0.004	0.007	0.127	-0.833	0.838**	0.209**	7.91**	26.147 **	1.112**
2077A x 68716	-0.837**	11.153**	-0.051	-0.188	1.969	0.397	-0.010	0.044	0.009	-0.355	0.113*	15.922**	60.953**	-4.468**
2077A x 68740	0.121	-1.243	0.426*	-0.239	-1.401	0.159	-0.008	0.090	1.745	0.593	0.483**	11.859**	60.760**	1.835**
2077A x 68918	-1.879**	-4.874**	-0.164	0.095	-0.942	0.229	0.029**	0.029	-2.862	-0.313	0.045	-5.124	-5.378**	-1.869**
2077A x 68786	2.079**	0.271	-0.088	0.365	1.096	-0.053	-0.004	0.108	3.202	-0.303	-0.216**	15.378**	116.507**	2.435**
2077A x 68814	2.913**	6.906**	0.119	0.529*	1.285	0.309	0.004	0.042	1.410	0.697*	0.752**	14.627**	60.578**	0.465
2077A x FS211	-1.275**	-3.444*	0.199	-0.025	2.198	0.082	0.008	-0.046	8.076**	0.781*	0.073	-7.213**	-25.504**	2.273**
2077A x FS205	0.579	1.834	0.120	-0.423	-0.604	-0.236	0.002	-0.037	-0.713	-1.198**	0.614**	4.412	7.721**	0.809**
2077A x FS9401	-0.629*	-2.170	0.155	-0.506*	-1.322	-0.163	-0.020**	0.014	-16.717**	0.281	-0.632**	-1.966	-20.571**	0.323
2077A x SS003	0.850*	-11.149**	0.095	0.058	-0.803	-0.157	-0.011*	-0.152	7.241**	0.114	0.748**	-1.135	10.410**	-0.175
2077A x SS012	1.413**	1.948	0.015	-0.303	-1.188	-0.122	0.016**	-0.085	0.158	-0.344	0.550**	-0.540	22.004**	1.156**
2077A x SS020	-0.921**	1.230	0.248	0.187	2.807	-0.009	0.013*	-0.127	-5.541**	0.552	-1.093**	-11.321**	-39.419**	1.352**
2077A x SRV605	-0.150	2.424	-0.168	0.226	-1.237	-0.114	-0.022**	0.002	-17.115**	0.010	-1.156**	-8.856**	-18.189**	2.294**
2077A x FS9604	0.329	-5.962**	-0.272	-0.364	-4.587**	-0.201	-0.009	-0.197*	14.538**	0.760*	-0.674**	-7.549**	-32.203**	1.650**
2077A x FS9605	-0.441	-3.277	-0.189	0.378	2.531	0.074	0.001	0.021	20.560**	0.114	0.770**	-6.557*	-34.114**	1.959**
2077A x FS9601	0.059	-12.370**	0.097	-0.503*	0.993	-0.209	0.015**	0.021	-4.528**	0.010	0.702**	-9.590**	-54.227**	0.018
2077A x FS9603	-0.004	4.863**	-0.253	0.281	-0.066	-0.026	-0.004	0.157	-17.552**	0.218	-0.108*	-6.952**	-30.410**	2.359**
2077A x 68710	2.079**	0.988	0.104	0.263	1.351	-0.055	0.017**	-0.023	8.174**	-1.010**	0.242**	14.207**	25.145**	2.252**
2077A x 68724	2.496**	-3.804*	0.217	-0.061	-0.396	-0.085	0.006	-0.044	12.351**	-0.907**	0.001	6.592*	-20.463**	-0.590
2077A x 68726	-1.525**	7.506**	-0.259	0.269	1.021	0.055	-0.006	0.010	2.554	0.114	-0.409**	19.405**	50.007**	-2.127**
2077A x Co27	-2.587**	2.846	0.294	-0.034	-0.778	0.250	-0.007	0.235*	-2.028	0.864**	-0.281**	9.264**	74.342**	-2.783**
2077A x SS032	-2.671**	6.323**	-0.644**	-0.003	-1.926	-0.125	-0.009	-0.063	-12.961**	-0.678*	-0.524**	-44.864**	-207.951**	-9.167**
111A x 68716	1.603**	-0.823	-0.102	0.123	0.775	-0.172	0.006	-0.035	-4.211*	0.411	-0.640**	-15.275**	-45.572**	-2.810**
111A x 68740	1.562**	11.209**	-0.538**	0.480*	2.865	-0.106	0.009	-0.052	-14.230**	-0.558	0.170**	-6.316*	-72.688**	-3.213**
111A x 68918	4.312**	4.603**	-0.084	-0.004	-1.239	-0.319	-0.015**	-0.082	-4.792**	0.453	-0.440**	-4.768	-47.283**	-1.975**
111A x 68786	0.187	-2.215	0.242	-0.357	-0.853	0.331	0.007	0.045	-14.563**	0.297	0.434**	-4.306	-29.891**	0.305
111A x 68814	1.437**	0.521	0.192	-0.235	3.693*	-0.132	-0.020**	-0.048	-2.592	-1.703**	-0.723**	11.738**	80.714**	3.023**
111A x FS211	-2.251**	-6.706**	0.004	0.024	-0.245	0.088	-0.013*	0.038	-20.517**	-0.703*	-0.265**	4.112	0.504	-2.123**

Table 8. (contd..)

Hybrids	Days to 50% flowering	Plant height	No. of tillers	No. of leaves	Leaf length	Leaf breadth	Leaf/stem ratio	Stem thickness	Hydrocyanic acid	Total soluble solids	Crude protein	DFV/plot	Green fodder yield/ plant	Green fodder yield/ plot
111A x FS205	-0.980**	-0.755	-0.104	0.099	-0.263	0.087	-0.005	0.000	-17.467**	0.734*	-0.486**	-0.049	-13.472**	0.257
111A x FS9401	-1.188**	2.262	-0.141	-0.196	0.515	0.082	-0.009	-0.027	2.625	0.713*	-1.120**	-5.658*	-12.967**	-2.198**
111A x SS003	-2.626**	-25.833**	-0.173	-0.455	-2.840	0.103	0.000	0.134	-1.758	-0.287	0.258**	-10.023**	-42.801**	-1.195**
111A x SS012	-1.480**	-2.861	-0.197	0.825**	-0.213	0.018	0.000	0.073	-3.431*	-0.162	-0.290**	1.186	-4.576*	-0.725*
111A x SS020	2.020**	-3.271	-0.308	0.115	-2.330	-0.264	0.007	-0.029	15.762**	-1.016**	1.222**	-8.618**	-24.304**	-1.968**
111A x SRV605	-0.376	-2.692	0.193	-0.311	-2.671	-0.249	-0.001	-0.089	10.527**	0.442	0.019	3.746	13.893**	5.315**
111A x FS9604	-2.647**	-6.228**	0.269	-0.275	1.208	-0.430	0.017**	-0.029	-9.052**	1.026**	0.936**	5.858*	1.522	1.819**
111A x FS9605	-1.334**	10.507**	0.404*	0.177	0.106	0.260	-0.013*	-0.003	1.998	0.797*	0.542**	14.523**	64.898**	1.013**
111A x FS9601	-1.084**	16.430**	-0.214	0.609**	-3.678*	0.246	0.001	-0.004	4.384**	-0.808**	-1.098**	-5.511*	-0.605	-1.689**
111A x FS9603	-0.480	0.032	0.623**	-0.433	-1.420	0.143	0.010	0.015	18.455**	0.567	-0.246**	20.849**	70.793**	-4.717**
111A x 68710	-0.480	-6.498**	0.132	-0.704**	-0.152	0.051	-0.015**	0.030	26.621**	0.588	0.192**	-2.424	6.224**	-5.393**
111A x 68724	1.020**	0.965	-0.052	0.236	2.063	0.179	0.007	0.102	11.678**	-0.558	0.216**	-8.181**	31.949**	3.619**
111A x 68726	0.166	1.439	-0.340	0.237	4.105*	0.003	0.015**	0.032	-1.451	-0.120	0.701**	-8.995**	-31.102**	6.204**
111A x Co27	1.937**	2.291	-0.212	0.086	0.234	0.007	0.002	-0.063	-16.030**	-0.287	0.224**	-5.300*	-47.001**	-0.909**
111A x SS032	0.687*	7.623**	0.408*	-0.041	0.340	0.075	0.009	-0.008	18.044**	0.172	0.391**	23.412**	101.766**	7.361**
SE(gp)	0.306	1.727	0.188	0.237	1.682	0.224	0.0057	0.096	1.7	0.313	0.055	2.637	1.945	0.306

* Significant at 5 per cent level

** Significant at 1 per cent level

significant in pooled data and in E₄ in the positive direction followed by 296 A x FS 9604 which was significant in E₂, E₄ and in pooled data over environments (Table 8).

4.6.5. Leaf length:

The maximum positive significant *sca* effect of 4.105 was recorded by 111 A x 68726 in pooled data followed by 111 A x 68814 (3.693) and 2219 A x SS 003 (3.524). All other hybrids showed either negative or non-significant values (Table 8).

4.6.6. Leaf breadth:

Among the different hybrids only two viz., 296 A x 68740 (0.515) and 2219 A x SRV 605 (0.457) had positive significant values in pooled data over environments. All other hybrids were found to be non-significant (Table 8).

4.6.7. Leaf stem ratio:

The *sca* effects ranged from -0.022 (2077 A x SRV 605) to 0.036 (296 A x 68814 and 296 A x SRV 605) in pooled data over environments. The hybrids that recorded maximum *sca* effects were found to have significant *sca* effects in individual environments (Table 8).

4.6.8. Stem thickness:

The maximum positive significant *sca* effects was recorded by 296 A x FS 9604 (0.27), 2077 A x Co 27 (0.235) and 296 A x SS 020 (0.198) in pooled data. The hybrid 2077 A x FS 9604 recorded a negatively significant *sca* effect. All other hybrids were non-significant (Table 8).

4.6.9. Hydrocyanic acid:

The *sca* effects ranged from -28.619 (296 A x 68710) to 27.316 (2219 A x FS 211). The maximum negative significant *sca* effect was recorded by 296 A x 68710 both in pooled data and in individual environments. Among the different hybrids twenty-nine had recorded negative significant *sca* effects (Table 8).

4.6.10. Total soluble solids:

The *sca* effects ranged from -1.895 (296 A x FS 9604) to 1.505 (2219 A x SS 012). Among the different hybrids seventeen had recorded highly positive significant *sca* effects (Table 8).

4.6.11. Crude protein:

For crude protein, the maximum positive *sca* effects was noticed in 111 A x SS 020 (1.222) followed by 296 A x 68716 (1.086) and 296 A x FS 941 (1.041). These hybrids recorded positive significant difference both in pooled and in individual environments. Among the eighty-four different combinations, thirty-eight hybrids showed positive significant values (Table 8).

4.6.12. Dry fodder yield:

The *sca* effects of ranged from -44.864 (2077 A x SS 032) to 23.906 (2219 A x 68716). The hybrids of 111 A x SS 032 (23.413) and 296 A x FS 9604 (21.171) were significant in pooled data and also in individual environments (Table 8).

4.6.13. Green fodder yield per plant:

2077A x 68786 (116.51) followed by 111A x SS032 (101.76) recorded the maximum *sca* effects. The lowest value was observed in 2077A x SS032 (-207.95) followed by 296A x 68814 (-120.75). Among the different hybrid combinations, thirty-eight hybrids recorded positive significant *sca* effects. All other hybrids either had negatively significant or non-significant effects in the pooled data. The hybrids showing maximum *sca* effects were also significant in individual environments (Table 8).

4.6.14. Green fodder yield per plot:

The range of *sca* effects among hybrids for green fodder yield per plot was from -9.167 (2077A x SS032) to 7.46(2219A x 68716). These hybrids were significant in individual as well as in pooled data in their respective directions. Among the different hybrid combinations

thirty-five hybrids recorded positive significant *sca* effects and most of these were 2077A derivatives (Table 8).

4.7.Heterosis:

Heterosis was calculated as deviation of hybrids from parental mean (relative heterosis = di), best parent (heterobeltiosis =dii) and standard parent CO 27 (standard heterosis =diii) for eighty-four hybrids. The estimates of heterosis for the fourteen characters expressed as percentage are presented in Appendices 36 to 49.

4.7.1. Days to 50 per cent flowering:

The range of relative heterosis was from -12.55 per cent (2219 A x 68710) to 14.36 per cent (2077 A x 68786). Regarding heterobeltiosis, it ranged from -19.71 (2219 A x 68786) to 12.55 per cent (2077 A x FS 9604). The range of standard heterosis was from -7.83 per cent (2219 A x FS 9601) to 14.98 per cent (2077 A x 68786). All these hybrids were significant in their respective direction in pooled as well as in individual environments (Table 9).

4.7.2. Plant height:

The relative heterosis ranged from 16.79 per cent (296 A x 68716) to 61.14 per cent (2219 A x SS 003). For heterobeltiosis, the range was from -19.33 per cent (296 A x 68716) to 24.33 per cent (2077 A x SS 012) and for standard heterosis it was from -15.05 per cent (296 A x 68918) to 24.36 per cent (2077 A x SS 020). All these hybrids were significant in their respective direction both in pooled data and in individual environments (Table 9).

4.7.3. Number of tillers:

For number of tillers, the range of relative heterosis was from -14.32 per cent (111 A x 68740) to 112.66 per cent (296 A x 68710). Regarding heterobeltiosis the range was from -36.69 per cent (111 A x 68740) to 77.40 per cent (296 A x 68710) and for standard heterosis it was from -36.47 per cent (2077 A x 68918) to 96.75 per cent (296 A x 68726) in pooled data. Considering their effect in individual environments for the above hybrids varying degrees of values and negative or non-significant effects (Table 9) were observed.

Table 9. Relative heterobeltosis (dli), Heterobeltosis (dli) and standard heterosis (dli) in pooled data for different characters

Hybrids	Days to 50 % flowering			Plant height			No. of tillers			No. of leaves			Leaf length		
	di	dli	dlii	di	dli	dlii	di	dli	dlii	di	dli	dlii	di	dli	dlii
296A x 68716	0.46	-0.77	3.91**	16.79**	-19.33**	-12.24**	10.28	-17.41	-25.58*	-4.46	-7.83*	-1.02	-1.33	-4.80	-1.65
296A x 68740	-4.60**	-6.36**	-0.67	26.81**	-13.32**	-2.02	12.08	-22.17*	-10.21	-4.38	-5.64	1.33	5.47	2.80	3.99
296A x 68918	-5.17**	-7.21**	-0.94	27.60**	-7.32**	-15.05**	39.58*	23.60	-28.08*	1.91	0.92	10.52**	11.47**	8.45*	4.16
296A x 68786	6.81**	4.97**	11.07**	20.45**	-19.71**	-0.02	-1.44	29.64**	-26.20*	-8.23**	-12.11**	3.11	2.43	-3.76	5.13
296A x 68814	-2.06**	-7.21**	5.94**	29.14**	-12.52**	2.29	40.81*	18.95	-22.60*	4.07	4.04	11.73**	12.49**	9.11*	11.50**
296A x FS211	3.90**	0.53	2.56**	42.24**	3.68**	-6.03**	36.11*	10.91	-20.99	-15.85**	-24.81**	2.60	9.67**	8.81*	6.16
296A x FS205	1.79**	1.72	3.78**	40.60**	-0.95	0.50	26.82	-4.52	-15.31	0.80	0.28	7.69	7.84*	5.76	1.58
296A x FS9401	-1.53*	-1.85	0.13	33.16**	-8.37**	1.05	28.42*	-5.20	-10.72	-1.95	-2.76	6.18	2.87	-2.69	4.77
296A x SS003	-3.62**	-3.94**	-1.21	43.16**	4.19**	-5.12**	39.59*	13.33	-18.49	-0.47	-4.79	2.24	3.71	-0.58	4.10
296A x SS012	-2.56**	-4.37**	-2.43**	33.38**	-0.83	-15.50**	23.32	8.11	-35.62**	-4.95	-8.34	-1.56	3.86	2.83	-1.24
296A x SS020	-1.07	-1.98	0.00	37.27**	-7.07**	8.92**	17.00	-13.64	-18.66	-8.89**	-11.93**	1.33	12.57**	6.64	14.49**
296A x SRV605	-0.51	-3.01**	4.32**	24.19**	-12.98**	-10.03**	37.81**	4.09	-8.56	-6.18	-6.84	0.04	7.31*	4.45	5.98
296A x FS9604	8.55**	5.82**	7.96**	46.65**	9.90**	-8.58**	44.10**	12.96	-10.75	12.01**	4.80	12.55**	9.81**	7.68*	3.42
296A x FS9605	-1.72**	-1.72*	0.40	30.93**	-9.45**	-1.95	18.90	-12.84	-16.10	-7.38*	-10.90**	-4.32	3.29	-3.78	7.07
296A x FS9601	-0.41	-3.04**	-1.08	35.16**	-6.22**	0.35	28.66*	-7.67	-4.83	-3.99	-7.33	-0.48	10.74**	10.02*	7.07
296A x FS9603	-3.37**	-3.43**	-1.21	34.31**	-4.19**	-6.83**	20.66	-18.02*	2.50	-7.09*	-11.91**	-5.40	6.18	2.59	5.68
296A x 68710	-10.34**	-17.75**	0.67	46.32**	5.43**	-0.82	112.66**	77.40**	19.08	-3.72	-5.73	1.23	12.27**	4.81	16.10**
296A x 68724	-5.91**	-6.52**	-3.24**	43.18**	0.79	2.55*	24.08*	-16.23	7.29	-5.29	-8.45**	-1.69	12.79**	9.97**	11.19**
296A x 68726	-4.69**	-5.95**	-4.05**	27.97**	-11.63**	-3.79**	95.47**	25.77**	96.75**	-11.16**	-13.29**	-6.88	-3.61	-10.58**	0.40
296A x Co27	-3.20**	-4.10**	-2.16**	30.85**	-7.43**	-7.43**	9.69	-20.55	-20.55	-6.53	-9.75**	-3.08	9.78**	7.60*	7.60*
296A x SS032	-3.94**	-4.56**	-1.21	27.84**	-9.33**	-10.10**	62.59**	20.74	11.64	-6.51*	-8.24*	2.34	-0.92	-4.14	-1.53
2219A x 68716	-4.93**	-7.99**	-3.64**	48.42**	1.32	10.24**	66.76**	27.75*	15.10	16.50**	8.67*	8.47*	22.32**	6.46	9.99**
2219A x 68740	-4.23**	-7.89**	-2.29**	41.04**	-4.68**	7.74**	23.00*	-12.94	0.45	11.35**	1.68	6.32	15.47**	1.41	2.58
2219A x 68918	-7.84**	-11.63**	-5.67**	36.64**	-2.05	-10.23**	56.57**	42.79*	-16.92	2.76	-8.08*	0.66	23.66**	13.92**	3.49
2219A x 68786	-3.18**	-6.76**	-1.35	28.99**	-14.92**	5.95**	9.16	-20.47	-16.58	9.26**	-5.14	11.29**	18.32**	0.60	9.89**
2219A x 68814	-10.69**	-17.02**	-5.26**	31.32**	-12.02**	2.88*	95.58**	69.84**	10.51	4.26	-5.91	0.99	20.87**	5.69	8.00*
2219A x FS211	-4.47**	-5.66**	-7.69**	42.36**	2.40	-7.20**	36.72*	14.38	-18.53	-11.53**	-27.76**	-1.42	13.98**	1.69	-0.79
2219A x FS205	-5.27**	-7.03**	-5.40**	47.73**	2.80*	4.31**	24.61	-4.02	-14.86	10.50**	0.16	6.45	20.98**	10.63*	2.14
2219A x FS9401	-6.23**	-7.73**	-6.61**	34.00**	-8.85**	0.52	41.06**	6.44	0.24	5.96	-5.10	3.62	11.77**	-4.40	2.93
2219A x SS003	-6.72**	-8.92**	-6.34**	61.14**	15.74**	5.39**	28.80	7.33	-22.81*	14.47**	7.67	5.57	19.14**	3.11	7.95*
2219A x SS012	-4.34**	-4.40**	-6.21**	53.23**	12.35**	-4.26**	56.36**	41.12*	-15.96	7.59*	0.39	0.12	10.88**	0.51	-5.38
2219A x SS020	-3.07**	-4.05**	-4.05**	39.41**	-6.65**	9.40**	16.00	-12.47	-17.57	3.81	-9.12**	4.56	16.30**	-0.41	6.93
2219A x SRV605	-2.30**	-6.65**	0.40	40.16**	-2.98*	0.31	0.83	-22.07	-31.54**	3.73	-5.82	-0.28	14.03**	0.02	1.48
2219A x FS9604	5.47**	4.97**	2.70**	50.48**	11.19**	-7.50**	2.19	-17.90	-35.14**	14.64**	10.25*	3.16	22.89**	12.38**	3.75
2219A x FS9605	-3.57**	-5.55**	-3.51**	38.35**	-5.44**	2.40*	26.95*	-4.91	-8.46	4.39	-2.36	-3.12	11.30**	-6.08	4.51
2219A x FS9601	-5.20**	-5.79**	-7.83**	39.62**	-4.26**	2.45*	22.45	-10.30	-7.53	2.72	-4.23	-4.31	15.26**	2.95	0.19
2219A x FS9603	-6.33**	-8.31**	-6.21**	34.47**	-5.28**	-7.89**	4.02	-28.05**	-10.03	6.62	1.16	-2.63	10.49**	-3.72	-0.81
2219A x 68710	-12.55**	-21.28**	-3.64**	47.41**	4.85**	-1.37	53.93**	31.94	-11.44	8.27*	-0.41	2.48	13.22**	-4.29	6.03
2219A x 68724	-3.28**	-5.87**	-2.56**	51.42**	5.29**	7.13**	-4.40	-34.30**	-15.86	18.83**	10.62**	10.88**	24.26**	9.16*	10.37**
2219A x 68726	-4.86**	-5.44**	-6.21**	43.38**	-2.13	6.55**	8.58	-29.07**	10.96	7.43*	-0.90	1.33	11.94**	-5.88	5.67
2219A x Co27	-4.29**	-5.26**	-5.26**	41.08**	-1.42	-1.42	29.63*	-4.11	-4.11	9.31*	1.88	1.88	18.28**	4.40	4.40
2219A x SS032	-6.10**	-8.60**	-5.40**	32.15**	-7.44**	-8.23**	34.10*	1.81	-5.86	-1.89	-12.95**	-2.91	10.01**	-4.02	-1.40
2077A x 68716	4.32**	-0.39	4.32**	55.42**	12.24**	22.11**	22.13	-3.08	-12.67	16.56**	13.00**	12.80**	16.75**	9.55*	13.18**
2077A x 68740	4.29**	-1.02	4.99**	48.47**	5.98**	19.79**	28.57*	-6.23	8.18	15.14**	9.17*	14.15**	10.41**	4.64	5.84

Table 9 (contd..)

Hybrids	Days to 50 % flowering			Plant height			No. of tillers			No. of leaves			Leaf length		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
2077A x 68918	-0.47	-5.82**	0.54	42.86**	9.10**	-0.00	14.36	9.18	-36.47**	17.15**	8.71*	19.05**	14.87**	14.69**	4.19
2077A x 68786	14.36**	8.67**	14.98**	36.20**	-5.47**	17.72**	-3.65	-27.52**	-23.97*	16.98**	5.21	23.44**	13.22**	3.54	13.10**
2077A x 68814	8.38**	-0.59	13.50**	48.73**	5.10**	22.90**	74.69**	58.37**	3.05	25.63**	17.66**	26.29**	23.94**	16.90**	19.45**
2077A x FS211	2.27**	2.27**	-2.56**	50.11**	15.08**	4.29**	45.66**	26.92	-9.59	-2.66	-17.91**	12.03**	18.46**	14.21**	11.43**
2077A x FS205	6.30**	2.92**	4.72**	58.43**	16.95**	18.67**	24.30	-0.77	-11.99	11.73**	5.13	11.73**	13.53**	12.45**	3.83
2077A x FS9401	0.96	-2.00**	-0.81	44.80**	4.13**	14.84**	34.99**	5.42	-0.72	4.75	-2.67	6.28	5.65	-2.74	4.71
2077A x SS003	2.04**	-1.71*	1.08	44.45**	10.56**	0.68	27.35	10.52	-20.51	18.84**	16.21**	13.95**	7.99*	0.70	5.44
2077A x SS012	6.35**	4.81**	2.83**	58.67**	24.33**	5.95**	22.59	15.76	-31.06**	14.26**	10.82**	10.52**	5.34	3.34	-2.71
2077A x SS020	4.77**	2.29**	2.29**	50.25**	6.11**	24.36**	20.56	-5.85	-11.34	13.80**	3.25	18.79**	20.49**	11.06**	19.25**
2077A x SRV605	5.12**	-0.88	6.61**	46.79**	7.71**	11.36**	1.46	-18.71	-28.60**	14.09**	7.54*	13.86**	6.47	0.75	2.23
2077A x FS9604	13.42**	12.55**	8.91**	53.79**	21.57**	1.14	-3.48	-19.42	-36.34**	18.88**	18.78**	11.32**	6.21	5.20	-2.88
2077A x FS9605	2.53**	-0.92	1.21	47.48**	6.65**	15.49**	10.19	-14.62	-17.81	20.21**	16.88**	15.97**	14.56**	3.90	15.62**
2077A x FS9601	4.01**	3.36**	-0.27	43.45**	4.12**	11.42**	19.56	-9.53	-6.75	7.32*	3.99	3.91	13.58**	9.65*	6.70
2077A x FS9603	2.05**	-1.45*	0.81	52.94**	14.47**	11.33**	2.58	-27.01**	-8.73	16.03**	14.52**	10.22*	8.24*	1.70	4.77
2077A x 68710	-0.68	-11.69**	8.10**	58.89**	20.26**	13.13**	84.59**	65.05**	10.79	16.08**	10.90**	14.12**	17.05**	6.38	17.84**
2077A x 68724	9.57**	5.22**	8.91**	56.41**	15.35**	17.37**	16.97	-17.35*	5.86	20.31**	16.40**	16.67**	20.12**	13.86**	15.12**
2077A x 68726	-1.04	-2.99**	-3.78**	55.67**	12.38**	22.36**	23.02*	-17.69*	28.77**	17.68**	12.77**	15.31**	10.86**	0.15	12.43**
2077A x Co27	-1.17	-3.51**	-3.51**	52.80**	13.33**	13.33**	29.90*	-0.68	-0.68	14.65**	11.05**	11.05**	13.29**	7.95*	7.95*
2077A x SS032	-3.73**	-7.56**	-4.32**	52.51**	13.43**	12.46**	-4.50	-24.93*	-30.58**	8.31*	-0.33	11.16**	1.19	-4.80	-2.20
1111A x 68716	4.20**	3.87**	8.77**	38.10**	1.04	9.93**	23.56	-0.42	-10.27	11.02**	6.56	15.66**	12.93**	6.21	9.72*
1111A x 68740	2.63**	1.65*	7.83**	46.36**	5.81**	19.61**	-14.32	-36.69**	-26.95*	14.45**	12.36**	21.95**	15.71**	9.91**	11.17**
1111A x 68918	5.38**	4.05**	11.07**	38.46**	7.30**	-1.65	25.84	22.54	-28.70**	7.27*	6.79	16.95**	12.38**	12.28**	2.18
1111A x 68786	7.14**	6.25**	12.42**	25.99**	-11.51**	10.20**	17.57	-10.32	-5.92	0.76	-3.01	13.79**	8.31*	-0.73	8.44*
1111A x 68814	2.29**	-2.25**	11.61**	35.61**	-2.97**	13.46**	83.93**	69.89**	10.55	7.60*	7.00	16.14**	26.09**	19.19**	21.80**
1111A x FS211	-3.32**	-7.27**	-3.64**	36.70**	6.36**	-3.61**	37.51*	21.97	-13.12	-8.80**	-18.13**	11.73**	12.39**	8.61*	5.97
1111A x FS205	-0.20	-1.17	2.70**	46.30**	9.49**	11.09**	15.86	-6.06	-16.68	9.07**	7.93*	17.15**	12.19**	11.38**	2.84
1111A x FS9401	-3.75**	-4.94**	-1.21	37.81**	0.40	10.71**	22.66	-2.76	-8.42	0.25	-0.06	9.13*	6.85*	-1.42	6.14
1111A x SS003	-7.24**	-7.65**	-4.05**	23.23**	-4.28**	-12.84**	14.82	1.43	-27.05*	3.42	-1.57	6.83	2.84	-3.89	0.63
1111A x SS012	-2.40**	-5.06**	-1.35	43.47**	14.17**	-2.71*	12.87	8.68	-35.27**	18.38**	13.58**	23.27**	5.13	3.38	-2.68
1111A x SS020	5.42**	-3.51**	7.56**	38.24**	-1.15	15.85**	-5.83	-25.35*	-29.69**	4.67	1.70	17.02**	10.35**	1.94	9.45*
1111A x SRV605	0.89	-0.75	6.75**	33.36**	-0.82	2.55*	26.95*	3.31	-9.25	-0.71	-1.92	6.45	2.24	-3.03	-1.61
1111A x FS9604	4.17**	0.65	4.59**	41.78**	13.84**	-5.29**	34.80*	14.43	-9.59	10.33**	2.72	11.50**	14.45**	13.64**	4.91
1111A x FS9605	-2.75**	-3.51**	0.27	46.15**	7.09**	15.96**	46.71**	15.37	11.06	8.43*	3.78	12.64**	8.94**	-0.98	10.18**
1111A x FS9601	-1.88**	-5.32**	-1.62*	51.53**	11.45**	19.27**	7.36	-17.61	-15.07	11.75**	7.31*	16.47**	3.71	0.35	-2.35
1111A x FS9603	-2.55**	-3.25**	0.54	39.05**	5.56**	2.66*	46.25**	5.37	31.75**	-1.69	-7.25	0.67	4.17	-1.90	1.06
1111A x 68710	-7.75**	-14.66**	4.45**	42.80**	9.66**	3.16**	90.48**	73.47**	16.44	-3.99	-6.48	1.50	12.88**	2.81	13.88**
1111A x 68724	3.12**	2.99**	7.02**	49.08**	11.46**	13.41**	8.37	-22.49**	-0.72	14.34**	9.97**	19.36**	22.37**	16.25**	17.54**
1111A x 68726	-2.12**	-4.29**	-0.54	41.99**	3.86**	13.08**	22.79*	-16.97*	29.90**	8.18*	5.05	14.02**	14.00**	3.20	15.86**
1111A x Co27	2.25**	0.39	4.32**	41.96**	6.76**	6.76**	7.02	-16.99	-16.99	7.03*	2.82	11.60**	13.13**	8.04*	8.04*
1111A x SS032	-2.08**	-2.21**	1.62*	42.83**	7.72**	6.80**	58.70**	26.67*	17.12	-0.21	-1.55	9.81*	3.14	-2.74	-0.09
S.E.(d)	0.3751	0.4331	0.4331	21.156	24.429	24.429	0.2306	0.2663	0.2663	0.2897	0.3345	0.3345	20.602	23.789	23.789
CD at 5%	0.7365	0.8505	0.8505	41.541	47.967	47.967	0.4528	0.5228	0.5228	0.5688	0.6568	0.6568	40.452	46.710	46.710
CD at 1%	0.9690	1.1189	1.1189	54.652	63.107	63.107	0.5957	0.6879	0.6879	0.7484	0.8642	0.8642	53.220	61.454	61.454

* Significant at 5 per cent level

** Significant at 1 per cent level

4.7.4. Number of leaves:

The relative heterosis for number of leaves ranged from -15.85 per cent (296A x FS211) to 25.63 per cent (2077 A x 68814) and for heterobeltiosis from -27.76 per cent (2219 A x FS 211) to 18.78 per cent (2077 A x FS 9604). The range for standard heterosis was from -6.88 per cent (296 A x 68726) to 26.29 per cent (2077 A x 68814) in pooled data (Table 9).

4.7.5. Leaf length:

The range of relative heterosis for leaf length was from -3.61 per cent (296 A x 68726) to 26.09 per cent (111 A x 68814) and for heterobeltiosis it ranged from -10.58 per cent (296 A x 68726) to 19.19 per cent (111 A x 68814). The range of standard heterosis was from -5.38 per cent (2219A x SSO12) to 21.80 per cent (111 A x 68814) in pooled data (Table 9).

4.7.6. Leaf breadth:

The relative heterosis ranged from -2.94 per cent (2219 A x CO 27) to 34.10 per cent (2077 A x 68716). Regarding heterobeltiosis the range was from -16.48 per cent (111 A x 68726) to 29.64 per cent (2077A x 68716) and for standard heterosis it was from -3.98 per cent (2219 A x 68726) to 43.40 per cent (296 A x 68918) in pooled data over environments. These hybrids were significant in their respective direction and showed varying degrees of significant and non-significant values in individual environments (Table 10).

4.7.7. Leaf stem ratio:

The range of relative heterosis for leaf stem ratio was from -36.45 per cent (111 A x 68710) to -7.44 per cent (2219 A x FS 9605) and for heterobeltiosis it was from -44.89 per cent (296A x SS012) to -18.84 per cent (2219A x FS9605). The range for standard heterosis was from -20.06 per cent (111 A x FS 211 and 111 A x 68710) to 12.85 per cent (296 A x 68814) in pooled environments (Table 10).

4.7.8. Stem thickness:

The relative heterosis ranged from -8.36 per cent (111 A x SRU605 020) to 27.62 per cent (2077 A x 68786) and for heterobeltiosis it was from -18.69 per cent (111A x FS9605)

Table 10. Relative heterosis (di), Heterobeltiosis (dii) and standard heterosis (diii) in pooled data for different characters

Hybrids	Leaf breadth			Leaf stem ratio			Stem thickness			Hydrocyanic acid			Total soluble solids		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
296A x 68716	6.31	-6.58	12.91*	-27.46**	-39.87**	-9.72**	3.18	-9.42	2.57	88.37**	79.42**	7.50**	1.90	-1.83	-13.90*
296A x 68740	8.51	-4.94	14.90*	-19.46**	-31.73**	2.51	8.93	-3.91	8.81	149.16**	146.98**	33.91**	25.32**	20.73**	5.88
296A x 68918	21.15**	18.65**	43.40**	-27.25**	-36.74**	-5.02	8.69	6.61	20.72**	67.58**	64.12**	-11.02**	-4.37	-18.22**	-6.42
296A x 68786	-0.08	-3.47	16.67**	-25.62**	-36.95**	-5.33	7.55	-0.35	12.84	55.93**	39.87**	-4.49	6.75	0.00	-6.95
296A x 68814	16.12**	2.19	23.52**	-14.18**	-24.84**	12.85**	10.54	0.27	13.55	63.29**	60.15**	-9.70**	30.49**	21.59**	-14.44*
296A x FS211	7.88	2.93	24.41**	-23.54**	-38.62**	-7.84*	9.78	1.41	14.83*	40.95**	25.41**	-12.77**	4.72	-18.38**	18.72**
296A x FS205	15.23**	9.27*	32.07**	-27.52**	-39.25**	-8.78**	5.37	-3.05	9.78	22.16**	6.64	-22.48**	-1.30	-18.45**	1.60
296A x FS9401	4.69	-1.21	19.41**	-24.43**	-37.37**	-5.96	1.63	-5.94	6.51	97.44**	93.36**	4.84	-20.20**	-35.25**	-15.51*
296A x SS003	7.12	0.77	21.79**	-26.50**	-38.62**	-7.84*	2.52	-6.22	6.20	36.25**	35.21**	-25.55**	21.02**	17.28*	1.60
296A x SS012	5.35	0.71	21.73**	-31.25**	-44.89**	-17.24**	1.30	-7.15	5.14	93.55**	90.56**	6.62**	8.18	3.61	-8.02
296A x SS020	14.54**	3.85	25.52**	-22.09**	-39.25**	-8.78**	14.38*	5.28	19.21**	-15.31**	30.36**	-41.41**	26.19**	15.22*	13.37*
296A x SRV605	3.62	-6.05	13.52*	-10.12**	-28.60**	7.21*	3.78	-1.76	11.24	89.45**	66.25**	19.39**	9.40	-3.52	2.67
296A x FS9604	15.96**	8.80	31.50**	-16.62**	-32.99**	0.63	23.26**	9.70	24.21**	45.69**	16.58**	5.29*	-15.95**	-31.69**	-11.23
296A x FS9605	1.70	-11.90*	6.48	-27.18**	-39.87**	-9.72**	-6.66	-13.72*	-2.30	4.16	-8.60*	-34.37**	12.53*	-2.42	8.02
296A x FS9601	7.29	-4.70	15.18*	-23.90**	-40.50**	-10.66**	3.15	-6.49	5.89	19.03**	-6.09*	-11.89**	42.20**	26.80**	31.55**
296A x FS9603	4.83	-4.66	15.23*	-24.81**	-36.74**	-5.02	-1.01	-10.28	1.59	45.52**	7.34**	22.47**	26.83**	18.18**	11.23
296A x 68710	8.78	3.00	24.49**	-34.26**	-40.50**	-10.66**	-2.10	-7.11	5.18	-26.78**	-42.43**	-45.47**	29.94**	13.86*	22.99**
296A x 68724	10.25	-6.16	13.42*	-33.99**	-43.63**	-15.36**	-0.07	-11.30*	0.44	31.43**	6.56*	-7.05**	26.15**	6.85	25.13**
296A x 68726	1.08	-15.91**	1.64	-30.18**	-43.01**	-14.42**	-5.94	-17.32**	-6.37	-9.44**	-33.20**	-23.79**	12.09*	-3.77	9.09
296A x Co27	6.88	-2.34	18.03**	-24.81**	-37.37**	-5.96	-4.17	-9.77	2.17	43.39**	10.57**	10.57**	27.43**	15.51*	15.51*
296A x SS032	6.64	3.04	24.54**	-29.99**	-41.75**	-12.54**	0.06	-1.37	11.69	55.26**	55.17**	-15.87**	13.80*	-0.49	8.02
2219A x 68716	12.15*	6.59	8.32	-12.76**	-23.19**	-0.31	18.44**	10.88	8.76	0.41	-21.16**	-17.18**	-8.08	-21.55**	-2.67
2219A x 68740	17.19**	11.01*	12.81*	-17.27**	-25.36**	-3.13	10.00	3.52	1.55	26.34**	-4.79*	0.01	-13.13**	-25.86**	-8.02
2219A x 68918	2.13	-4.15	11.07	-17.19**	-23.19**	-0.31	4.75	-0.45	8.41	25.71**	-6.04**	-1.30	-22.87**	-25.86**	-8.02
2219A x 68786	2.58	-2.44	9.91	-14.86**	-23.19**	-0.31	7.78	6.95	4.91	-24.25**	-37.50**	-34.35**	-29.06**	-37.93**	-22.90**
2219A x 68814	2.07	-2.82	-1.24	-22.48**	-27.54**	-5.96	2.86	-0.23	-2.12	-39.42**	-53.45**	-51.10**	0.00	-12.07*	9.09
2219A x FS211	0.52	-3.22	6.25	-18.18**	-30.43**	-9.72**	4.70	3.56	1.59	28.69**	6.95**	12.34**	-23.02**	-28.68**	3.74
2219A x FS205	3.05	-0.15	8.20	-11.38**	-21.01**	2.51	3.00	1.44	-0.49	-20.19**	-32.48**	-29.08**	-9.68*	-9.87*	12.30*
2219A x FS9401	6.68	3.88	11.42	-9.47**	-20.29**	3.45	1.53	0.63	-1.28	-0.12	-25.35**	-21.58**	-22.69**	-24.59**	-1.60
2219A x SS003	5.80	3.36	10.11	-12.65**	-22.46**	0.63	6.59	4.33	2.35	-10.30**	-31.64**	-28.19**	5.58	-10.34*	11.23
2219A x SS012	0.57	-3.35	6.53	-20.63**	-32.61**	-12.54**	10.10	7.99	5.93	-5.32	-27.45**	-23.79**	16.58**	0.00	24.06**
2219A x SS020	9.23	7.45	9.20	-7.62**	-23.91**	-1.25	4.01	2.48	0.53	-18.50**	-26.61**	-22.91**	-9.62*	-18.97**	0.53
2219A x SRV605	10.89*	9.05	10.82	-16.38**	-29.71**	-8.78**	2.16	0.61	1.77	-21.79**	-34.16	-30.84**	-25.75**	-31.03**	-14.44*
2219A x FS9604	11.19*	8.92	15.40*	-10.64**	-23.91**	-1.25	9.00	3.56	1.59	-30.54**	-35.42**	-32.16**	-9.89*	-11.73*	14.44*
2219A x FS9605	7.43	0.51	2.14	-7.44**	-18.84**	5.33	-0.71	-1.71	-3.59	-53.16**	-60.57**	-58.58**	2.96	-2.59	20.86**
2219A x FS9601	2.17	-1.74	-0.15	-16.67**	-31.16**	-10.66**	4.98	1.76	-0.18	-37.97**	-41.29**	-38.32**	-4.23	-12.07*	9.09
2219A x FS9603	2.48	1.14	2.78	-22.27**	-30.43**	-9.72**	0.72	-2.39	-4.25	-1.90	-5.79**	7.49**	-16.67**	-26.72**	-9.09
2219A x 68710	0.25	-2.72	5.09	-27.43**	-29.71**	-8.78**	3.72	1.92	3.59	-41.16**	-44.05**	-41.23**	-4.15	-10.34*	11.23
2219A x 68724	8.85	-0.11	1.51	-22.71**	-29.71**	-8.78**	12.88	6.95	4.91	-49.60**	-53.88**	-51.55**	1.11	-1.72	21.93**
2219A x 68726	5.60	-5.51	-3.98	-18.83**	-29.71**	-8.78**	5.37	-1.22	-3.10	-42.91**	-40.45**	-37.44**	5.41	0.86	25.13**
2219A x Co27	-2.94	-3.72	-2.15	-16.51**	-26.09**	-4.08	3.51	2.52	2.52	-34.68**	-36.25**	-33.03**	-4.53	-13.79**	6.95
2219A x SS032	2.42	-2.62	9.76	-17.21**	-26.81**	-5.02	10.96	4.95	15.45*	-14.25**	-35.02**	-31.74**	5.75	-0.86	22.99**
2077A x 68716	34.10**	29.64**	27.13**	-26.02**	-35.46**	-14.42**	23.95**	14.82**	15.23*	-10.93**	-30.12**	-26.42**	-28.46**	-35.61**	-29.41**
2077A x 68740	31.17**	26.38**	23.93**	-22.22**	-30.50**	-7.84*	26.29**	17.60**	18.02*	17.09**	-11.84**	-7.17**	-8.94	-18.05**	-10.16

Table 10 (contd.).

Hybrids	Leaf breadth			Leaf stem ratio			Stem thickness			Hydrocyanic acid			Total soluble solids		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
2077A x 68918	28.36**	18.49**	37.31**	-12.74**	-19.86**	6.27*	16.35**	11.79	21.74**	-14.30**	-36.00**	-32.60**	-35.08**	-36.45**	-27.27**
2077A x 68786	15.22**	7.75	21.40**	-23.02**	-31.21**	-8.78**	27.62**	25.23**	25.68**	-32.50**	-44.36**	-41.41**	-36.68**	-41.46**	-35.83**
2077A x 68814	32.08**	27.92**	25.44**	-21.07**	-26.95**	-3.13	19.26**	14.42**	14.83*	-36.80**	-51.48*	-18.90**	-4.46	-11.22*	-2.67
2077A x FS211	20.33**	13.90*	25.04**	-20.90**	-33.33**	-11.60**	14.68*	12.17	12.57	-5.78*	-21.77**	-17.62**	-17.82**	-27.94**	4.81
2077A x FS205	16.60**	11.06	20.35**	-21.29**	-30.50**	-7.84*	11.28	8.38	8.76	-50.01**	-57.75**	-55.51**	-38.81**	-42.49**	-28.34**
2077A x FS9401	14.70**	9.78	17.75**	-30.08**	-39.01**	-19.12**	11.84	9.62	10.00	-40.07**	-55.24**	-52.87**	-29.62**	-35.25**	-15.51*
2077A x SS003	16.03**	11.42	18.69**	-26.61**	-35.46**	-14.42**	5.81	2.43	2.79	-19.80**	-38.93**	-35.69**	-8.45	-18.05**	-10.16
2077A x SS012	12.40*	6.19	17.05**	-19.94**	-32.62**	-10.66**	10.69	7.37	7.75	-12.58**	-33.07**	-29.52**	-15.90**	-23.90**	-16.58**
2077A x SS020	23.10**	22.94**	20.87**	-8.83**	-25.53**	-1.25	8.42	5.65	6.02	-49.31**	-54.40**	-51.98**	-9.51	-14.15**	-5.88
2077A x SRV605	14.81**	14.69*	12.69*	-25.96**	-38.30**	-18.18**	10.46	10.02	11.29	-39.79**	-49.36**	-46.68**	-25.74**	-26.83**	-19.79**
2077A x FS9604	17.24**	12.87*	19.59**	-16.81**	-29.79**	-6.90*	9.67	3.09	3.45	-12.62**	-18.84**	-14.53**	-11.61**	-18.52**	5.88
2077A x FS9605	23.79**	17.76**	15.50*	-20.82**	-31.21**	-8.78**	7.57	5.29	5.67	-23.42**	-35.60**	-32.18**	-4.85	-5.31	4.81
2077A x FS9601	14.76**	12.29*	16.04*	-14.29**	-29.79**	-6.90*	15.85*	11.07	11.47	-29.33**	-51.89**	-49.34**	-7.77	-10.24	-1.60
2077A x FS9603	17.79**	17.25**	16.04*	-25.60**	-34.04**	-12.54**	23.33**	18.22**	18.64**	-29.33**	-32.05**	-22.47**	-9.71	-16.10**	-8.02
2077A x 68710	16.49**	11.12	20.04**	-27.50**	-30.50**	-7.84*	9.31	8.62	10.40	-35.69**	-38.92**	-35.68**	-22.36**	-22.93**	-15.51*
2077A x 68724	23.65**	15.35**	13.11*	-26.77**	-34.04**	-12.54**	15.81*	8.56	8.94	-19.92**	-26.79**	-22.91**	-24.53**	-26.94**	-14.44*
2077A x 68726	19.90**	9.01**	6.89	-27.27**	-37.59**	-17.24**	11.70	3.62	3.98	-51.42**	-49.39**	-46.70**	-8.87	-10.38	1.60
2077A x Co27	23.05**	21.86**	21.86**	-25.61**	-34.75**	-13.48**	26.20**	25.98**	26.43**	-43.78**	-45.20**	-42.29**	4.08	-0.49	9.09
2077A x SS032	14.40**	6.97	20.57**	-28.74**	-37.59**	-17.24**	9.64	4.83	15.32*	-42.55**	-56.50**	-54.19**	-20.59**	-20.98**	-13.37*
1111A x 68716	7.85	-9.01**	21.18**	-20.49**	-30.22**	-8.78**	2.76	-13.40**	8.10	15.79**	-1.31	-16.08**	-13.04**	-25.11**	-9.09
1111A x 68740	10.70*	-6.87**	24.03**	-16.80**	-25.18**	-2.19	1.74	-13.84**	7.33	31.23**	6.72**	-9.25**	-18.16**	-29.52**	-14.44*
1111A x 68918	5.82	-1.06*	31.77**	-26.07**	-31.65**	-10.66**	-3.37	-9.54	12.93	17.01**	-5.73**	-19.84**	-21.09**	-23.35**	-6.95
1111A x 68786	9.33*	0.91	34.39**	-19.20**	-27.34**	-5.02	7.88	-4.33	19.43**	-28.76**	-35.78**	-45.39**	-23.19**	-32.16**	-17.65**
1111A x 68814	8.45	-8.36*	22.04**	-28.19**	-33.09**	-12.54**	-1.33	-14.22**	7.08	-12.79**	-27.48**	-38.33**	-28.54**	-36.56**	-22.99**
1111A x FS211	7.46	-1.98	30.54**	-27.86**	-38.85**	-20.06**	3.37	-8.56	14.12	-13.38**	-21.27**	-33.05**	-27.86**	-33.82**	-3.74
1111A x FS205	9.42*	-0.77	32.15**	-23.08**	-31.65**	-10.66**	-1.99	-13.65**	7.79	-47.28**	-51.11**	-58.42**	-13.04**	-14.16**	6.95
1111A x FS9401	6.47	-3.89	27.99**	-26.23**	-35.25**	-15.36**	-5.14	-15.96**	4.91	20.26**	-18.15**	-30.40**	-20.17**	-21.59**	0.53
1111A x SS003	7.81	-2.97	29.22**	-22.76**	-31.65**	-10.66**	5.18	-7.84	15.05*	-0.64	-18.15**	-30.40**	-8.48	-21.59**	-4.81
1111A x SS012	2.89	-5.97	25.22**	-25.21**	-36.69**	-17.24**	3.29	-9.33	13.19	15.60**	-4.17	-18.51**	-8.40	-20.70**	-3.74
1111A x SS020	4.67	-9.03*	21.15**	-10.66**	-26.62**	-4.08	-1.55	-13.23**	8.32	0.90	0.36	-14.66**	-23.11**	-30.40**	-15.51*
1111A x SRV605	-0.29	-13.36**	15.38*	-18.45**	-31.65**	-10.66**	-8.36	-17.06**	3.54	24.14**	14.48**	-2.65	-15.49**	-20.70**	-3.74
1111A x FS9604	0.70	-9.59*	20.40**	-7.63**	-21.58**	2.51	2.68	-12.34*	9.43	-14.08**	-16.59**	-24.67**	-4.68	-7.82	19.79**
1111A x FS9605	12.36*	-6.47	24.56**	-25.10**	-34.53**	-14.42**	-8.11	-18.69**	1.51	-19.67**	-25.92**	-37.00**	6.91	2.20	24.06**
1111A x FS9601	9.71*	-6.50	24.53**	-18.78**	-33.09**	-12.54**	-1.18	-14.15**	7.17	-16.26**	-20.18**	-25.11**	-12.59**	-18.94**	-1.60
1111A x FS9603	7.50	-6.31	24.78**	-20.97**	-29.50**	-7.84*	-0.27	-13.35**	8.15	30.97**	14.29**	30.40**	-0.74	-11.89*	6.95
1111A x 68710	5.73	-4.26	27.51**	-36.65**	-38.85**	-20.06**	-2.62	-11.67*	10.27	9.73**	4.12	-1.37	0.70	-4.85	15.51*
1111A x 68724	13.47**	-7.11	23.72**	-26.19**	-33.09**	-12.54**	7.02	-8.87	13.77	5.87*	4.54	-8.82**	-15.70**	-17.18**	0.53
1111A x 68726	4.24	-16.48**	11.24	-20.00**	-30.94**	-9.72**	-2.96	-18.12**	2.21	-35.86**	-44.02**	-36.13**	-7.06	-10.13*	9.09
1111A x Co27	4.99	-8.09	22.41**	-22.55**	-31.65**	-10.66**	-4.23	-13.76**	7.66	-37.63**	-42.29**	-42.29**	-5.31	-13.66**	4.81
1111A x SS032	5.67	-2.45	29.91**	-22.45**	-31.65**	-10.66**	-1.79	-7.62	15.32*	34.19**	9.83**	-6.61**	-6.05	-11.01*	8.02
S.E.(d)	0.2738	0.3162	0.3162	0.0070	0.0081	0.0081	0.1172	0.1354	0.1354	20.821	24.042	24.042	0.4091	0.4724	0.4724
CD at 5%	0.5377	0.6209	0.6209	0.0137	0.0159	0.0159	0.2302	0.2658	0.2658	40.882	47.206	47.206	0.8033	0.9275	0.9275
CD at 1%	0.7074	0.8169	0.8169	0.0181	0.0209	0.0209	0.3029	0.3497	0.3497	53.785	62.106	62.106	10.568	12.203	12.203

* Significant at 5 per cent level

** Significant at 1 per cent level

to 25.98 per cent (2077 A x Co27). The range for standard heterosis was from -6.37 per cent (296 A x 68726) to 26.43 per cent (2077 A x Co 27) in pooled data over environments (Table 10).

4.7.9. Hydrocyanic acid:

For hydrocyanic acid, the range of relative heterosis was from - 53.16 per cent (2219A x FS 9605) to 149.16 per cent (296 A x 68740). Regarding heterobeltiosis, it was from -60.57 per cent (2219 A x FS9605) to 146.98 per cent (296 A x 68740) and for standard heterosis it ranged from -58.58 per cent (2219 A x FS 9605 and 111 A x FS 205) to 33.91 per cent (296 A x 68740) in the pooled data. These hybrids recorded significant heterosis in their respective direction in individual environments (Table 10).

4.7.10. Total soluble solids:

The maximum relative heterosis was recorded by 296 A x FS 9601 (42.2 per cent) in pooled as well as in individual environments. The range of heterobeltiosis was from -42.49 per cent (2077 A x FS 205) to 26.60 per cent (296A x FS 9601) and for standard heterosis 296 A x FS 9601 (31.55 per cent) recorded maximum heterosis in pooled data (Table 10).

4.7.11. Crude protein:

For crude protein the hybrids 2219 A x 68918 (30.54 per cent), 2219 A x FS 9401 (30.07 per cent), 2219 A x 68710 and 111 A x SS 020 (3.56 per cent) recorded maximum positive significant relative heterosis in pooled as well as in individual environments. Regarding heterobeltiosis 2219 A x FS 9604 and 111A x FS 9604 (28.10 per cent) recorded maximum heterosis and hybrids 2219 A x FS 9604 and 111 A x FS 9604 (25.39 per cent) recorded maximum standard heterosis (Table 11).

4.7.12. Dry fodder yield per plant:

The range of relative heterosis for dry fodder yield was from -19.20 per cent (2077 A x SS 032) to 169.24 per cent (111 A x 68814) and for heterobeltiosis, it was from -45.14 per cent (296 A x 68786) to 135.04 per cent (2077 A x 68814). Among the different

Table 11. Relative heterosis (dl), Heterobeltiosis (dli) and standard heterosis (dlii) in pooled data for different characters

Hybrids	Crude protein			Dry fodder yield			Green fodder yield / plant			Green fodder yield / plot		
	dl	dli	dlii	dl	dli	dlii	dl	dli	dlii	dl	dli	dlii
296A x 68716	26.12**	22.73**	20.13**	33.56**	0.80	-16.84**	44.10**	19.09**	21.18**	15.68**	12.24*	-7.43
296A x 68740	17.96**	16.57**	10.58**	51.35**	2.89	20.23**	42.98**	9.11**	37.75**	38.64**	21.41**	25.32**
296A x 68918	22.37**	21.67**	12.70**	56.72**	21.46**	-7.20	53.41**	25.43**	31.17**	71.12**	47.53**	14.43**
296A x 68786	9.00**	7.79**	2.12*	-10.66**	-45.14**	1.09	16.32**	-20.98**	46.34**	-56.23**	-68.11**	-45.91**
296A x 68814	20.53**	17.29**	14.81**	79.78**	38.96**	6.98	52.94**	32.45**	20.19**	9.60*	-5.38	1.00
296A x FS211	20.36**	18.28**	9.55**	46.15**	6.37	-1.89	57.44**	26.38**	38.68**	59.08**	52.76**	28.71**
296A x FS205	8.43**	7.73**	1.09	44.06**	2.88	0.96	42.32**	17.60**	19.72**	27.68**	26.13**	0.26
296A x FS9401	27.62**	23.96**	14.81**	43.69**	0.87	4.93	38.20**	9.79**	23.88**	74.33**	68.03**	40.48**
296A x SS003	7.70**	4.25**	3.17**	78.37**	48.34**	-6.01	46.47**	27.93**	13.77**	44.05**	39.92**	15.13**
296A x SS012	20.07**	17.45**	13.75**	51.69**	38.94**	-29.80**	41.20**	33.55**	-0.50	29.22**	18.26**	-8.28
296A x SS020	13.22**	12.53**	4.23**	71.47**	28.71**	7.91	62.11**	37.05**	31.79**	-22.62**	-38.27**	-19.60**
296A x SRV605	15.60**	13.08**	9.52**	49.19**	7.54	2.32	40.64**	17.78**	15.94**	-68.27**	-72.91**	-70.30**
296A x FS9604	13.87**	10.81**	8.46**	111.06**	60.88**	28.91**	116.95**	84.92**	74.32**	-45.63**	-48.69**	-55.15**
296A x FS9605	-3.31**	-7.36**	-6.35**	56.84**	20.39**	-5.46	54.35**	31.36**	24.29**	52.55**	45.30**	24.53**
296A x FS9601	22.17**	21.50**	13.78**	89.23**	39.11**	24.31**	54.88**	27.35**	31.27**	99.66**	96.56**	57.33**
296A x FS9603	5.71**	0.56	3.20**	51.98**	5.17	15.10**	51.56**	19.66**	37.28**	-10.38*	-16.17**	-25.33**
296A x 68710	-5.19**	-5.74**	-12.70**	92.90**	43.54**	23.57**	96.43**	59.01**	70.66**	35.11**	21.08**	18.52**
296A x 68724	16.09**	12.97**	10.58**	88.06**	28.37**	47.71**	73.26**	32.47**	66.32**	29.56**	3.90	33.46**
296A x 68726	8.07**	6.82**	-1.06	119.22**	47.23**	80.05**	113.77**	58.62**	117.69**	-56.39**	-67.93**	-47.14**
296A x Co27	19.21**	14.81**	14.81**	64.50**	16.82**	16.82**	55.57**	29.46**	29.46**	51.27**	34.30**	34.30**
296A x SS032	10.28**	6.09**	6.35**	55.10**	3.42	30.28**	53.90**	10.18**	69.51**	-6.88	-29.37**	5.95
2219A x 68716	12.04**	10.81**	8.46**	156.66**	74.20**	43.70**	143.47**	82.59**	85.79**	303.44**	171.73**	124.12**
2219A x 68740	23.84**	23.27**	18.02**	51.60**	-5.08	10.92	54.59**	8.43**	36.90**	123.79**	42.93**	47.53**
2219A x 68918	30.54**	27.69**	22.25**	84.04**	27.53**	-2.57	72.24**	28.00**	33.86**	266.84**	176.88**	55.55**
2219A x 68786	20.55**	19.92**	14.81**	18.35**	-31.36**	26.50**	35.76**	-13.48**	60.23**	65.82**	-3.10	64.33**
2219A x 68814	22.97**	24.34**	19.04**	117.14**	50.15**	15.59**	106.00**	60.73**	45.85**	168.55**	70.29**	81.77**
2219A x FS211	25.19**	21.06**	15.90**	64.73**	8.69	0.25	51.69**	11.00**	21.81**	138.93**	60.05**	34.85**
2219A x FS205	28.97**	27.69**	22.25**	34.31**	-12.67*	-14.29**	42.77**	7.05**	8.98**	100.32**	36.23**	8.29
2219A x FS9401	30.07**	24.34**	19.04**	74.51**	11.99*	16.49**	51.80**	10.11**	24.25**	189.20**	94.11**	62.28**
2219A x SS003	7.06**	5.31**	4.23**	100.13**	46.63**	-7.09	57.39**	23.71**	10.00**	158.17**	73.99**	43.17**
2219A x SS012	20.36**	19.66**	15.90**	101.94**	59.90**	-19.21**	77.22**	49.10**	11.09**	165.91**	92.06**	23.67**
2219A x SS020	26.06**	23.27**	18.02**	93.50**	30.78**	9.64	66.16**	27.02**	22.15**	119.96**	34.15**	74.73**
2219A x SRV605	19.26**	18.57**	14.84**	35.28**	-11.40*	-15.70**	33.45**	1.20	-0.38	84.55**	16.37**	27.58**
2219A x FS9604	29.52**	28.10**	25.39**	16.69*	-20.19**	-36.05**	34.49**	3.52**	-2.41*	86.66**	23.90**	8.30
2219A x FS9605	15.59**	12.53**	13.75**	98.64**	36.62**	7.27	57.59**	21.15**	14.63**	126.08**	50.79**	29.24**
2219A x FS9601	6.69**	5.53**	1.03	90.90**	26.95**	13.44*	65.79**	23.80**	27.61**	176.59**	87.75**	50.28**
2219A x FS9603	12.59**	8.81**	11.67**	36.25**	-13.52**	-5.35	27.05**	-8.31**	5.20**	119.20**	44.83**	29.00**
2219A x 68710	30.56**	27.68**	22.25**	86.30**	25.03**	7.66	61.38**	18.93**	27.64**	52.25**	-1.61	-3.70
2219A x 68724	17.53**	16.24**	13.78**	48.41**	-6.78	7.27	47.39**	3.55**	30.01**	105.45**	25.62**	61.36**
2219A x 68726	23.34**	19.96**	14.84**	48.26**	-7.99	12.47*	44.31**	-1.10	35.73**	109.91**	23.18**	103.06**
2219A x Co27	15.15**	12.70**	12.70**	42.58**	-7.69	-7.69	45.56**	9.80**	9.80**	149.29**	60.33**	60.33**
2219A x SS032	20.44**	17.73**	18.02**	47.49**	-9.00*	14.64**	32.34**	-11.95**	35.45**	78.32**	6.17	59.27**
2077A x 68716	6.33**	3.10**	7.44**	136.07**	102.20**	66.80**	142.44**	122.46**	126.36**	-17.89**	-24.81**	-37.99**
2077A x 68740	19.61**	14.24**	19.04**	89.75**	42.63**	66.67**	93.95**	62.25**	104.84**	63.24**	35.85**	40.22**

Table 11. (contd..).

	Crude protein			Dry fodder yield			Green fodder yield / plant			Green fodder yield / plot		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
Hybrids												
2077A x 68918	12.97**	6.12**	10.58**	63.23**	44.45**	10.36*	75.68**	59.22**	66.51**	36.85**	24.47**	-14.64**
2077A x 68786	2.66**	-2.00*	2.12*	42.94**	-5.72*	73.74**	93.57**	41.20**	161.50**	19.07**	-16.39**	41.78**
2077A x 68814	19.91**	16.28**	21.16**	166.48**	135.04**	80.95**	161.94**	153.63**	130.15**	78.76**	46.80**	56.70**
2077A x FS211	10.94**	3.08**	7.41**	55.35**	27.21**	17.33**	66.18**	47.44**	61.80**	94.45**	76.36**	48.59**
2077A x FS205	15.95**	10.18**	14.81**	69.61**	35.64**	33.11**	74.00**	59.63**	62.51**	48.84**	38.62**	10.19*
2077A x FS9401	-2.19*	-10.12**	-6.35**	63.43**	27.92**	33.07**	57.59**	38.14**	55.88**	78.90**	62.83**	36.13**
2077A x SS003	12.01**	9.20**	13.78**	89.10**	82.32**	15.52**	79.32**	75.35**	55.92**	47.48**	35.19**	11.25*
2077A x SS012	17.40**	13.26**	18.02**	93.29**	79.66**	5.68	105.00**	92.36**	63.48**	71.36**	66.14**	13.93**
2077A x SS020	-4.29**	-10.12**	-6.35**	53.20**	30.35**	9.28	60.79**	51.44**	45.63**	31.03**	0.01	30.26**
2077A x SRV605	-14.18**	-17.20**	-13.72**	39.94**	13.23*	7.73	59.39**	48.50**	46.18**	52.67**	24.09**	36.04**
2077A x FS9604	4.23**	1.07	5.32**	65.67**	43.64**	15.10**	82.77**	73.77**	63.81**	34.12**	19.68**	4.61
2077A x FS9605	12.91**	11.23**	15.90**	86.06**	62.72**	27.77**	76.49**	67.50**	58.49**	101.67**	81.52**	55.57**
2077A x FS9601	9.64**	4.09**	8.46**	69.02**	40.14**	25.22**	53.23**	39.78**	44.08**	83.49**	70.35**	36.35**
2077A x FS9603	-4.33**	-5.05	-1.06	60.89**	23.68**	35.36**	63.79**	42.56**	63.56**	34.47**	19.01**	6.00
2077A x 68710	7.58**	1.04	5.29**	140.72**	102.59**	74.41**	119.70**	96.84**	111.25**	27.58**	8.49	6.19
2077A x 68724	7.34**	4.09**	8.46**	91.09**	44.39**	66.15**	79.30**	50.33**	88.74**	51.07**	15.86**	48.83**
2077A x 68726	1.37	-5.31**	-1.33	133.53**	72.95**	111.41**	121.42**	79.27**	146.03**	1.45	-28.18**	18.40**
2077A x Co27	2.80**	0.73	4.96**	109.48**	66.35**	66.35**	116.25**	100.01**	100.01**	5.13	-11.39*	-11.39*
2077A x SS032	-2.17**	-4.03**	0.00	-19.20**	-40.74**	-25.35**	-18.26**	-36.36**	-2.40*	-86.24**	-89.98**	-84.97**
111A x 68716	2.19**	1.08	-1.06	77.26**	43.50**	18.38**	91.90**	73.67**	76.71**	29.20**	9.17*	30.50**
111A x 68740	21.57**	20.99**	15.87**	62.68**	16.89**	36.59**	38.75**	14.66**	44.76**	22.23**	13.89**	36.14**
111A x 68918	12.44**	9.97**	5.32**	66.89**	39.23**	6.37	51.77**	35.69**	41.90**	53.38**	12.74**	34.76**
111A x 68786	16.09**	15.47**	10.38**	20.27**	-23.20**	41.54**	46.78**	6.05**	96.40**	17.10**	-0.18	69.27**
111A x FS11	7.34**	6.18**	3.93**	169.24**	123.93**	72.39**	165.17**	133.01**	129.59**	107.64**	96.54**	134.93**
111A x FS211	12.24**	8.52**	3.93**	79.74**	39.64**	28.79**	70.18**	49.00**	63.51**	48.73**	26.78**	51.55**
111A x FS205	7.72**	6.63**	2.12*	63.99**	24.66**	22.34**	58.43**	43.34**	45.93**	55.52**	29.47**	54.76**
111A x FS9401	-3.47**	-7.73**	-11.64**	59.10**	18.61**	23.38**	54.11**	33.33**	50.46**	56.93**	33.34**	59.39**
111A x SS003	11.39**	9.59**	8.46**	72.19**	55.49**	-1.48	48.17**	42.75**	26.94**	49.40**	26.12**	50.76**
111A x SS012	12.62**	11.99**	8.46**	103.99**	102.89**	3.62	84.57**	75.71**	44.81**	56.71**	20.57**	44.12**
111A x SS020	30.56**	27.63**	22.25**	61.00**	29.54**	8.60	60.29**	48.83**	43.12**	16.00**	11.22**	44.87**
111A x SRV605	4.96**	4.37**	1.09	65.50**	27.17**	20.99**	66.15**	52.63**	50.25**	91.37**	83.47**	119.28**
111A x FS9604	29.50**	28.10**	25.39**	97.40**	61.61**	29.50**	90.75**	78.76**	68.51**	51.71**	31.33**	56.98**
111A x FS9605	15.57**	12.53**	13.75**	136.08**	94.81**	52.97**	112.94**	99.21**	88.49**	90.87**	63.86**	95.87**
111A x FS9601	-7.82**	-8.84**	-12.70**	80.14**	41.55**	26.48**	68.73**	51.82**	56.49**	68.78**	40.90**	68.43**
111A x FS9603	-1.33	-4.62**	-2.12*	111.85**	55.35**	70.03**	97.22**	69.45**	94.41**	-23.34**	-33.11**	-20.04**
111A x 68710	12.43**	9.94**	5.29**	113.62**	70.18**	46.50**	106.13**	82.21**	95.55**	-31.94**	-38.10**	-26.01**
111A x 68724	15.33**	14.08**	11.67**	69.56**	22.41**	40.85**	92.99**	59.84**	100.68**	97.53**	90.67**	144.92**
111A x 68726	21.02**	17.68**	12.70**	92.63**	36.56**	66.92**	87.78**	50.27**	106.23**	82.22**	57.18**	159.10**
111A x Co27	14.08**	11.67**	11.67**	66.67**	25.89**	25.89**	58.57**	44.63**	44.63**	45.25**	33.38**	59.43**
111A x SS032	13.94**	11.40**	11.67**	87.90**	32.04**	66.33**	77.14**	36.02**	109.25**	81.38**	62.96**	144.45**
S.E.(d)	0.0676	0.0780	0.0780	32.298	37.295	37.295	23.826	27.511	27.511	0.4009	0.4629	0.4629
CD at 5%	0.1327	0.1532	0.1532	63.418	73.229	73.229	46.782	54.019	54.019	0.7871	0.9089	0.9089
CD at 1%	0.1746	0.2016	0.2016	83.434	96.342	96.342	61.548	71.069	71.069	10.356	11.958	11.958

* Significant at 5 per cent level

** Significant at 1 per cent level

hybrids, 2077 A x 68726 (111.41 per cent) recorded maximum standard heterosis in pooled environments. All the above mentioned hybrids also recorded significant heterosis in their respective direction in individual environments (Table 11).

4.7.13. Green fodder yield per plant:

Among the different hybrid combinations, the range for relative heterosis was from -18.26 per cent (2077 A x SS 032) to 165.17 per cent (111 A x 68814) and for heterobeltiosis, the range was from -36.56 per cent (2077 A x SS 032) to 153.63 per cent (2077 A x 68814 and 111 A x 68814). Regarding standard heterosis, the range was from -2.41 per cent (2219 A x FS 9604) to 161.50 per cent (2077 A x 68786). All these hybrids were significant both in individual and pooled data in their respective direction. In general all the hybrids recorded significant values for all the three types of heterosis in pooled environments except 296 A x SS 012 and 2219 A x SRV 605 and 2219 A x 68726 for heterobeltiosis (Table 11).

4.7.14. Green fodder yield per plot:

Among the eighty-four hybrid combinations seventy-one hybrids for relative heterosis, sixty-three hybrids for heterobeltiosis and sixty-two hybrids for standard heterosis recorded positive significant values in pooled data. Among them 2219 A x 68716 recorded the highest relative heterosis (303.44 per cent) and heterobeltiosis (171.73 per cent). Regarding standard heterosis 111 A x 68726 (159.10 per cent) recorded maximum heterosis in pooled data (Table 11).

4.8. Association of characters in individual environments:

The correlation coefficients among the fourteen characters studied are presented in Table 12. The characters plant height, number of tillers, number of leaves, leaf length, leaf breadth, dry fodder yield and green fodder yield per plot recorded highly significant positive correlation with green fodder yield per plant in all the environments including pooled data. Hydrocyanic acid recorded non-significant negative correlation with green fodder yield per plant in all the environments while crude protein recorded a non-significant positive

Table 12. Correlation coefficients of green fodder yield and yield components in individual environments and pooled data

Characters	Env	Plant height	Days to 50 per cent flowering	No. tillers	No. leaves	Leaf length	Leaf breadth	Leaf stem ratio	Stem thickness	Hydro cyanic acid	Total soluble solids	Crude protein	Dry Fodder yield	Green Fodder yield per plot	Green Fodder yield per plant
plant height	E ₁	1.000	0.318**	0.441**	0.256**	0.640**	-0.040	-0.394**	-0.013	-0.311**	0.163	0.142	0.498**	0.243*	0.434**
	E ₂	1.000	0.303**	0.330**	0.802**	0.630**	0.219**	-0.510**	0.294**	-0.257**	-0.344**	-0.061	0.694**	0.337**	0.667**
	E ₃	1.000	0.119	0.299**	0.673**	0.735**	0.186	-0.240*	0.451**	-0.073	-0.223*	0.148	0.577**	0.486**	0.493**
	E ₄	1.000	0.126	0.517**	0.389**	0.694**	0.110	-0.451**	-0.214*	-0.223*	-0.320**	0.055	0.532**	0.434**	0.504**
	P	1.000	0.235*	0.481**	0.580**	0.723**	-0.032	-0.766**	-0.053	-0.393**	-0.403**	0.038	0.716**	0.370**	0.594**
	E ₁	1.000	1.000	-0.290**	0.639**	0.655**	0.553**	-0.126	0.379**	0.087	0.121	0.105	0.347*	0.101	0.503**
Days To 50 per cent Flowering	E ₂	1.000	1.000	-0.121	0.260**	0.095	0.280**	0.101	0.518**	-0.108	-0.270**	-0.152	0.135	0.020	0.186
	E ₃	1.000	1.000	-0.240*	0.564**	0.347**	0.119	0.400**	0.270**	-0.096	-0.261**	-0.090	0.022	0.048	0.101
	E ₄	1.000	1.000	0.061	0.262**	0.105	0.053	0.070	0.047	-0.088	-0.390**	-0.005	0.234*	-0.002	0.221*
	P	1.000	1.000	-0.146	0.512**	0.334**	0.237*	0.228*	0.224*	-0.066	-0.672**	-0.236*	0.216*	-0.085	0.321**
	E ₁	1.000	1.000	1.000	-0.579**	-0.137	-0.618**	-0.351**	-0.374**	-0.212	0.189	0.052	0.534**	0.289**	0.272**
	E ₂	1.000	1.000	1.000	-0.239*	0.407**	-0.370**	-0.374**	-0.537**	0.002	0.040	-0.134	0.641**	0.262**	0.552**
Number of tillers	E ₃	1.000	1.000	1.000	-0.094	0.103	-0.083	-0.247*	-0.059	0.198*	-0.005	-0.186	0.850**	0.264**	0.731**
	E ₄	1.000	1.000	1.000	0.062	0.545**	0.046	-0.176	-0.315**	0.048	-0.022	-0.039	0.604**	0.522**	0.522**
	P	1.000	1.000	1.000	-0.150	0.505**	-0.359**	-0.477**	-0.360**	0.128	0.304**	-0.039	0.726**	0.264**	0.541**
	E ₁	1.000	1.000	1.000	0.681**	0.681**	0.694**	0.094	0.487**	0.003	0.142	0.294**	0.290**	0.438**	0.532**
	E ₂	1.000	1.000	1.000	0.276**	0.276**	0.611**	-0.616**	0.378**	-0.392**	-0.250*	-0.054	0.559**	0.238*	0.611**
	E ₃	1.000	1.000	1.000	0.680**	0.680**	0.410**	0.044	0.701**	-0.114	-0.236*	0.148	0.440**	0.422**	0.454**
leaf length	E ₄	1.000	1.000	1.000	0.402**	0.402**	0.470**	0.007	0.424**	-0.242*	-0.266**	-0.089	0.492**	0.431**	0.525**
	P	1.000	1.000	1.000	0.411**	0.411**	0.572**	-0.306**	0.595**	-0.565**	-0.634**	-0.056	0.500**	0.338**	0.593**
	E ₁	1.000	1.000	1.000	0.345**	0.345**	0.345**	-0.164	0.377**	0.019	0.087	0.284**	0.587**	0.309**	0.717**
	E ₂	1.000	1.000	1.000	0.054	0.054	0.054	-0.236*	0.086	-0.191	-0.263**	0.159	0.738**	0.311**	0.732**
	E ₃	1.000	1.000	1.000	0.443**	0.443**	0.443**	-0.129	0.558**	0.151	-0.242*	0.310**	0.471**	0.443**	0.472**
	E ₄	1.000	1.000	1.000	0.300**	0.300**	0.300**	-0.271**	-0.091	-0.176	-0.080	0.008	0.505**	0.468**	0.456**
leaf breadth	P	1.000	1.000	1.000	0.061	0.061	0.061	-0.469**	0.103	-0.344**	-0.311	0.169	0.737**	0.467**	0.689**
	E ₁	1.000	1.000	1.000	0.045	0.045	0.045	-0.045	0.817**	-0.173	0.040	-0.206*	0.197**	0.027	0.511**
	E ₂	1.000	1.000	1.000	-0.168	-0.168	-0.168	-0.168	0.689**	-0.123	-0.192	0.107	0.319**	0.054	0.473**
	E ₃	1.000	1.000	1.000	-0.230*	-0.230*	-0.230*	-0.230*	0.946**	0.358**	-0.167	0.516**	0.323**	0.224*	0.401**
	E ₄	1.000	1.000	1.000	-0.144	-0.144	-0.144	-0.144	0.684**	0.144	-0.197*	0.343**	0.325**	0.247*	0.324**
	P	1.000	1.000	1.000	-0.206*	-0.206*	-0.206*	-0.206*	1.066**	-0.037	-0.426**	0.159	0.264**	0.052	0.443**
Leaf stem ratio	E ₁	1.000	1.000	1.000	1.000	1.000	1.000	1.000	-0.175	0.076	-0.057	0.092	-0.299**	-0.042	-0.36**
	E ₂	1.000	1.000	1.000	1.000	1.000	1.000	1.000	-0.115	0.099	-0.018	0.218*	-0.414**	-0.277**	-0.404**
	E ₃	1.000	1.000	1.000	1.000	1.000	1.000	1.000	-0.225*	-0.177	0.128	-0.148	-0.156	-0.155	-0.154
	E ₄	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.190	-0.012	0.193	-0.256**	-0.300**	-0.207*	-0.296**
	P	1.000	1.000	1.000	1.000	1.000	1.000	1.000	-0.074	0.193	0.138	-0.135	-0.624**	-0.312**	-0.591**
	P	1.000	1.000	1.000	1.000	1.000	1.000	1.000	-0.074	0.193	0.138	-0.135	-0.624**	-0.312**	-0.591**

Table 12. (cont.)

Characters	Env	Plant height	Days to 50 per cent flowering	No. tillers	No. leaves	Leaf length	Leaf breadth	Leaf stem weight ratio	Stem thickness	Hydro cyanic acid	Total soluble solids	Crude protein	Dry Fodder yield	Green Fodder yield per plot	Green Fodder yield per plant
Stem Thickness	E ₁								1.000	0.034	-0.062	0.053	0.288**	-0.041	0.608**
	E ₂								1.000	-0.090	-0.224*	-0.376**	0.360**	-0.031	0.409**
	E ₃								1.000	0.237**	-0.346**	0.466**	0.453**	0.340**	0.593**
	E ₄								1.000	0.025	0.029	0.460**	-0.007	0.218*	0.083
	P								1.000	-0.171	-0.595**	0.280**	0.354**	0.007	0.581**
Hydrocyanic Acid	E ₁								1.000	1.000	0.087	0.041	-0.143	0.009	-0.049
	E ₂								1.000	1.000	0.144	0.016	-0.125	-0.132	-0.185
	E ₃								1.000	1.000	-0.118	0.227**	0.185	0.017	0.177
	E ₄								1.000	1.000	0.056	0.086	-0.117	-0.168	-0.139
	P								1.000	1.000	0.139	0.143	-0.119	-0.175	-0.153
Total soluble Solids	E ₁										1.000	-0.041	0.102	0.148	0.095
	E ₂										1.000	-0.068	-0.094	-0.067	-0.224*
	E ₃										1.000	-0.042	-0.146	0.017	-0.26**
	E ₄										1.000	-0.030	-0.262**	-0.045	-0.307**
	P										1.000	-0.111	-0.280**	-0.032	-0.427**
Crude Protein	E ₁											1.000	0.158	0.278**	0.203*
	E ₂											1.000	0.031	0.238*	0.073
	E ₃											1.000	0.050	0.199*	0.095
	E ₄											1.000	0.165	0.288**	0.183
	P											1.000	0.136	0.324**	0.167
Dry fodder Yield	E ₁												1.000	0.266**	0.851**
	E ₂												1.000	0.491**	0.934**
	E ₃												1.000	0.501**	-0.618**
	E ₄												1.000	0.690**	0.975**
	P												1.000	0.379**	0.953**
Green fodder Yield per plot	E ₁													1.000	0.343**
	E ₂													1.000	0.449**
	E ₃													1.000	0.487**
	E ₄													1.000	0.703**
	P													1.000	0.347**
Green fodder Yield per plant	E ₁														1.000
	E ₂														1.000
	E ₃														1.000
	E ₄														1.000
	P														1.000

* Significant at 5% level

** Significant at 1% level

correlation with green fodder yield per plant except in E_1 . Days to 50 per cent flowering had positive significant correlation with green fodder yield per plant. Leaf stem ratio recorded negative significant values in E_1 , E_2 and E_4 while positive significant correlation was recorded in the pooled data. Stem thickness had positive significant correlation with green fodder yield in all the environments except E_4 .

Regarding inter correlations among yield components, plant height had positive correlation with number of tillers, number of leaves, leaf length, leaf stem ratio and green fodder yield per plot. Days to 50 per cent flowering had positive correlation with number of leaves. Number of tillers had positive correlation with dry fodder yield and green fodder yield per plot in all the environments and also in pooled data. Dry fodder yield recorded positive correlation with number of leaves, leaf length and leaf breadth in all the environments and also in pooled data. However it recorded a negative significant correlation with leaf per stem ratio in all the environments except in E_3 . Green fodder yield per plot had significant positive effect with crude protein and dry fodder yield in all the environments.

4.9. Path analysis:

Path co-efficient analysis showing direct and indirect effects of thirteen characters on green fodder yield per plant is presented in Table 13. Direct effect of plant height was high (3.86) and positive on green fodder yield in pooled data followed by that of leaf breadth (2.108), leaf per stem ratio (2.104) and stem thickness (0.804). Number of leaves had high negative significant (-3.118) direct effect on green fodder yield per plant. The indirect effect of leaf length (2.789) was high via plant height followed number of leaves (2.237), dry fodder yield per plant (2.762) and number of tillers (1.856) in the pooled data. Regarding leaf stem ratio though it had high positive direct effect, its indirect effect via plant height was highly negative.

4.10. Stability analysis I:

The mean data averaged over replications for the 25 parents and 84 hybrids over four environments for seven characters was subjected to pooled analysis over environments for

TABLE 2.5. 1 and 2 component analyses of nutrient characters with green fodder yield in individual environments and pooled data

Characters	ENV	Plant height	Days to 50 per cent flowering	No. tillers	No. leaves	Leaf length	Leaf breadth	Leaf stem ratio	Stem thickness	Hydro cyanic acid	Total soluble solids	Crude protein	Dry Fodder yield	Green Fodder yield per plot	Green Fodder yield per plant
plant height	E ₁	-0.252	0.120	-0.082	0.184	-0.099	0.063	0.051	-0.016	0.121	0.014	-0.068	0.356	0.042	0.434**
	E ₂	-0.040	0.013	0.006	-0.048	0.087	0.071	0.023	-0.040	0.011	0.034	0.003	0.546	0.003	0.667**
	E ₃	0.080	0.007	-0.042	0.287	-0.196	0.217	0.017	-0.615	0.004	0.068	0.005	0.630	0.032	0.493**
	E ₄	-0.003	-0.009	-0.023	-0.031	0.042	-0.026	0.029	-0.076	-0.003	0.037	-0.006	0.584	-0.012	0.504**
	P	3.860	0.060	0.283	-1.807	-0.919	-0.068	-1.612	-0.430	0.339	-0.015	-0.012	0.229	0.297	0.594**
Days To 50 per cent Flowering	E ₁	-0.080	0.379	0.054	0.460	-0.101	-0.876	0.016	0.461	-0.034	0.010	-0.051	0.248	0.018	0.503**
	E ₂	-0.012	0.042	-0.002	-0.016	0.013	0.091	-0.005	-0.071	0.005	0.027	0.008	0.106	0.000	0.186
	E ₃	0.010	0.059	0.034	0.240	-0.092	0.139	-0.027	-0.368	0.005	0.080	-0.003	0.024	0.003	0.101
	E ₄	0.000	-0.072	-0.003	-0.021	0.006	-0.013	-0.005	0.017	-0.001	0.045	0.010	0.257	0.000	0.221*
	P	0.907	0.256	-0.086	-1.597	-0.425	0.500	0.479	0.180	0.057	-0.025	0.073	0.069	-0.068	0.321**
Number of tillers	E ₁	-0.111	-0.110	-0.186	-0.417	0.021	0.979	0.045	-0.455	0.083	0.016	-0.025	0.382	0.050	0.272**
	E ₂	-0.013	-0.005	0.020	0.014	0.056	-0.120	0.017	0.074	0.000	-0.004	0.007	0.504	0.002	0.552**
	E ₃	0.024	-0.014	-0.142	-0.040	-0.027	-0.097	0.017	0.080	-0.010	0.002	-0.007	0.928	0.017	0.731**
	E ₄	-0.001	-0.004	-0.044	-0.005	0.033	-0.011	0.011	-0.111	0.001	0.003	0.004	0.662	-0.014	0.522**
	P	1.856	-0.037	0.589	0.468	-0.641	-0.756	-1.004	-0.290	-0.111	0.011	0.012	0.232	0.212	0.541**
Number of Leaves	E ₁	-0.065	0.242	0.108	0.720	-0.105	-1.100	-0.012	0.592	-0.001	0.012	-0.141	0.208	0.076	0.532**
	E ₂	-0.032	0.011	-0.005	-0.060	0.038	0.198	0.027	-0.052	0.016	0.025	0.003	0.440	0.002	0.611**
	E ₃	0.054	0.033	0.013	0.426	-0.181	0.478	-0.003	-0.957	0.006	0.072	0.005	0.480	0.028	0.454**
	E ₄	-0.001	-0.019	-0.003	-0.050	0.025	-0.112	0.000	0.150	-0.003	0.031	0.010	0.540	-0.012	0.525**
	P	2.237	0.131	-0.088	-3.118	-0.522	1.205	-0.643	0.479	0.488	-0.024	0.017	0.160	0.271	0.593**
Leaf length	E ₁	-0.161	0.248	0.025	0.490	-0.155	-0.546	0.021	0.458	-0.008	0.007	-0.137	0.419	0.054	0.717**
	E ₂	-0.025	0.004	0.008	-0.017	0.138	0.018	0.010	-0.012	0.008	0.026	-0.009	0.580	0.003	0.732**
	E ₃	0.059	0.020	-0.015	0.289	-0.266	0.516	0.009	-0.761	-0.007	0.074	0.011	0.514	0.029	0.472**
	E ₄	-0.002	-0.008	-0.024	-0.032	0.061	-0.072	0.018	-0.032	-0.002	0.009	-0.001	0.553	-0.013	0.456**
	P	2.789	0.086	0.297	-1.281	-1.271	0.129	-0.986	0.083	0.297	-0.012	-0.052	0.236	0.375	0.689**
leaf breadth	E ₁	0.010	0.209	0.115	0.500	-0.053	-1.585	0.006	0.994	0.067	0.003	0.099	0.141	0.005	0.511**
	E ₂	-0.009	0.012	-0.007	-0.037	0.008	0.324	0.007	-0.095	0.005	0.019	-0.006	0.251	0.001	0.473**
	E ₃	0.015	0.007	0.012	0.174	-0.118	1.166	0.016	-1.291	-0.017	0.051	0.018	0.353	0.015	0.401**
	E ₄	0.000	-0.004	-0.002	-0.038	0.018	-0.239	0.009	0.242	0.002	0.023	-0.037	0.356	-0.007	0.324**
	P	-0.124	0.061	-0.211	-1.783	-0.078	2.108	-0.433	0.809	0.032	-0.016	-0.049	0.085	0.042	0.443**
Leaf stem ratio	E ₁	0.099	-0.048	0.065	0.068	0.025	0.071	-0.129	-0.212	-0.030	-0.005	-0.044	-0.214	-0.007	-0.360**
	E ₂	0.020	0.004	-0.007	0.037	-0.033	-0.054	-0.044	0.016	-0.004	0.002	-0.012	-0.326	-0.002	-0.404**
	E ₃	-0.019	0.024	0.035	0.019	0.034	-0.268	-0.069	0.307	0.009	-0.039	-0.005	-0.171	-0.010	-0.154
	E ₄	0.001	-0.005	0.008	-0.001	-0.017	0.034	-0.065	0.067	0.000	-0.022	0.028	-0.329	0.006	-0.296**
	P	-2.957	0.058	-0.281	0.953	0.596	-0.433	2.104	-0.060	-0.167	0.005	0.042	-0.200	-0.251	0.591**

Table 13. (contd...)

Characters	ENV	Plant height	Days to 50 per cent flowering	No. tillers	No. leaves	Leaf length	Leaf breadth	Leaf stem ratio	Stem thickness	Hydro cyanic acid	Total soluble solids	Crude protein	Dry Fodder yield	Green Fodder yield per plot	Green Fodder yield per plant
Stem Thickness	E ₁	0.003	0.143	0.069	0.350	-0.058	-1.294	0.022	1.217	-0.013	-0.005	-0.026	0.206	-0.007	0.608**
	E ₂	-0.012	0.022	-0.011	-0.023	0.012	0.223	0.005	-0.137	0.004	0.022	0.021	0.283	0.000	0.409**
	E ₃	0.036	0.016	0.008	0.299	-0.148	1.104	0.015	-1.364	-0.012	0.106	0.017	0.494	0.022	0.593**
	E ₄	0.001	-0.003	0.014	-0.034	-0.006	-0.163	-0.012	0.353	0.000	-0.003	-0.050	-0.008	-0.006	0.083
	P	-0.204	0.057	-0.212	-1.856	-0.130	2.121	-0.156	0.804	0.147	-0.022	-0.086	0.113	0.005	0.581**
Hydrocyanic Acid	E ₁	0.078	0.033	0.039	0.002	-0.003	0.273	-0.010	0.041	-0.390	0.007	-0.020	-0.102	0.002	-0.049
	E ₂	0.010	-0.005	0.000	0.024	-0.026	-0.040	-0.004	0.012	-0.042	-0.014	-0.001	-0.098	-0.001	-0.185
	E ₃	-0.006	-0.006	-0.028	-0.049	-0.040	0.418	0.012	-0.324	-0.049	0.036	0.008	0.202	0.001	0.177
	E ₄	0.001	0.006	-0.002	0.019	-0.011	-0.034	0.001	0.009	0.012	-0.007	-0.009	-0.128	0.005	-0.139
	P	-1.516	-0.017	0.076	1.759	0.437	-0.079	0.406	-0.137	-0.864	0.005	-0.044	-0.038	-0.140	-0.153
Total soluble Solids	E ₁	-0.041	0.046	-0.035	0.102	-0.013	-0.063	0.007	-0.075	-0.034	0.083	0.020	0.073	0.026	0.095
	E ₂	0.014	-0.011	0.001	0.015	-0.036	-0.062	0.001	0.031	-0.006	-0.098	0.004	-0.074	-0.001	-0.224*
	E ₃	-0.018	-0.015	0.001	-0.101	0.065	-0.195	-0.009	0.472	0.006	-0.306	-0.002	-0.159	0.001	-0.260**
	E ₄	0.001	0.028	0.001	0.021	-0.005	0.047	-0.013	0.010	0.001	-0.116	0.003	-0.288	0.001	-0.307**
	P	-1.556	-0.172	0.179	1.976	0.396	-0.897	0.290	-0.48	-0.120	0.037	0.034	-0.090	-0.026	-0.427**
Crude Protein	E ₁	-0.036	0.040	-0.010	0.212	-0.044	0.327	-0.012	0.065	-0.016	-0.003	-0.480	0.113	0.048	0.203*
	E ₂	0.002	-0.006	-0.003	0.003	0.022	0.035	-0.010	0.052	-0.001	0.007	-0.055	0.025	0.002	0.073
	E ₃	0.012	-0.005	0.026	0.063	-0.082	0.602	0.010	-0.536	-0.011	0.013	0.035	0.055	0.013	0.095
	E ₄	0.000	0.007	0.002	0.007	0.001	-0.082	0.017	0.163	0.001	0.004	-0.108	0.181	-0.008	0.183
	P	0.147	-0.060	-0.023	0.175	-0.215	0.335	-0.284	0.225	-0.124	-0.004	-0.308	0.043	0.260	0.167
Dry fodder Yield	E ₁	-0.126	0.131	-0.099	0.209	-0.091	-0.313	0.038	0.350	0.056	0.008	-0.076	0.715	0.046	0.851**
	E ₂	-0.028	0.006	0.013	-0.034	0.102	0.103	0.018	-0.049	0.005	0.009	-0.002	0.786	0.004	0.934**
	E ₃	0.046	0.001	-0.120	0.187	-0.125	0.377	0.011	-0.618	-0.009	0.045	0.002	1.092	0.033	0.920**
	E ₄	-0.001	-0.017	-0.027	-0.039	0.031	-0.078	0.020	-0.003	-0.001	0.030	-0.018	1.096	-0.019	0.975**
	P	2.762	0.055	0.427	-1.560	-0.937	0.558	-1.314	0.285	0.103	-0.010	-0.042	0.320	0.305	0.953**
Green fodder yield per plot	E ₁	-0.061	0.038	-0.054	0.315	-0.048	-0.042	0.005	-0.050	-0.004	0.012	-0.134	0.190	0.173	0.343**
	E ₂	-0.014	0.001	0.005	-0.014	0.043	0.018	0.012	0.004	0.006	0.007	-0.013	0.386	0.009	0.449**
	E ₃	0.039	0.003	-0.037	0.180	-0.118	0.261	0.011	-0.464	-0.001	-0.005	0.007	0.547	0.065	0.487**
	E ₄	-0.001	0.000	-0.023	-0.035	0.029	-0.059	0.014	0.077	-0.002	0.005	-0.031	0.757	-0.027	0.703**
	P	1.427	-0.022	0.156	-1.053	-0.593	0.109	-0.657	0.005	0.151	-0.001	-0.100	0.121	0.803	0.347**

Residual effects: E₁ = 0.3518; E₂ = 0.2543; E₃ = 0.4589; E₄ = 0.1408; P = 0.2277

* significant at 5 per cent level

** Significant at 1 per cent level

Diagonal values (bold) are direct effects

genotypes x environment interaction.. The mean squares (MS) due to genotypes (G), environments (E) and genotypes x environments tested against MS due to pooled error were highly significant for all the characters, thus satisfying the requirement of stability analysis and as such stability analysis was carried out on these seven characters. The analysis of variance is given in (Table 14).

The variance due to G x E when partitioned into its components viz., variance due to G x E (linear) and due to pooled deviation (non-linear) revealed that linear component of G x E interaction as well as the non-linear component when tested against pooled error were highly significant for all the characters. High magnitude of E (linear) effect in comparison to G x E (linear) for all the characters was observed.

The mean square due to genotypes when tested against MS due to pooled deviation was found to be highly significant for all the characters, while MS due to G x E (linear) when tested against pooled deviation was not significant for all the characters.

The ratio of non-linear to linear component of variance ranged from 1: 0.88 (green fodder yield per plant) to 1: 1.63 (dry fodder yield). The magnitude of linear component was more than one except for green fodder yield per plant wherein the non-linear component was high. From the analysis of variance tables, the genotypic variance (σ^2_g) and G x E variance (σ^2_{gn}) were worked out for all the characters. The σ^2_g values were more than σ^2_{gn} for all the characters except days to 50 per cent flowering and dry fodder yield. The ratio of σ^2_g to σ^2_{gn} ranged from 1: 0.36 (plant height) to 1: 1.61 (days to 50 per cent flowering). The G x E component was maximum for days to 50 per cent flowering and exceeded unity.

4.11. Environmental index:

Environmental indices for seven characters namely, plant height, days to 50 per cent flowering, number of tillers, crude protein, dry fodder yield, green fodder yield per plant and green fodder yield per plot are presented in Table 15. The environmental index (Ij) for plant height ranged from -13.914 (E_2) to 7.084 (E_3). For days to 50 per cent flowering the range of

Table 14. Analysis of variance for stability for different characters

Source	df	Plant height	Days to 50 per cent flowering	Number of tillers	Crude protein	Dry fodder yield	Green yield per plant	fodder Green yield per plot
Genotypes	108	3655.639**	46.896**	1.116**	2.627**	2126.932**	43363.030**	71.290**
Env. + (Genotypes * Env.)	327	402.878**	114.447**	0.379**	0.562**	978.219**	12381.502**	27.362**
Environments	3	10423.442**	11030.386**	9.800**	31.732**	54047.701**	554648.548**	1859.688**
Genotypes * Env.	324	310.095**	13.373**	0.292**	0.273**	486.835**	7360.511**	10.396**
Environments (Linear.)	1	31270.325**	33091.157**	29.400**	95.195**	162143.102**	1663945.643**	5579.065**
Genotypes * Env. (Linear.)	108	359.803**	15.044**	0.333**	0.306**	651.969**	6714.143**	12.050**
Pooled Deviation (Non linear)	218	282.624**	12.423**	0.269**	0.255**	400.559**	7613.202**	9.481**
Pooled Error	864	11.843	0.322	0.125	0.012	25.710	14.970	0.382
Non linear : Linear		1:1.27	1:1.21	1:1.24	1:1.20	1:1.63	1:0.88	1:1.27
σ^2_g		839.39	8.38	0.21	0.59	410.02	9000.63	15.22
σ^2_{gn}		298.25	13.05	0.17	0.26	461.125	7345.54	10.01
$\sigma^2_g : \sigma^2_{gn}$		1:0.36	1:1.16	1:0.81	1:0.44	1:1.12	1:0.82	1:0.66

* Significant at 5 per cent level

** Significant at 1 per cent level

Table 15. Environmental indices for seven different characters

Environment	Plant height	Days to 50 per cent flowering	Number of tillers	Crude protein	Dry fodder yield	Green fodder yield per plant	Green fodder yield per plot
E ₁	0.271	-91.542	-0.355	13.453	1.363	-20.979	-0.178
E ₂	-13.914	27.363	-0.007	1.307	2.569	-7.495	0.216
E ₃	7.084	77.242	0.379	-4.935	2.217	31.352	0.611
E ₄	6.559	-13.063	-0.016	-9.825	-6.149	-2.878	-0.649

Ij was from -91.542 (E_4) to 77.242 (E_3) and for number of tillers it ranged from -0.355 (E_1) to 0.379 (E_3). Regarding crude protein the range was from -9.825 (E_4) to 13.453 (E_1) and for dry fodder yield it was from -6.149 (E_4) to 2.569 (E_2). For green fodder yield, E_1 recorded lowest Ij of -20.979 and E_3 recorded maximum index of 31.352. For green fodder yield per plot the range was from -0.649 (E_4) to 0.611 (E_3).

4.12. Stability parameters:

The mean performance of genotypes and stability parameters i.e., regression (b_i) and mean square deviation from regression (S^2_{di}) for the seven characters are presented in Tables 59 to 65. Based on the nearness to 1.0, the b_i values were ranked and the S^2_{di} values were ranked based on their nearness to 0. The ranks for b_i and S^2_{di} values are also presented along with b_i and S^2_{di} values.

4.12.1. Days to 50 per cent flowering:

For days to 50 per cent flowering eightyseven genotypes had non-significant b_i values and among them, 68726 (Rank 2), 296 A x FS 9603 (Rank 4) and 111 A x FS 9401 (Rank 6) recorded top ranking with non-significant mean values.

The mean square deviation from regression was non-significant for nine genotypes and among which the top ranking genotypes were 2077 A x 68786 (0.06), 2219 A x FS 9605 (0.11), 111 A x FS 9601 (0.12) and 2219 A x 68716 (0.12) all of which recorded non-significant mean values except 2077 A x 68786 (Table 16).

4.12.2. Plant height:

Among the 109 genotypes, seventy two had non-significant b_i values, among which 2077 A x Co27 (0.998) followed by 2077 A x SS 020 (0.989), 2077 A x FS 9605 and SS 032 (1.013) recorded top ranks for b_i values around unity with significant mean values (except SS 032) (Table 17).

Table 16. Stability parameters of parents and hybrids for days to 50 per cent flowering

Sl.No	Genotypes	Mean	b_i	Rank	S^2_{di}	Rank	R^2
1	296A	63.08	0.762	85	13.31**	73	0.866
2	2219A	60.50	0.441	107	38.32**	105	0.433
3	2077A	58.83	1.233**	84	-0.29	6	1.000
4	111A	64.25	0.889	44	15.55**	80	0.883
5	68716	64.67	0.863	55	43.65**	107	0.72
6	68740	65.50	0.971	17	43.18**	106	0.767
7	68918	65.92	1.185	69	17.88**	86	0.921
8	68786	65.33	0.800	74	6.77**	46	0.932
9	68814	70.50	0.913	36	25.54**	95	0.830
10	FS211	58.83	1.184	68	8.51**	54	0.960
11	FS205	62.83	0.834	61	11.24**	66	0.901
12	FS9401	62.50	0.774	83	13.26**	72	0.870
13	SS003	63.50	1.132	52	17.08**	84	0.918
14	SS012	60.58	1.013	11	2.11**	20	0.985
15	SS020	61.75	0.918	31	0.39	7	0.995
16	SRV605	66.42	0.781	81	71.63**	109	0.563
17	FS9604	59.75	1.011	9	8.54**	55	0.946
18	FS9605	63.08	0.912	37	6.93**	47	0.946
19	FS9601	59.58	1.103	40	12.49**	70	0.935
20	FS9603	63.17	0.827	62	8.47**	53	0.922
21	68710	75.58	1.540**	106	-0.26	5	1.000
22	68724	63.92	1.218	79	17.91**	87	0.925
23	68726	61.25	1.004	2	6.17**	44	0.959
24	Co27	61.75	0.972	16	3.59**	33	0.974
25	SS032	63.92	0.811	71	10.19**	61	0.905
26	296A x 68716	64.17	1.215	78	20.19**	91	0.916
27	296A x 68740	61.33	1.189	72	2.97**	31	0.985
28	296A x 68918	61.17	1.243	87	24.94**	94	0.903
29	296A x 68786	68.58	1.627**	109	15.56**	81	0.962
30	296A x 68814	65.42	0.993	5	22.34**	93	0.869
31	296A x FS211	63.33	1.385*	99	10.88**	64	0.963
32	296A x FS205	64.08	0.886	46	15.03**	78	0.886
33	296A x FS9401	61.83	1.121	49	1.35**	17	0.991
34	296A x SS003	61.00	1.175	64	7.22**	48	0.965
35	296A x SS012	60.25	1.182	67	13.86**	75	0.937
36	296A x SS020	61.75	1.126	50	3.63**	34	0.980
37	296A x SRV605	64.42	0.731	91	15.35**	79	0.838
38	296A x FS9604	66.67	0.883	47	12.40**	69	0.903
39	296A x FS9605	62.00	0.989	10	4.35**	38	0.970
40	296A x FS9601	61.08	1.068	27	2.48**	24	0.984
41	296A x FS9603	61.00	0.993	4	1.01**	12	0.991
42	296A x 68710	62.17	1.009	7	16.19**	82	0.904

Table 16. (contd...)

Sl.No	Genotypes	Mean	b_i	Rank	S^2_{di}	Rank	R^2
43	296A x 68724	59.75	1.134	53	14.95**	77	0.927
44	296A x 68726	59.25	1.202	75	21.82**	92	0.908
45	296A x Co27	60.42	1.026	15	9.36**	57	0.943
46	296A x SS032	61.00	0.967	18	32.78**	100	0.811
47	2219A x 68716	59.50	0.804**	73	0.12	4	0.996
48	2219A x 68740	60.33	0.754**	88	1.13**	15	0.984
49	2219A x 68918	58.25	0.887	45	10.55**	63	0.917
50	2219A x 68786	60.92	0.546**	103	2.82**	28	0.935
51	2219A x 68814	58.50	0.855	56	13.24**	71	0.891
52	2219A x FS211	57.00	0.956	21	3.86**	36	0.971
53	2219A x FS205	58.42	0.866*	54	0.64*	10	0.992
54	2219A x FS9401	57.67	0.853	58	2.63**	26	0.974
55	2219A x SS003	57.83	0.842*	60	1.16**	16	0.987
56	2219A x SS012	57.92	0.921	30	6.30**	45	0.951
57	2219A x SS020	59.25	0.853	57	6.06**	43	0.945
58	2219A x SRV605	62.00	0.484**	105	2.12**	21	0.936
59	2219A x FS9604	63.42	0.669	96	9.79**	59	0.870
60	2219A x FS9605	59.58	0.777**	82	0.11	2	0.995
61	2219A x FS9601	56.92	0.902	39	1.02**	13	0.989
62	2219A x FS9603	57.92	0.918	32	0.57	9	0.993
63	2219A x 68710	59.50	0.791*	77	2.21**	22	0.974
64	2219A x 68724	60.17	1.297**	93	3.49**	32	0.985
65	2219A x 68726	57.92	0.959	20	0.86*	11	0.992
66	2219A x Co27	58.50	0.880*	48	0.51	8	0.993
67	2219A x SS032	58.42	0.986	12	4.90**	40	0.966
68	2077A x 68716	64.42	1.179	65	34.70**	103	0.858
69	2077A x 68740	64.83	1.071	29	30.67**	98	0.849
70	2077A x 68918	62.08	1.367	98	13.85**	74	0.952
71	2077A x 68786	71.00	1.478**	104	0.06	1	0.999
72	2077A x 68814	70.08	1.053	23	10.98**	65	0.937
73	2077A x FS211	60.17	1.104	42	2.96**	30	0.983
74	2077A x FS205	64.67	0.677**	94	3.86**	35	0.943
75	2077A x FS9401	61.25	0.747**	89	1.42**	18	0.980
76	2077A x SS003	62.42	0.870	51	16.79**	83	0.870
77	2077A x SS012	63.50	0.782	80	12.33**	68	0.880
78	2077A x SS020	63.17	0.757	86	10.09**	60	0.893
79	2077A x SRV605	65.83	0.582	100	17.49**	85	0.743
80	2077A x FS9604	67.25	0.906	38	19.43**	88	0.863
81	2077A x FS9605	62.50	1.037	19	2.90**	29	0.981
82	2077A x FS9601	61.58	0.741**	90	2.01**	19	0.973
83	2077A x FS9603	62.25	1.049	22	8.04**	50	0.952
84	2077A x 68710	66.75	1.290	92	47.30**	108	0.842
85	2077A x 68724	67.25	1.418**	101	5.65**	42	0.981
86	2077A x 68726	59.42	1.010	8	9.33**	56	0.941

Table 16. (contd...)

SL.No	Genotypes	Mean	b_i	Rank	S^2_{di}	Rank	R^2
87	2077A x Co27	59.58	1.064	25	9.49**	58	0.946
88	2077A x SS032	59.08	0.915	33	3.98**	37	0.967
89	111A x 68716	67.17	1.207	76	26.39**	96	0.892
90	111A x 68740	66.58	1.104	41	33.19**	101	0.847
91	111A x 68918	68.58	1.002	1	26.85**	97	0.849
92	111A x 68786	69.42	1.597**	108	8.31**	52	0.978
93	111A x 68814	68.92	1.182	66	19.46**	89	0.915
94	111A x FS211	59.50	1.025	14	2.55**	25	0.982
95	111A x FS205	63.42	0.976	13	11.89**	67	0.922
96	111A x FS9401	61.00	1.009	6	1.12**	14	0.991
97	111A x SS003	59.25	1.175	63	2.65**	27	0.986
98	111A x SS012	60.92	1.155	59	4.40**	39	0.977
99	111A x SS020	66.42	1.086	34	37.47**	104	0.826
100	111A x SRV605	65.92	0.670	95	34.63**	102	0.661
101	111A x FS9604	64.58	0.914	35	20.04**	90	0.862
102	111A x FS9605	61.92	0.929	28	10.30**	62	0.925
103	111A x FS9601	60.75	0.811**	70	0.12	3	0.996
104	111A x FS9603	62.08	1.108	43	5.59**	41	0.969
105	111A x 68710	64.50	1.444	102	32.71**	99	0.906
106	111A x 68724	66.08	1.357*	97	8.00**	49	0.971
107	111A x 68726	61.42	1.067	26	2.29**	23	0.985
108	111A x Co27	64.42	0.996	3	14.74**	76	0.909
109	111A x SS032	62.75	1.061	24	8.21**	51	0.952
	Population Mean	62.58	1.000				
	SE	2.03	0.202				

* Significant at 5 per cent level

** Significant at 1 per cent level

Table 17. Stability parameters of parents and hybrids for plant height

SLNo	Genotypes	Mean	b_i	Rank	S^2_{di}	Rank	R^2
1	296A	84.49	-0.348*	89	102.05**	48	0.132
2	2219A	80.93	0.788*	16	-8.81	17	0.966
3	2077A	98.42	0.232*	52	15.42	25	0.220
4	111A	102.63	1.370	28	31.94*	31	0.860
5	68716	221.54	-0.816**	99	47.71**	36	0.615
6	68740	230.16	-1.450	105	487.32**	95	0.377
7	68918	186.63	0.232**	53	5.08	5	0.311
8	68786	253.55	-1.610**	106	64.73**	42	0.829
9	68814	238.09	0.725	22	2839.62**	109	0.026
10	FS211	184.53	0.584	33	236.85**	75	0.164
11	FS205	206.60	0.104**	66	45.7**	35	0.026
12	FS9401	224.54	-0.296	85	237.04**	76	0.048
13	SS003	185.41	2.513	94	1782.08**	107	0.336
14	SS012	173.51	1.803	57	312.01**	84	0.590
15	SS020	238.64	4.185**	109	365.98**	87	0.869
16	SRV605	210.53	1.415	31	264.19**	82	0.510
17	FS9604	169.39	0.864	10	-4.13	3	0.932
18	FS9605	220.48	0.445	41	56.2**	39	0.294
19	FS9601	217.89	1.416**	32	-8.48	15	0.988
20	FS9603	198.02	2.474**	92	5.67	7	0.980
21	68710	191.54	1.177	14	225.57**	72	0.455
22	68724	207.18	0.816	15	1941.17**	108	0.047
23	68726	221.69	-0.370	90	1096.09**	104	0.017
24	Co27	203.62	2.079**	74	0.86	2	0.980
25	SS032	201.87	1.013	4	296.03**	83	0.323
26	296A x 68716	178.70	-0.134**	76	466.19**	93	0.005
27	296A x 68740	199.49	-0.314	86	225.29**	71	0.056
28	296A x 68918	172.97	0.155	60	255.41**	79	0.013
29	296A x 68786	203.58	-0.936**	101	123.96**	52	0.481
30	296A x 68814	208.29	-1.662	107	846.31**	100	0.316
31	296A x FS211	191.33	-0.163	77	513.28**	97	0.007
32	296A x FS205	204.64	-0.207	82	238.9**	77	0.024
33	296A x FS9401	205.75	0.391	45	177.63**	65	0.104
34	296A x SS003	193.19	0.301	50	172.76**	63	0.066
35	296A x SS012	172.06	1.220	17	170.9**	62	0.539
36	296A x SS020	221.77	0.834	12	131.21**	54	0.411
37	296A x SRV605	183.19	0.527	36	261.46**	81	0.127
38	296A x FS9604	186.15	0.189	59	1029.27**	103	0.005
39	296A x FS9605	199.65	1.076	7	20.00	29	0.839
40	296A x FS9601	204.34	1.437	35	105.91**	49	0.715
41	296A x FS9603	189.71	1.135	9	14.60	24	0.874
42	296A x 68710	201.94	0.485	38	458.04**	92	0.067

Table 17. (contd...)

Sl.No	Genotypes	Mean	b_1	Rank	S^2_{d1}	Rank	R^2
43	296A x 68724	208.81	0.927	6	160.17**	59	0.417
44	296A x 68726	195.91	-0.012	72	169.88**	61	0.000
45	296A x Co27	188.49	0.207	56	343.51**	86	0.017
46	296A x SS032	183.04	0.773	18	-4.55	4	0.920
47	2219A x 68716	224.47	0.717	23	385.42**	90	0.157
48	2219A x 68740	219.38	0.374	46	248.37**	78	0.072
49	2219A x 68918	182.79	1.684**	49	7.37	11	0.955
50	2219A x 68786	215.72	1.600	44	200.04**	68	0.634
51	2219A x 68814	209.48	1.971	70	28.94*	30	0.932
52	2219A x FS211	188.96	1.852**	61	16.78	27	0.945
53	2219A x FS205	212.38	1.997	71	199.11**	67	0.731
54	2219A x FS9401	204.67	2.189**	81	39.86**	34	0.930
55	2219A x SS003	214.60	2.869	100	391.17**	91	0.745
56	2219A x SS012	194.94	1.733**	51	13.56	23	0.944
57	2219A x SS020	222.76	3.264**	104	69.15**	43	0.950
58	2219A x SRV605	204.25	2.341	88	160.78**	60	0.820
59	2219A x FS9604	188.35	2.554	95	326.17**	85	0.735
60	2219A x FS9605	208.50	1.640	48	69.95**	44	0.825
61	2219A x FS9601	208.61	1.771**	54	0.86	1	0.972
62	2219A x FS9603	187.55	1.941**	68	10.29	19	0.960
63	2219A x 68710	200.83	2.251**	83	36.99**	33	0.937
64	2219A x 68724	218.14	1.941**	67	-5.46	6	0.988
65	2219A x 68726	216.96	2.172**	79	60.75**	40	0.903
66	2219A x Co27	200.72	2.805**	98	16.63	26	0.975
67	2219A x SS032	186.86	1.879**	64	-10.38	21	0.997
68	2077A x 68716	248.64	-0.494	93	377.05**	88	0.083
69	2077A x 68740	243.91	-0.790**	97	6.98	10	0.825
70	2077A x 68918	203.61	-0.315**	87	10.33	20	0.390
71	2077A x 68786	239.69	-2.042**	108	476.81**	94	0.550
72	2077A x 68814	250.24	0.193**	58	8.35	14	0.208
73	2077A x FS211	212.36	-0.068	73	190.58**	66	0.003
74	2077A x FS205	241.62	0.828	13	153.26**	58	0.373
75	2077A x FS9401	233.82	0.222	55	226.09**	74	0.029
76	2077A x SS003	204.99	1.382	29	10.91	22	0.923
77	2077A x SS012	215.73	1.316	24	101.46**	47	0.687
78	2077A x SS020	253.21	0.989	2	1381.06**	105	0.092
79	2077A x SRV605	226.75	-0.455**	91	19.86	28	0.483
80	2077A x FS9604	205.93	0.934	5	9.41	18	0.854
81	2077A x FS9605	235.15	1.012	3	205.26**	69	0.404
82	2077A x FS9601	226.87	1.125	8	7.38	12	0.904
83	2077A x FS9603	226.68	2.082	75	88.66**	46	0.861
84	2077A x 68710	230.35	1.232	19	701.41**	99	0.234
85	2077A x 68724	238.99	0.420	42	62.55**	41	0.254
86	2077A x 68726	249.15	0.748	21	1733.38**	106	0.044

Table 17. (contd...)

Sl.No	Genotypes	Mean	b_1	Rank	S^2_{dl}	Rank	R^2
87	2077A x Co27	230.76	0.998	1	860.93**	101	0.141
88	2077A x SS032	228.98	1.874	62	510.37**	96	0.491
89	111A x 68716	223.84	-1.031**	102	88.4**	45	0.603
90	111A x 68740	243.54	-0.261	84	222.11**	70	0.040
91	111A x 68918	200.26	1.546**	40	-5.72	8	0.982
92	111A x 68786	224.38	1.353	26	255.79**	80	0.495
93	111A x 68814	231.03	1.634	47	113.09**	51	0.754
94	111A x FS211	196.27	1.370	27	49.14**	37	0.815
95	111A x FS205	226.21	0.482	39	34.89*	32	0.415
96	111A x FS9401	225.43	1.598	43	51.29**	38	0.853
97	111A x SS003	177.48	1.350	25	127.57**	53	0.652
98	111A x SS012	198.09	2.174**	80	8.67	16	0.970
99	111A x SS020	235.88	3.163**	103	111.42**	50	0.921
100	111A x SRV605	208.81	1.875	63	147.27**	56	0.760
101	111A x FS9604	192.84	1.886	65	967.95**	102	0.342
102	111A x FS9605	236.11	2.163	78	147.84**	57	0.808
103	111A x FS9601	242.84	1.150	11	553.03**	98	0.251
104	111A x FS9603	209.02	1.249	20	176.14**	64	0.543
105	111A x 68710	210.04	1.394**	30	-7.99	13	0.986
106	111A x 68724	230.93	1.955	69	225.89**	73	0.698
107	111A x 68726	230.26	1.435**	34	-5.91	9	0.980
108	111A x Co27	217.38	1.498	37	380.8**	89	0.450
109	111A x SS032	217.46	2.715**	96	131.46**	55	0.881
	Population Mean	207.16	1.000				
	SE	9.70	0.9926				

* Significant at 5 per cent level

** Significant at 1 per cent level

The mean square deviation from regression was non significant for twenty nine genotypes and among these the top ranking genotype 2219 A x FS 9601 (0.86) followed by Co 27 (0.86), FS 9604 (-4.13) and 296 A x SS 032(-4.55).

4.12.3. Number of tillers:

The top ranking genotypes for b_i value around unity were for 111 A x 68740 (1.017), 111 A x FS 211 (0.972), 296 A x 68470 (0.966) and 111 A x FS 205 (0.96). Among the 109 genotypes, eightyfive recorded non-significant b_i values. The top ranking genotypes had recorded non-significant mean values also (Table 18).

The top five ranking genotypes viz., FS 9604, 111 A x FS 211, 2077 A x FS 9603, 2219 A x 68710 and 111 A x Co 27 recorded a value of zero as deviation from regression. However, their mean values were not significant from the population mean.

4.12.4. Dry fodder yield:

Eighty genotypes recorded non-significant b_i values and twentyseven genotypes recorded non-significant S^2_{di} values (Table 19). The three top ranking genotypes for b_i values nearer to unity were 2219 A x FS 9603 (0.995) 296 A x FS 211 (0.994) and 2077 A (1.014). The three top ranking genotypes for S^2_{di} values nearer to zero were 296 A (0.52), 111 A x Co 27 (-1.11) and 2219 A x FS 211 (1.18). The highest R^2 value of 0.998 was recorded by 111 A x SS 032 with b_i value of 2.787 (Rank 108) and a S^2_{di} value of -12.73 (rank 14) with highly significant mean value.

4.12.5. Green fodder yield per Plant:

Among the 109 genotypes, ninetyfour had non-significant b_i values but none recorded non-significant S^2_{di} values (Table 20). The top three ranking genotypes for b_i values were 111 A x 68740 (1.005), 111 A x SS 003 (1.014) and 2077 A x SRV 605 (0.966) but none of them recorded higher mean values than the population mean. The highest R^2 value was observed for 111 A x FS 9601 in which both the b_i values and S^2_{di} value were significant. The genotype ranked first for S^2_{di} and ninetyeighth for b_i values.

Table 18. Stability parameters of parents and hybrids for number of tillers

SLNo	Genotypes	Mean	b_i	Rank	S^2_{di}	Rank	R^2
1	296A	1.09	0.271**	60	-0.12	74	0.578
2	2219A	1.17	0.172**	66	-0.11	69	0.240
3	2077A	1.29	0.310	57	-0.07	35	0.183
4	111A	1.34	0.816	21	-0.07	43	0.640
5	68716	2.19	1.507	43	0.07	34	0.617
6	68740	2.81	0.728	27	0.41**	97	0.118
7	68918	1.42	0.373**	50	-0.12	76	0.775
8	68786	2.55	2.049	80	0.18	84	0.650
9	68814	1.58	0.081	72	0.61**	102	0.001
10	FS211	1.73	0.103*	68	-0.08	45	0.033
11	FS205	2.16	0.242	62	0.18	85	0.025
12	FS9401	2.29	-0.221	88	-0.02	11	0.058
13	SS003	1.75	-1.170	107	0.28*	92	0.316
14	SS012	1.45	-0.719**	100	-0.11	70	0.849
15	SS020	2.29	0.027	77	1.14**	106	0.000
16	SRV605	2.14	-0.333	92	0.16	82	0.049
17	FS9604	1.92	-0.411*	94	0.00	1	0.155
18	FS9605	2.34	1.102	14	-0.11	63	0.911
19	FS9601	2.51	1.055	7	0.45**	98	0.207
20	FS9603	3.04	0.479	45	2.06**	108	0.014
21	68710	1.63	0.062	74	0.27*	91	0.001
22	68724	3.12	1.232	24	1.8**	107	0.096
23	68726	3.81	2.520	97	0.69**	103	0.513
24	Co27	2.43	0.365**	52	-0.11	71	0.599
25	SS032	2.25	1.797	63	0.56**	100	0.388
26	296A x 68716	1.81	1.041	5	-0.02	10	0.574
27	296A x 68740	2.19	0.966	3	0.35*	95	0.210
28	296A x 68918	1.75	-0.420	95	0.12	79	0.087
29	296A x 68786	1.8	1.806	64	0.39**	96	0.462
30	296A x 68814	1.88	-0.158**	86	-0.09	48	0.080
31	296A x FS211	1.92	0.958	6	0.02	12	0.453
32	296A x FS205	2.06	0.371*	51	-0.10	58	0.431
33	296A x FS9401	2.17	0.632**	36	-0.12	78	0.953
34	296A x SS003	1.98	0.899	13	-0.12	73	0.930
35	296A x SS012	1.57	0.673	33	0.09	54	0.220
36	296A x SS020	1.98	0.538	40	-0.04	22	0.310
37	296A x SRV605	2.23	0.926	9	0.03	14	0.432
38	296A x FS9604	2.17	2.818**	101	-0.04	23	0.927
39	296A x FS9605	2.04	0.929	8	0.14	81	0.307
40	296A x FS9601	2.32	2.229	90	0.13	80	0.725
41	296A x FS9603	2.49	3.138*	106	0.12	72	0.847
42	296A x 68710	2.9	2.999**	105	-0.09	53	0.973

Table 18. (contd...)

SLNo	Genotypes	Mean	b_i	Rank	S^2_{di}	Rank	R^2
43	296A x 68724	2.61	2.225	89	0.07	36	0.775
44	296A x 68726	4.79	7.273	109	3.66**	109	0.653
45	296A x Co27	1.93	0.679	32	0.11	68	0.209
46	296A x SS032	2.72	2.584	98	0.21	87	0.728
47	2219A x 68716	2.8	2.353**	93	-0.07	41	0.934
48	2219A x 68740	2.44	0.880	18	-0.04	24	0.565
49	2219A x 68918	2.02	1.317	31	0.08	46	0.528
50	2219A x 68786	2.03	0.320**	56	-0.10	57	0.360
51	2219A x 68814	2.69	-0.135	84	0.06	33	0.013
52	2219A x FS211	1.98	1.587	48	-0.01	7	0.752
53	2219A x FS205	2.07	0.080**	73	-0.11	66	0.054
54	2219A x FS9401	2.44	1.316	29	0.04	19	0.592
55	2219A x SS003	1.88	0.897	15	-0.07	42	0.673
56	2219A x SS012	2.05	0.554	39	-0.09	47	0.516
57	2219A x SS020	2.01	1.300	28	-0.05	29	0.762
58	2219A x SRV605	1.67	0.385	49	-0.09	52	0.369
59	2219A x FS9604	1.58	-0.099**	81	-0.09	49	0.035
60	2219A x FS9605	2.23	1.107	16	-0.11	61	0.905
61	2219A x FS9601	2.25	1.108	17	-0.09	50	0.821
62	2219A x FS9603	2.19	0.251	61	0.25*	89	0.022
63	2219A x 68710	2.16	1.243	26	0.00	4	0.633
64	2219A x 68724	2.05	0.184	65	0.03	13	0.030
65	2219A x 68726	2.7	1.903**	70	-0.12	77	0.994
66	2219A x Co27	2.33	-0.897**	102	-0.11	64	0.873
67	2219A x SS032	2.29	0.526	41	-0.07	37	0.399
68	2077A x 68716	2.13	0.350	53	-0.03	15	0.148
69	2077A x 68740	2.63	-0.440	96	0.58**	101	0.036
70	2077A x 68918	1.55	0.644	35	-0.05	27	0.420
71	2077A x 68786	1.85	2.149	85	0.33*	94	0.581
72	2077A x 68814	2.51	1.342	34	0.81**	105	0.206
73	2077A x FS211	2.2	2.127*	82	-0.04	21	0.874
74	2077A x FS205	2.14	-0.295	91	0.19	86	0.036
75	2077A x FS9401	2.42	1.317	30	-0.11	65	0.938
76	2077A x SS003	1.93	0.762	25	-0.05	28	0.507
77	2077A x SS012	1.68	0.869	19	0.04	20	0.387
78	2077A x SS020	2.16	0.288	58	0.56**	99	0.016
79	2077A x SRV605	1.74	-0.933**	104	-0.09	55	0.792
80	2077A x FS9604	1.55	0.833	20	-0.01	6	0.455
81	2077A x FS9605	2	0.493	44	-0.05	26	0.298
82	2077A x FS9601	2.27	0.330	55	0.25*	90	0.037
83	2077A x FS9603	2.22	0.906	12	0.00	3	0.464
84	2077A x 68710	2.7	2.026	78	0.07	38	0.740
85	2077A x 68724	2.58	1.908	71	0.12	75	0.669
86	2077A x 68726	3.13	1.093	11	-0.11	62	0.906

Table 18. (contd...)

Sl.No	Genotypes	Mean	b_1	Rank	S^2_{dt}	Rank	R^2
87	2077A x Co27	2.42	1.658	54	0.03	18	0.701
88	2077A x SS032	1.69	0.573	37	-0.06	32	0.422
89	111A x 68716	2.18	1.947	75	0.03	16	0.765
90	111A x 68740	1.78	1.017	1	-0.05	25	0.639
91	111A x 68918	1.74	0.050	76	0.03	17	0.002
92	111A x 68786	2.29	0.801	23	-0.06	30	0.557
93	111A x 68814	2.69	1.831	67	0.24*	88	0.555
94	111A x FS211	2.11	0.972	2	0.00	2	0.499
95	111A x FS205	2.03	0.960	4	0.10	56	0.361
96	111A x FS9401	2.23	1.897*	69	-0.07	40	0.899
97	111A x SS003	1.78	1.503	42	0.10	60	0.572
98	111A x SS012	1.58	0.559	38	-0.11	67	0.739
99	111A x SS020	1.71	0.810	22	0.09	51	0.292
100	111A x SRV605	2.21	0.274	59	0.07	39	0.050
101	111A x FS9604	2.20	0.917	10	0.77**	104	0.112
102	111A x FS9605	2.70	2.042	79	0.17	83	0.653
103	111A x FS9601	2.07	1.528	46	-0.06	31	0.833
104	111A x FS9603	3.21	3.204**	108	0.02	9	0.908
105	111A x 68710	2.83	2.903**	103	-0.08	44	0.963
106	111A x 68724	2.42	2.130	83	-0.01	8	0.846
107	111A x 68726	3.16	2.609	99	0.28*	93	0.695
108	111A x Co27	2.02	-0.207	87	0.00	5	0.046
109	111A x SS032	2.85	1.534	47	-0.10	59	0.935
	Population Mean	2.18	1.000				
	SE	0.299	0.999				

* Significant at 5 per cent level

** Significant at 1 per cent level

Table 19. Stability parameters of parents and hybrids for dry fodder yield per plant

Sl.No	Genotypes	Mean	b_i	Rank	S^2_{di}	Rank	R^2
1	296A	29.84	0.176	89	0.52	1	0.466
2	2219A	20.94	0.252	85	215.87**	60	0.163
3	2077A	41.76	1.014	3	13.78	16	0.951
4	111A	36.26	0.554	50	110.41**	42	0.626
5	68716	58.57	1.161	25	260.96**	64	0.778
6	68740	82.97	1.349	38	280.23**	68	0.816
7	68918	54.25	-0.128**	102	224.44**	62	0.046
8	68786	130.85	1.825	90	284.21**	69	0.889
9	68814	54.66	0.460	69	650.06**	87	0.189
10	FS211	65.49	0.211**	86	77.78**	33	0.242
11	FS205	69.68	0.673	35	145.99**	50	0.663
12	FS9401	73.86	1.085	13	2.80	4	0.968
13	SS003	44.99	-0.064**	99	219.66**	61	0.012
14	SS012	35.87	0.136**	94	78.36**	34	0.116
15	SS020	59.53	0.917	11	94.28**	37	0.839
16	SRV605	67.56	0.088	95	543.77**	82	0.010
17	FS9604	56.89	0.332**	81	-11.16	12	0.849
18	FS9605	55.75	0.461*	67	46.16	28	0.687
19	FS9601	63.45	1.352	39	76.63**	32	0.930
20	FS9603	77.71	1.082	10	731.19**	92	0.535
21	68710	61.12	0.194	87	671.33**	88	0.039
22	68724	81.70	-0.309	104	1764.49**	104	0.038
23	68726	86.79	0.526	57	118.4**	45	0.588
24	Co27	71.00	0.715	30	610.65**	86	0.374
25	SS032	89.44	2.469*	105	563.75**	84	0.885
26	296A x 68716	59.04	0.437	70	196.17**	59	0.390
27	296A x 68740	85.36	1.305	34	886.28**	98	0.582
28	296A x 68918	65.89	-0.276**	103	-13.70	15	0.824
29	296A x 68786	71.78	0.521	59	687.31**	90	0.221
30	296A x 68814	75.96	0.351	77	136.97**	48	0.361
31	296A x FS211	69.66	0.994	2	5.04	5	0.960
32	296A x FS205	71.69	1.116	20	-14.06	17	0.988
33	296A x FS9401	74.51	1.485	60	99.98**	40	0.929
34	296A x SS003	66.74	1.498	62	88.92**	36	0.936
35	296A x SS012	49.84	0.509**	61	6.74	8	0.856
36	296A x SS020	76.62	1.427	49	137.67**	49	0.903
37	296A x SRV605	72.65	1.269	29	393.19**	77	0.741
38	296A x FS9604	91.53	2.652*	107	776.29**	95	0.867
39	296A x FS9605	67.12	0.916	12	430.81**	79	0.577
40	296A x FS9601	88.26	1.538*	66	63.78*	31	0.952
41	296A x FS9603	81.72	1.287	31	194.04**	58	0.849
42	296A x 68710	87.74	1.539	68	530.19**	81	0.760

LIBRARY
TNAU, Coimbatore - 3



000157210



Table 19. (contd...)

Sl.No	Genotypes	Mean	b_1	Rank	S^2_{d1}	Rank	R^2
43	296A x 68724	104.88	1.3	33	1933.78**	107	0.391
44	296A x 68726	127.84	1.673	83	809.41**	96	0.714
45	296A x Co27	82.94	0.634*	41	5.31	7	0.906
46	296A x SS032	92.50	1.604	73	689.29**	91	0.728
47	2219A x 68716	102.03	1.048	7	955.16**	101	0.455
48	2219A x 68740	78.76	0.537	53	672.72**	89	0.235
49	2219A x 68918	69.18	1.114	19	231.89**	63	0.782
50	2219A x 68786	89.82	1.036	4	348.31**	73	0.681
51	2219A x 68814	82.08	0.064**	96	118.21**	44	0.021
52	2219A x FS211	71.18	0.850	23	1.18	3	0.952
53	2219A x FS205	60.86	0.864	22	-12.55	13	0.977
54	2219A x FS9401	82.71	1.468**	54	15.65	18	0.975
55	2219A x SS003	65.97	1.642**	76	9.22	9	0.983
56	2219A x SS012	57.36	0.499**	64	9.81	11	0.839
57	2219A x SS020	77.85	1.851	92	192.98**	57	0.921
58	2219A x SRV605	59.86	1.471	55	120.43**	46	0.917
59	2219A x FS9604	45.41	0.48**	65	9.56	10	0.829
60	2219A x FS9605	76.17	0.925	8	38.12	25	0.909
61	2219A x FS9601	80.54	0.874**	21	-23.92	20	0.997
62	2219A x FS9603	67.20	0.995	1	180.55**	54	0.781
63	2219A x 68710	76.44	0.957	6	51.14*	29	0.899
64	2219A x 68724	76.16	0.592	45	97.58**	39	0.679
65	2219A x 68726	79.86	1.651	78	80.68**	35	0.950
66	2219A x Co27	65.54	0.381	75	146.17**	51	0.386
67	2219A x SS032	81.40	0.921	9	272.76**	66	0.679
68	2077A x 68716	118.43	0.542**	52	-24.96	22	0.996
69	2077A x 68740	118.34	0.607	43	322.90**	71	0.440
70	2077A x 68918	78.36	0.780	27	345.25**	72	0.549
71	2077A x 68786	123.36	0.704	32	407.89**	78	0.460
72	2077A x 68814	128.48	1.102	14	1872.83**	106	0.322
73	2077A x FS211	83.31	1.409	47	179.65**	53	0.878
74	2077A x FS205	94.51	1.237	28	95.96**	38	0.903
75	2077A x FS9401	94.48	1.038	5	44.13**	26	0.920
76	2077A x SS003	82.02	0.170*	91	181.62**	55	0.094
77	2077A x SS012	75.03	1.109	17	468.43**	80	0.649
78	2077A x SS020	77.59	0.55**	51	17.58	19	0.838
79	2077A x SRV605	76.49	0.526	56	125.74**	47	0.576
80	2077A x FS9604	81.72	1.364	40	320.15**	70	0.800
81	2077A x FS9605	90.72	0.342	79	895.54**	99	0.987
82	2077A x FS9601	88.91	1.412	48	44.41	27	0.955
83	2077A x FS9603	96.11	1.157	24	188.43**	56	0.823
84	2077A x 68710	123.83	0.329	82	2878.21**	109	0.027
85	2077A x 68724	117.97	0.39**	74	5.06	6	0.786
86	2077A x 68726	150.11	-0.545	106	1041.24**	102	0.172

Table 19. (contd...)

SLNo	Genotypes	Mean	b_i	Rank	S^2_{di}	Rank	R^2
87	2077A x Co27	118.11	1.943*	97	279.27**	67	0.902
88	2077A x SS032	53.01	0.591**	46	-24.46	21	0.995
89	111A x 68716	84.05	1.857	93	763.9**	94	0.765
90	111A x 68740	96.98	1.103	15	356.27**	75	0.703
91	111A x 68918	75.53	0.500	63	564.26**	85	0.240
92	111A x 68786	100.49	0.658	36	53.57*	30	0.802
93	111A x 68814	122.40	0.598	44	2415.58**	108	0.098
94	111A x FS211	91.45	0.886	18	1335.33**	103	0.300
95	111A x FS205	86.87	1.578	72	114.81**	43	0.930
96	111A x FS9401	87.60	1.662	80	162.41**	52	0.916
97	111A x SS003	69.95	1.108	16	35.59	24	0.937
98	111A x SS012	73.57	0.617	42	373.46**	76	0.415
99	111A x SS020	77.11	1.564	71	355.31**	74	0.827
100	111A x SRV605	85.91	2.105	100	816.06**	97	0.797
101	111A x FS9604	91.95	1.819	88	760.21**	93	0.758
102	111A x FS9605	108.61	2.108	101	950.06**	100	0.772
103	111A x FS9601	89.81	1.962**	98	100.89**	41	0.958
104	111A x FS9603	120.73	3.114**	109	553.62**	83	0.926
105	111A x 68710	104.02	1.166	26	266.56**	65	0.776
106	111A x 68724	100.01	1.476*	58	32.91	23	0.965
107	111A x 68726	118.52	1.695	84	1855.09**	105	0.532
108	111A x Co27	89.39	1.348**	37	-1.11	2	0.982
109	111A x SS032	118.1	2.787**	108	-12.73	14	0.998
	Population Mean	81.15	1.000				
	SE	11.55	0.5189				

* Significant at 5 per cent level

** Significant at 1 per cent level

Table 20. Stability parameters of parents and hybrids for green fodder yield per plant

SLNo	Genotypes	Mean	b_i	Rank	S^2_{di}	Rank	R^2
1	296A	171.44	0.112*	92	1950.34**	33	0.047
2	2219A	131.25	-0.126	97	8406.12**	77	0.014
3	2077A	219.31	0.624	58	4247.05**	55	0.410
4	111A	212.68	0.261	85	6176.41**	67	0.078
5	68716	262.59	1.516	70	2405.39**	41	0.879
6	68740	325.80	1.244	39	3140.19**	47	0.789
7	68918	269.88	0.320	82	4534.4**	59	0.147
8	68786	477.91	1.658	80	6757.86**	70	0.756
9	68814	234.18	0.816	33	5164.98**	88	0.251
10	FS211	283.19	0.104**	94	1654.28**	27	0.047
11	FS205	262.72	0.876	15	2250.83**	38	0.721
12	FS9401	291.20	0.825	31	1243.84**	22	0.805
13	SS003	229.47	0.253**	88	355.41**	5	0.569
14	SS012	192.27	0.174*	90	1575.91**	26	0.127
15	SS020	248.16	0.350	78	2087.63**	36	0.308
16	SRV605	254.03	0.755	40	3315.47**	49	0.566
17	FS9604	243.27	0.797	35	1465.8**	24	0.766
18	FS9605	244.17	0.837	25	948.04**	17	0.847
19	FS9601	266.00	0.843	24	2001.15**	34	0.729
20	FS9603	296.08	1.178	32	5550.28**	90	0.405
21	68710	276.96	0.599	61	5889.89**	66	0.317
22	68724	324.00	-0.364	103	2102.18**	109	0.024
23	68726	354.17	0.334	81	3082.04**	46	0.216
24	Co27	258.06	0.486	69	2389.95**	40	0.429
25	SS032	397.00	2.519	106	5225.91**	89	0.761
26	296A x 68716	312.71	0.505	68	7963.03**	74	0.196
27	296A x 68740	355.49	1.352	56	4686.57**	86	0.487
28	296A x 68918	338.51	-0.511**	105	4328.01**	56	0.315
29	296A x 68786	377.65	0.837	26	8258.16**	106	0.159
30	296A x 68814	310.17	0.063	95	5242.38**	63	0.006
31	296A x FS211	357.89	0.862	18	3055.12**	45	0.649
32	296A x FS205	308.95	1.282**	46	126.26**	2	0.989
33	296A x FS9401	319.70	1.272	43	1133.32**	20	0.915
34	296A x SS003	293.61	1.111	14	2128.63**	37	0.815
35	296A x SS012	256.77	0.515	67	1115.62**	18	0.642
36	296A x SS020	340.10	1.403	62	3633.97**	51	0.805
37	296A x SRV605	299.20	1.267	42	4605.14**	61	0.726
38	296A x FS9604	449.86	3.049	108	5581.13**	105	0.735
39	296A x FS9605	320.75	1.225	37	9432.27**	80	0.548
40	296A x FS9601	338.75	1.254	41	1356.07**	23	0.897
41	296A x FS9603	354.28	1.053	5	5463.61**	65	0.607
42	296A x 68710	440.40	0.861	19	4560.22**	104	0.187

Table 20. (contd...)

SLNo	Genotypes	Mean	b_i	Rank	S^2_{di}	Rank	R^2
43	296A x 68724	429.21	1.164	27	6905.48**	95	0.379
44	296A x 68726	561.78	1.156	23	4958.35**	87	0.405
45	296A x Co27	334.09	0.849	21	1667.16**	28	0.766
46	296A x SS032	437.43	1.427	64	8333.23**	97	0.459
47	2219A x 68716	479.44	2.245	102	1516.54**	83	0.769
48	2219A x 68740	353.28	1.336	55	9205.70**	79	0.596
49	2219A x 68918	345.45	0.810	34	5389.52**	64	0.481
50	2219A x 68786	413.50	1.170	30	3427.70**	50	0.752
51	2219A x 68814	376.39	-0.148**	99	749.90**	11	0.180
52	2219A x FS211	314.34	0.776	36	803.79**	13	0.849
53	2219A x FS205	281.24	0.835	28	1131.08**	19	0.823
54	2219A x FS9401	320.65	1.132	17	519.33**	7	0.948
55	2219A x SS003	283.86	1.278	44	569.55**	8	0.955
56	2219A x SS012	286.68	0.464**	71	330.72**	4	0.826
57	2219A x SS020	315.22	1.555	72	4562.48**	60	0.801
58	2219A x SRV605	257.08	1.084	11	2322.71**	39	0.793
59	2219A x FS9604	251.84	0.699	48	932.75**	16	0.797
60	2219A x FS9605	295.82	0.860	20	615.65**	9	0.899
61	2219A x FS9601	329.31	1.044	4	689.12**	10	0.922
62	2219A x FS9603	271.47	0.554	66	4103.43**	54	0.362
63	2219A x 68710	329.39	0.692	50	2078.10**	35	0.636
64	2219A x 68724	335.51	0.669	54	6386.15**	69	0.348
65	2219A x 68726	350.25	0.919	8	3265.27**	48	0.663
66	2219A x Co27	283.34	0.257**	86	770.8**	12	0.390
67	2219A x SS032	349.55	0.680	52	3946.51**	53	0.471
68	2077A x 68716	584.15	1.082	9	3007.64**	102	0.280
69	2077A x 68740	528.61	0.699	49	4366.3**	57	0.460
70	2077A x 58918	429.70	0.108	93	5851.15**	91	0.006
71	2077A x 68786	674.82	1.434	65	4332.02**	85	0.522
72	2077A x 68814	593.93	1.651	79	6623.56**	93	0.556
73	2077A x FS211	417.54	1.374	57	8281.16**	76	0.635
74	2077A x FS205	419.37	1.056	6	1869.38**	31	0.819
75	2077A x FS9401	402.26	0.847	22	2554.6**	42	0.681
76	2077A x SS003	402.38	0.618*	59	470.58**	6	0.857
77	2077A x SS012	421.87	1.634	77	63.65**	81	0.669
78	2077A x SS020	375.81	0.681	51	3749.82**	52	0.485
79	2077A x SRV605	377.23	0.966	3	1212.41**	21	0.853
80	2077A x FS9604	422.73	2.185	100	9334.98**	107	0.554
81	2077A x FS9605	408.99	1.087	12	2560.76**	84	0.418
82	2077A x FS9601	371.81	1.128	16	1754.66**	29	0.846
83	2077A x FS9603	422.08	1.084	10	1904.95**	32	0.824
84	2077A x 68710	545.15	0.376	76	6800.39**	94	0.060
85	2077A x 68724	487.07	0.676	53	8985.19**	78	0.279
86	2077A x 68726	634.90	-0.191	101	9306.85**	98	0.014

Table 20. (contd...)

Sl.No	Genotypes	Mean	b_i	Rank	S^2_{di}	Rank	R^2
87	2077A x Co27	516.16	1.806	89	4482.43**	58	0.847
88	2077A x SS032	251.88	0.593**	63	330.01**	3	0.886
89	111A x 68716	456.03	2.013	96	6206.97**	92	0.656
90	111A x 68740	373.57	1.005	1	7566.65**	72	0.504
91	111A x 68918	366.20	0.441	73	2614.12**	43	0.361
92	111A x 68786	506.83	0.428	74	6941.75**	71	0.167
93	111A x 68814	592.48	0.927	7	3966.93**	108	0.162
94	111A x FS211	421.95	0.717	47	1418.42**	100	0.155
95	111A x FS205	376.58	1.399	60	1779.06**	30	0.893
96	111A x FS9401	388.27	1.107	13	873.43**	14	0.913
97	111A x SS003	327.57	1.014	2	2725.62**	44	0.741
98	111A x SS012	373.70	0.406	75	7974.12**	75	0.136
99	111A x SS020	369.33	1.279	45	8017.19**	96	0.409
100	111A x SRV605	387.72	2.378	104	2949.48**	101	0.653
101	111A x FS9604	434.87	1.709	83	3196.63**	103	0.490
102	111A x FS9605	486.41	1.745	87	1012.18**	82	0.678
103	111A x FS9601	403.84	2.131**	98	80.92**	1	0.997
104	111A x FS9603	501.69	3.08**	109	7784.05**	73	0.903
105	111A x 68710	504.64	1.230	38	6373.25**	68	0.644
106	111A x 68724	517.89	1.839**	91	896.98**	15	0.966
107	111A x 68726	532.2	1.720	84	9567.77**	99	0.536
108	111A x Co27	373.22	0.831	29	1556.8**	25	0.770
109	111A x SS032	540.00	2.808**	107	5041.98**	62	0.923
	Population Mean	367.06	1.000				
	SE	50.37	0.7062				

* Significant at 5 per cent level

** Significant at 1 per cent level

4.12.6. Green fodder yield per plot:

Among the 109 genotypes, eighty-nine recorded non-significant b_i values, and eighteen recorded non-significant S^2_{di} values (Table 21). The genotypes having top ranking b_i values for nearness to unity were 68740 (1.004), Co 27 (0.993), 68716 (0.991), 2219 A x 68726 (1.012) and 2077 A x SS 003 (0.986). Regarding their mean values, none of the genotypes except 2219 A x 68726 (18.74 kg per plot) exceeded the population mean.

The top ranking genotype for S^2_{di} value was 111 A x Co 27 (-0.02) followed by 2219A x FS 211 (-0.08), 296 A x 68726 (0.11), 111 A x FS 9401 (-0.14) and 296 A x SS020 (-0.15) which recorded S^2_{di} values nearer to zero. Among these hybrids only 111 A x Co 27 recorded highly significant mean over population mean.

4.12.7. Crude protein:

A total of hundred and eight genotypes showed non-significant b_i values among which thirty-eight genotypes recorded non-significant S^2_{di} values (Table 22). The genotype having top ranking b_i value for nearness to unity was 2219 A x 68740 (0.97) followed by 2219 A x SS 032 (0.97). Both the genotypes recorded highly significant mean from the population mean. Regarding S^2_{di} values the top ranking entries were 111 A x FS 9601 and 296 A x 68740 with S^2_{di} value of 0.000. The highest R^2 value (0.998) was observed for the genotype 296 A x 68710 with b_i value of 1.052 (Rank 14) and S^2_{di} value of -0.01 (Rank 14) followed by 2077 A x FS 9601 (Rank 16) and 2219 A x FS 9604 (Rank 20) which had recorded the same b_i and S^2_{di} values.

4.13. Association between stability parameters:

The correlation coefficient between stability parameters for seven characters is presented in Table 23. Significant positive correlations were observed between mean and b_i for all the characters except plant height and between mean and S^2_{di} for only five characters viz., days to 50 per cent flowering, number of tillers, dry fodder yield, green fodder yield per plant and green fodder yield per plot. The correlation between b_i vs S^2_{di} indicated that only

Table 21. Stability parameters of parents and hybrids for green fodder yield per plot

Sl.No	Genotypes	Mean	b_i	Rank	S^2_{di}	Rank	R^2
1	296A	7.17	0.627	62	24.3**	102	0.289
2	2219A	2.65	0.158**	103	3.93**	51	0.130
3	2077A	6.34	0.162	102	11.29**	76	0.055
4	111A	11.05	-0.064**	106	0.74	19	0.084
5	68716	7.62	0.991	3	0.86	23	0.953
6	68740	9.54	1.004	1	0.85	21	0.954
7	68918	5.19	0.616	64	14.36**	85	0.397
8	68786	15.67	1.541	84	9.16**	72	0.864
9	68814	9.86	1.481	79	14.95**	86	0.786
10	FS211	7.79	0.919	16	16.00**	90	0.569
11	FS205	7.35	0.877	27	3.16**	46	0.847
12	FS9401	7.73	0.819	37	2.85**	44	0.842
13	SS003	7.60	0.793	41	4.20**	54	0.778
14	SS012	5.95	0.734	46	30.66**	105	0.307
15	SS020	12.04	0.898	21	9.45**	74	0.677
16	SRV605	10.13	1.160	34	5.78**	64	0.848
17	FS9604	8.08	1.018	6	1.81**	33	0.923
18	FS9605	7.92	1.086	17	1.87**	34	0.931
19	FS9601	7.40	0.882	23	0.74*	20	0.947
20	FS9603	8.23	0.377**	89	1.98**	36	0.606
21	68710	9.04	1.028	8	5.40**	57	0.824
22	68724	11.87	-0.160*	108	10.08**	75	0.059
23	68726	15.23	1.091	20	5.70**	63	0.833
24	Co27	9.24	0.993	2	8.91**	71	0.731
25	SS032	13.86	1.703	94	35.94**	106	0.671
26	296A x 68716	8.55	1.190	39	3.55**	48	0.902
27	296A x 68740	11.58	1.676**	91	1.12*	28	0.979
28	296A x 68918	10.57	1.415	69	20.34**	96	0.712
29	296A x 68786	5.00	0.676	55	2.71**	43	0.791
30	296A x 68814	9.33	1.147	32	15.15**	87	0.684
31	296A x FS211	11.89	1.554	85	5.69**	62	0.910
32	296A x FS205	9.26	0.914	18	1.02*	26	0.938
33	296A x FS9401	12.98	1.771**	99	4.12**	53	0.947
34	296A x SS003	10.64	1.384*	65	0.93*	24	0.974
35	296A x SS012	8.48	1.088	19	12.69**	81	0.699
36	296A x SS020	7.43	0.923	14	-0.15	5	0.989
37	296A x SRV605	2.74	0.317**	92	0.29	10	0.793
38	296A x FS9604	4.14	0.518*	80	2.01**	38	0.741
39	296A x FS9605	11.51	1.687**	93	1.22**	29	0.979
40	296A x FS9601	14.54	1.831	101	12.25**	79	0.872
41	296A x FS9603	6.90	0.479**	82	1.11*	27	0.797
42	296A x 68710	10.95	1.471	76	15.57**	88	0.776
43	296A x 68724	12.33	1.456**	74	0.11	3	0.991

Table 21. (contd...)

Sl.No	Genotypes	Mean	b _i	Rank	S ² _{di}	Rank	R ²
44	296A x 68726	4.88	0.28**	95	0.25	7	0.761
45	296A x Co27	12.41	1.493*	81	2.60**	41	0.950
46	296A x SS032	9.79	1.120	24	4.31**	55	0.872
47	2219A x 68716	20.71	1.475	78	73.70**	109	0.429
48	2219A x 68740	13.63	1.048	9	12.44**	80	0.687
49	2219A x 68918	14.37	0.776	42	13.09**	83	0.533
50	2219A x 68786	15.18	1.130	30	0.44	15	0.975
51	2219A x 68814	16.80	1.295	52	24.19**	101	0.636
52	2219A x FS211	12.46	1.188*	38	-0.08	2	0.992
53	2219A x FS205	10.01	0.753	44	1.48**	30	0.886
54	2219A x FS9401	15.00	1.371	61	7.95**	68	0.852
55	2219A x SS003	13.23	0.873	29	12.19**	78	0.608
56	2219A x SS012	11.43	0.721*	47	0.37	14	0.947
57	2219A x SS020	16.15	1.281	50	24.15**	100	0.631
58	2219A x SRV605	11.79	1.375	63	3.43**	47	0.927
59	2219A x FS9604	10.01	0.601**	67	0.33	12	0.928
60	2219A x FS9605	11.94	1.283*	51	0.35	13	0.983
61	2219A x FS9601	13.89	1.366	60	3.10**	45	0.932
62	2219A x FS9603	11.92	1.121	25	4.04**	52	0.879
63	2219A x 68710	8.90	0.564*	73	1.57**	31	0.806
64	2219A x 68724	14.91	0.641	59	15.62**	89	0.397
65	2219A x 68726	18.76	1.012	4	14.18**	84	0.643
66	2219A x Co27	14.81	1.281	49	1.94**	35	0.947
67	2219A x SS032	14.72	1.347*	58	0.86**	22	0.974
68	2077A x 68716	5.73	0.251**	96	3.60**	50	0.288
69	2077A x 68740	12.96	0.874	28	9.20**	73	0.671
70	2077A x 68918	7.89	0.835	35	17.05**	93	0.506
71	2077A x 68786	13.10	0.919	15	5.54**	60	0.785
72	2077A x 68814	14.48	0.526	77	7.75**	67	0.465
73	2077A x FS211	13.73	1.429**	72	0.44	16	0.985
74	2077A x FS205	10.18	0.897	22	-0.24	6	0.993
75	2077A x FS9401	12.58	0.671	57	3.56**	49	0.745
76	2077A x SS003	10.28	0.986	5	0.63	17	0.961
77	2077A x SS012	10.53	0.840	33	8.56**	69	0.669
78	2077A x SS020	12.04	0.758	43	2.63**	42	0.830
79	2077A x SRV605	12.57	0.929	13	-0.26	8	0.994
80	2077A x FS9604	9.67	0.389	87	16.94**	91	0.183
81	2077A x FS9605	14.38	0.830	36	23.43**	99	0.425
82	2077A x FS9601	12.6	0.878	26	2.26**	39	0.882
83	2077A x FS9603	9.79	0.577**	71	0.97*	25	0.863
84	2077A x 68710	9.81	0.687	54	12.77**	82	0.479
85	2077A x 68724	13.75	0.675	56	20.04**	95	0.364
86	2077A x 68726	10.94	0.333	90	7.17**	66	0.273
87	2077A x Co27	8.19	0.239**	98	0.66	18	0.584

Table 21. (contd...)

SLNo	Genotypes	Mean	b_1	Rank	S^2_{dl}	Rank	R^2
88	2077A x SS032	1.39	0.046**	105	-0.27	9	0.326
89	111A x 68716	12.06	1.535	83	5.53**	59	0.911
90	111A x 68740	12.58	1.419	70	8.85**	70	0.848
91	111A x 68918	12.45	1.052	11	12.14**	77	0.693
92	111A x 68786	15.64	1.387	66	18.77**	94	0.720
93	111A x 68814	21.71	0.931	12	2.44**	40	0.887
94	111A x FS211	14.00	1.048	10	0.33	11	0.975
95	111A x FS205	14.30	1.783*	100	7.00**	65	0.917
96	111A x FS9401	14.73	1.464**	75	-0.14	4	0.996
97	111A x SS003	13.93	1.755*	97	4.61**	56	0.940
98	111A x SS012	13.32	1.280	48	1.77**	32	0.951
99	111A x SS020	13.39	0.066	104	16.99**	92	0.006
100	111A x SRV605	20.26	2.837	109	58.24**	108	0.778
101	111A x FS9604	14.51	0.979	7	22.93**	98	0.513
102	111A x FS9605	18.10	1.413	68	20.48**	97	0.710
103	111A x FS9601	15.56	1.612	88	24.91**	103	0.724
104	111A x FS9603	7.39	0.739	45	5.64**	61	0.699
105	111A x 68710	6.84	0.403**	86	1.98**	37	0.637
106	111A x 68724	22.63	1.203	40	5.47**	58	0.864
107	111A x 68726	23.94	0.696	53	28.30**	104	0.302
108	111A x Co27	14.73	1.138	31	-0.02	1	0.989
109	111A x SS032	22.59	2.072	107	55.73**	107	0.662
	Population Mean	11.58	1.000				
	SE	1.77	0.4304				

* Significant at 5 per cent level

** Significant at 1 per cent level

Table 22. Stability parameters of parents and hybrids for crude protein

SLNo	Genotypes	Mean	b_i	Rank	S^2_{di}	Rank	R^2
1	296A	7.66	0.97	7	-0.01	7	0.996
2	2219A	7.92	1.361	58	0.08**	55	0.895
3	2077A	8.62	1.045	13	-0.01	26	0.998
4	111A	7.92	0.419	78	0.27**	81	0.214
5	68716	8.10	1.042	8	-0.01	22	0.998
6	68740	7.85	0.50	69	0.19**	70	0.348
7	68918	7.57	0.567	62	0.11**	60	0.542
8	68786	7.84	0.807	35	0.02	38	0.899
9	68814	8.10	0.572	61	0.14**	66	0.488
10	FS211	7.40	0.726	46	0.05**	51	0.785
11	FS205	7.76	0.901	21	0.05**	39	0.862
12	FS9401	7.22	0.573	60	0.14**	67	0.480
13	SS003	8.19	1.44	63	0.13**	65	0.861
14	SS012	8.01	0.654	56	0.09**	59	0.643
15	SS020	7.57	1.045	12	-0.01	25	0.998
16	SRV605	8.01	0.970	6	-0.01	8	0.996
17	FS9604	8.10	1.521	73	0.19**	74	0.830
18	FS9605	8.36	0.970	5	-0.01	9	0.996
19	FS9601	7.75	0.726	43	0.05**	48	0.785
20	FS9603	8.49	1.192	28	0.34**	83	0.641
21	68710	7.57	-0.080	100	0.56**	92	0.005
22	68724	8.10	-0.223	104	1.18**	107	0.018
23	68726	7.48	0.014	97	0.76**	98	0.000
24	Co27	8.27	0.735	42	0.05**	47	0.791
25	SS032	8.29	-0.487**	108	0.27**	80	0.271
26	296A x 68716	9.94	1.440	64	0.13**	64	0.861
27	296A x 68740	9.15	0.889	25	0.00	2	0.968
28	296A x 68918	9.32	1.368	59	0.09**	57	0.894
29	296A x 68786	8.45	-0.223	103	1.18**	106	0.018
30	296A x 68814	9.5	1.205	40	0.02	27	0.955
31	296A x FS211	9.06	1.920	95	0.63**	93	0.715
32	296A x FS205	8.36	1.920	94	0.63**	95	0.715
33	296A x FS9401	9.50	1.205	39	0.02	28	0.955
34	296A x SS003	8.53	2.229	105	1.17**	105	0.648
35	296A x SS012	9.41	1.443	65	0.13**	61	0.862
36	296A x SS020	8.62	2.155	102	1.01**	102	0.666
37	296A x SRV605	9.06	2.708	109	2.25**	109	0.586
38	296A x FS9604	8.97	1.838	89	0.52**	90	0.736
39	296A x FS9605	7.75	0.726	45	0.05*	50	0.785
40	296A x FS9601	9.41	0.654	55	0.09**	58	0.643
41	296A x FS9603	8.54	2.073	99	0.88**	101	0.678
42	296A x 68710	7.22	1.052	14	-0.01	14	0.998

Table 22. (contd...)

SLNo	Genotypes	Mean	b ₁	Rank	S ² _{df}	Rank	R ²
43	296A x 68724	9.15	1.205	38	0.02	29	0.955
44	296A x 68726	8.18	0.014	96	0.76**	99	0.000
45	296A x Co27	9.50	1.522	74	0.19**	71	0.830
46	296A x SS032	8.80	0.409	79	0.27**	82	0.206
47	2219A x 68716	8.97	1.052	17	-0.01	15	0.998
48	2219A x 68740	9.76	0.970	1	-0.01	12	0.996
49	2219A x 68918	10.11	1.603	80	0.26**	78	0.806
50	2219A x 68786	9.50	1.522	75	0.19**	72	0.830
51	2219A x 68814	9.85	0.889	24	0.00	3	0.968
52	2219A x FS211	9.59	0.491	72	0.20**	75	0.332
53	2219A x FS205	10.11	1.287	51	0.05**	41	0.927
54	2219A x FS9401	9.85	1.042	11	-0.01	24	0.998
55	2219A x SS003	8.62	2.155	101	1.01**	103	0.666
56	2219A x SS012	9.59	0.807	29	0.02	33	0.899
57	2219A x SS020	9.76	1.287	49	0.05**	42	0.927
58	2219A x SRV605	9.50	0.552	68	0.08**	54	0.584
59	2219A x FS9604	10.37	1.052	20	-0.01	20	0.998
60	2219A x FS9605	9.41	1.443	66	0.13**	62	0.862
61	2219A x FS9601	8.36	0.012	98	0.77**	100	0.000
62	2219A x FS9603	9.24	0.807	31	0.02	34	0.899
63	2219A x 68710	10.11	1.287	52	0.05**	40	0.927
64	2219A x 68724	9.41	0.970	3	-0.01	11	0.996
65	2219A x 68726	9.50	0.236	88	0.19**	69	0.106
66	2219A x Co27	9.32	1.052	19	-0.01	18	0.998
67	2219A x SS032	9.76	0.970	2	-0.01	13	0.996
68	2077A x 68716	8.89	1.757	87	0.43**	88	0.754
69	2077A x 68740	9.85	1.042	10	-0.01	23	0.998
70	2077A x 68918	9.15	1.205	37	0.02	30	0.955
71	2077A x 68786	8.45	0.093	91	0.65**	96	0.006
72	2077A x 68814	10.02	0.735	41	0.05**	46	0.791
73	2077A x FS211	8.88	-0.303	107	1.33**	108	0.029
74	2077A x FS205	9.50	1.522	76	0.19**	73	0.83
75	2077A x FS9401	7.75	1.359	57	0.08**	56	0.894
76	2077A x SS003	9.41	0.970	4	-0.01	10	0.996
77	2077A x SS012	9.76	1.287	50	0.05**	43	0.927
78	2077A x SS020	7.75	0.726	44	0.05**	49	0.785
79	2077A x SRV605	7.14	1.124	26	0.00	4	0.982
80	2077A x FS9604	8.71	2.236	106	1.16**	104	0.651
81	2077A x FS9605	9.59	0.807	30	0.02	32	0.899
82	2077A x FS9601	8.97	1.052	16	-0.01	16	0.998
83	2077A x FS9603	8.18	0.330	82	0.35**	86	0.117
84	2077A x 68710	8.71	0.493	71	0.2**	77	0.333
85	2077A x 68724	8.97	0.256	86	0.44**	89	0.059
86	2077A x 68726	8.16	1.106	22	-0.01	6	0.989

Table 22. (contd...)

Sl.No	Genotypes	Mean	b_i	Rank	S^2_{di}	Rank	R^2
87	2077A x Co27	8.68	0.310	85	0.38**	87	0.097
88	2077A x SS032	8.27	1.685	84	0.34**	84	0.779
89	111A x 68716	8.18	0.330	83	0.35**	85	0.117
90	111A x 68740	9.58	1.279	47	0.05**	45	0.924
91	111A x 68918	8.71	1.287	48	0.05**	44	0.927
92	111A x 68786	9.15	1.205	36	0.02	31	0.955
93	111A x 68814	8.60	0.708	53	0.06**	52	0.754
94	111A x FS211	8.60	0.708	54	0.06**	53	0.754
95	111A x FS205	8.45	0.093	92	0.65**	97	0.006
96	111A x FS9401	7.31	1.126	27	0.00	5	0.982
97	111A x SS003	8.97	1.838	90	0.52**	91	0.736
98	111A x SS012	8.97	1.052	15	-0.01	17	0.998
99	111A x SS020	10.11	1.603	81	0.26**	79	0.806
100	111A x SRV605	8.36	1.920	93	0.63**	94	0.715
101	111A x FS9604	10.37	1.522	77	0.19**	68	0.835
102	111A x FS9605	9.41	1.443	67	0.13**	63	0.862
103	111A x FS9601	7.22	0.889	23	0.00	1	0.964
104	111A x FS9603	8.10	1.042	9	-0.01	21	0.998
105	111A x 68710	8.71	0.493	70	0.20**	76	0.333
106	111A x 68724	9.24	0.807	32	0.02	35	0.899
107	111A x 68726	9.32	1.052	18	-0.01	19	0.998
108	111A x Co27	9.24	0.807	33	0.02	36	0.899
109	111A x SS032	9.24	0.807	34	0.02	37	0.899
	Population Mean	8.767	1.000				
	SE	0.2914	0.54				

* Significant at 5 per cent level

** Significant at 1 per cent level

Table 23. Correlation between stability parameters of seven characters

Characters	$\bar{X}$ vs b_i	$\bar{X}$ vs S^2_{di}	b_i vs S^2_{di}
Plant height	-0.0297	0.1852	-0.0931
Days to 50 per cent flowering	0.3136**	0.4202**	0.0203
Number of tillers	0.6497**	0.5591**	0.3926**
Crude protein	0.2546**	-0.1145	0.1281
Dry fodder yield	0.3481**	0.4643**	0.0056
Green fodder yield per plant	0.4173**	0.4702**	0.1978*
Green fodder yield per plot	0.5369**	0.4569**	0.3316**

* = Significant at 5 per cent level

** = Significant at 1 per cent level

$\bar{X}$ = Mean

b_i = Regression coefficient

S^2_{di} = Deviation from regression coefficient

three characters namely, number of tillers, green fodder yield per plant and green fodder yield per plot recorded significant positive values.

4.14. AMMI analysis I:

Analysis of variance for AMMI model of two characters viz., green fodder yield per plant and per plot for eighty-four hybrids is presented in Table 24 and 25. Analysis of variance for these two characters revealed that genotypes, environments, genotype x environment, AMMI 1 and AMMI 2 were highly significant for both the characters.

4.14.1. Green fodder yield per plant:

AMMI biplot 1 (Fig .1) depicts that the hybrids 111 A x 68710, 296 A x FS 205, 2219 A x FS9605, 296 A x 68918, 2077 A x SS020, 111 A x 68740, and 2077 A x FS 9401, 2219A x FS 9605 and 2219 A x FS 9401 were found to be nearer to the abscissa axis and they differed only in main effects. 2077 A x 9401 and 2077A x SS003 were found dispersed along the ordinate axis indicating differences in interaction effects though they had similar main effects. The other hybrids like 2077 A x FS 9603 differed both in main effect and interaction effect. AMMI biplot II (Fig.2) depicts that 2219 A x SRV 605, 296 A x SS003, 111 A x FS 205, 2077 A x SRV 605, 2077 A x 68740 and 111 A x 68710 were found to be near the origin of abscissa.

4.14.2. Green fodder yield per plot:

AMMI 1 biplots (Fig.3) shows that 2077 A x FS 9604, 296 A x Co 27, 2219 A x FS211, 2077 A x 68814, 2219 A x SSO 32, 2219 A x Co 27 did not differ much from the main abscissa main additive effects. 296 A x 68724 and 2077 A x FS 9601 differed for their interaction effect though they had the same main effect. AMMI biplot II (Fig.4) depicts that 2219A x 68786 and 111 A x Co 27 were found to be near the origin and did not differ for the interaction.

Table 24. Analysis of variance for the AMMI model for green fodder yield per plant

Source of variation	df	Sum of square	Per cent of treatment SS	Per cent of G x E SS	Per cent of RMS
Treatments	335	6380144			
Genotypes	83	2956235			
Environments	3	1540470			
Genotypes x Environments	249	1883438			
AMMI component 1	85	891215	84.48	47.32	
AMMI component 2	83	645119	94.56(10.08)	34.25	54.34
Residual	81	347104	100(5.44)	18.42	32.19

Table 25. Analysis of variance for the AMMI model for green fodder yield per plot

Source of variation	df	Sum of square	Per cent of treatment SS	Per cent of G x E SS	Per cent of RMS
Treatments	335	13278.9			
Genotypes	83	5941.2			
Environments	3	4770.5			
Genotypes x Environments	249	2567.2			
AMMI component 1	85	1245.1	90.04	48.50	
AMMI component 2	83	841.6	96.38 (6.34)	32.78	1.98
Residual	81	480.4	100 (3.62)	18.71	1.19

Fig 1. AMMI 1 biplot of main effects and interactions for green fodder yield per plant

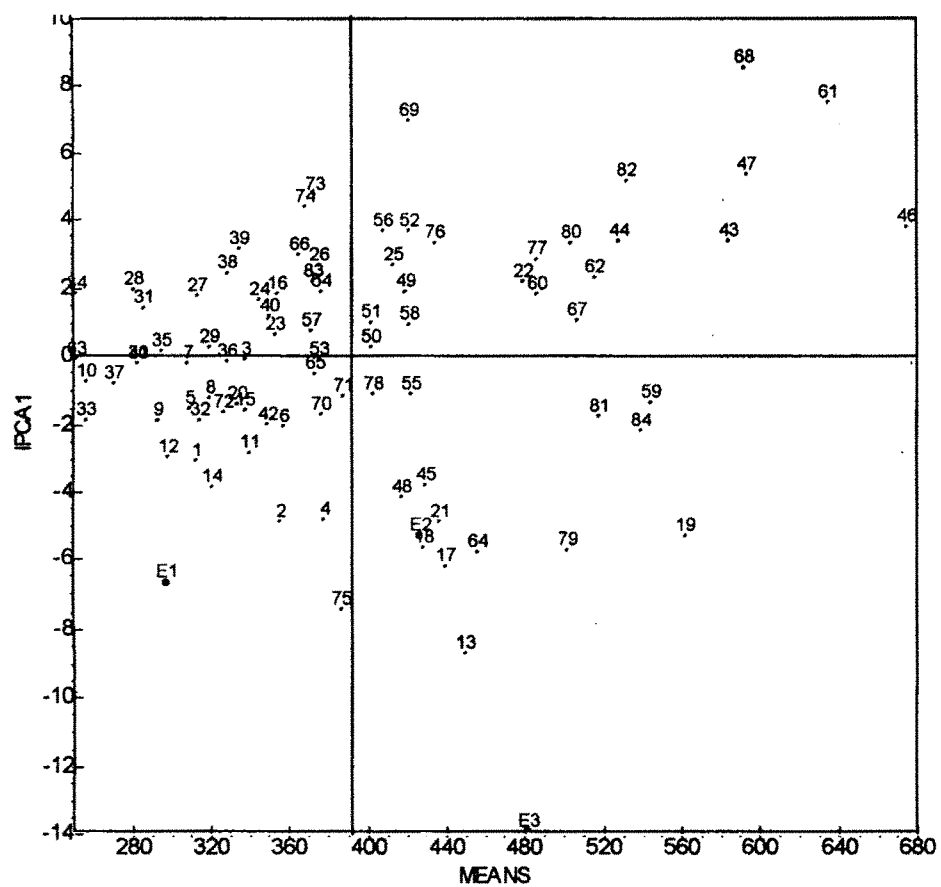


Fig 2. Interaction biplot for the AMMI 2 model for green fodder yield per plant

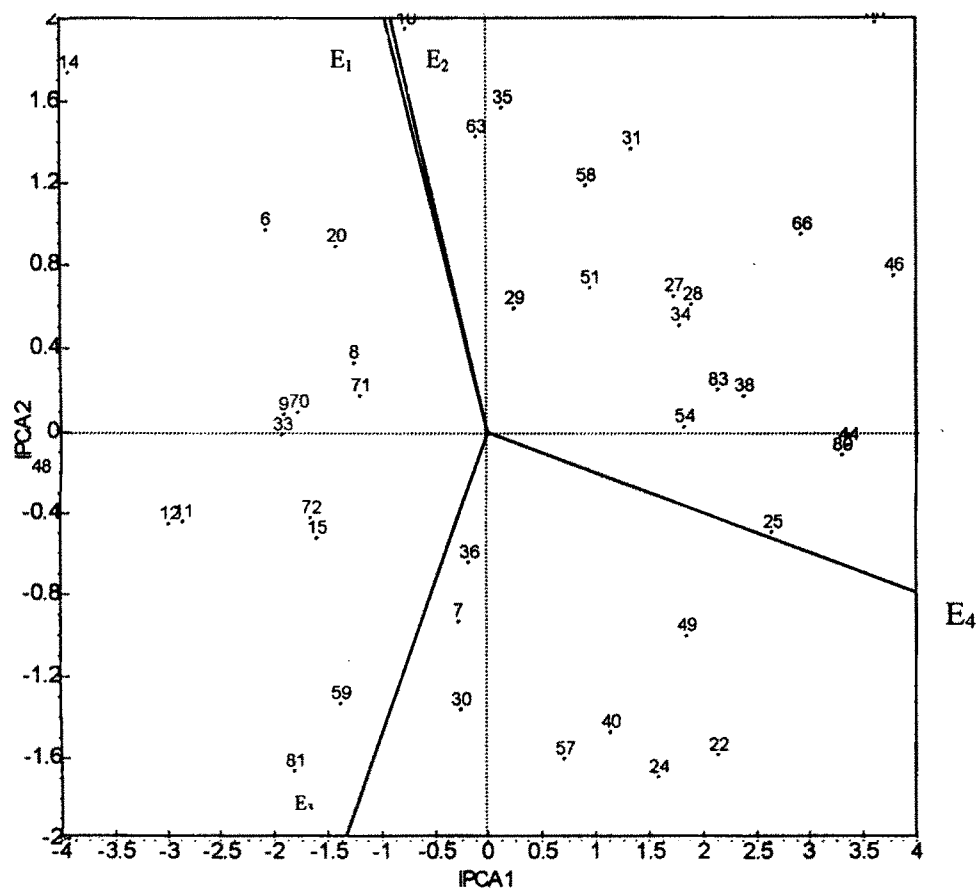


Fig 3. AMMI biplot 1 for main and interaction effects for green fodder yield per plot

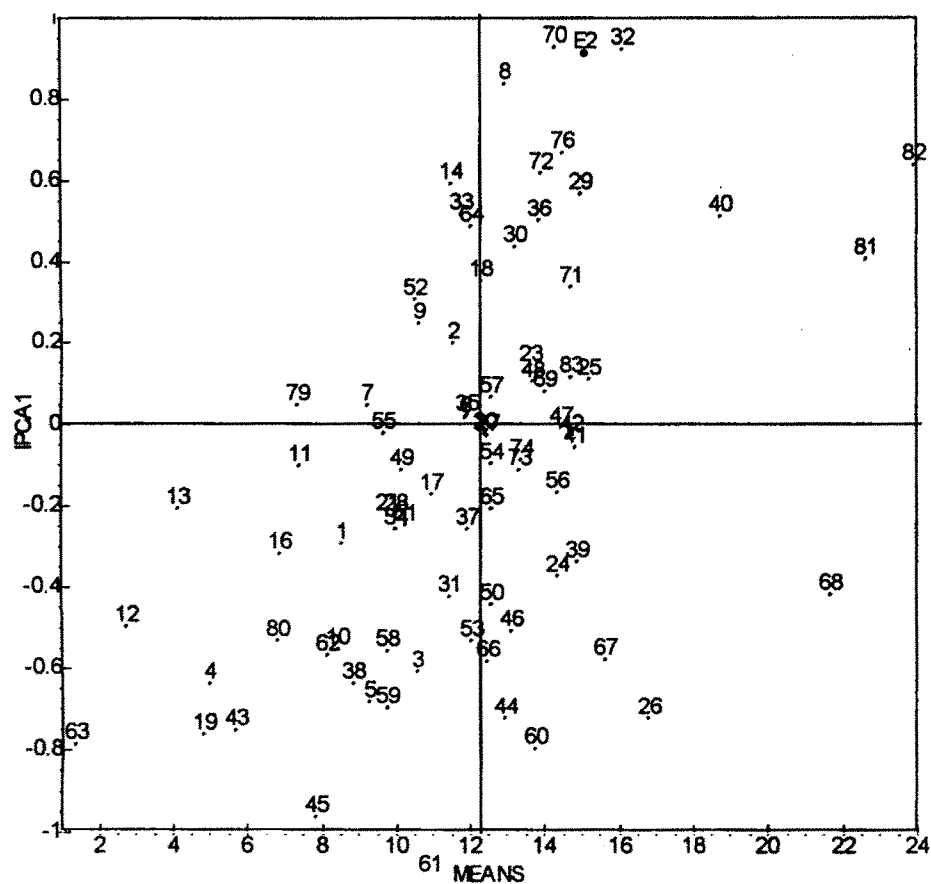
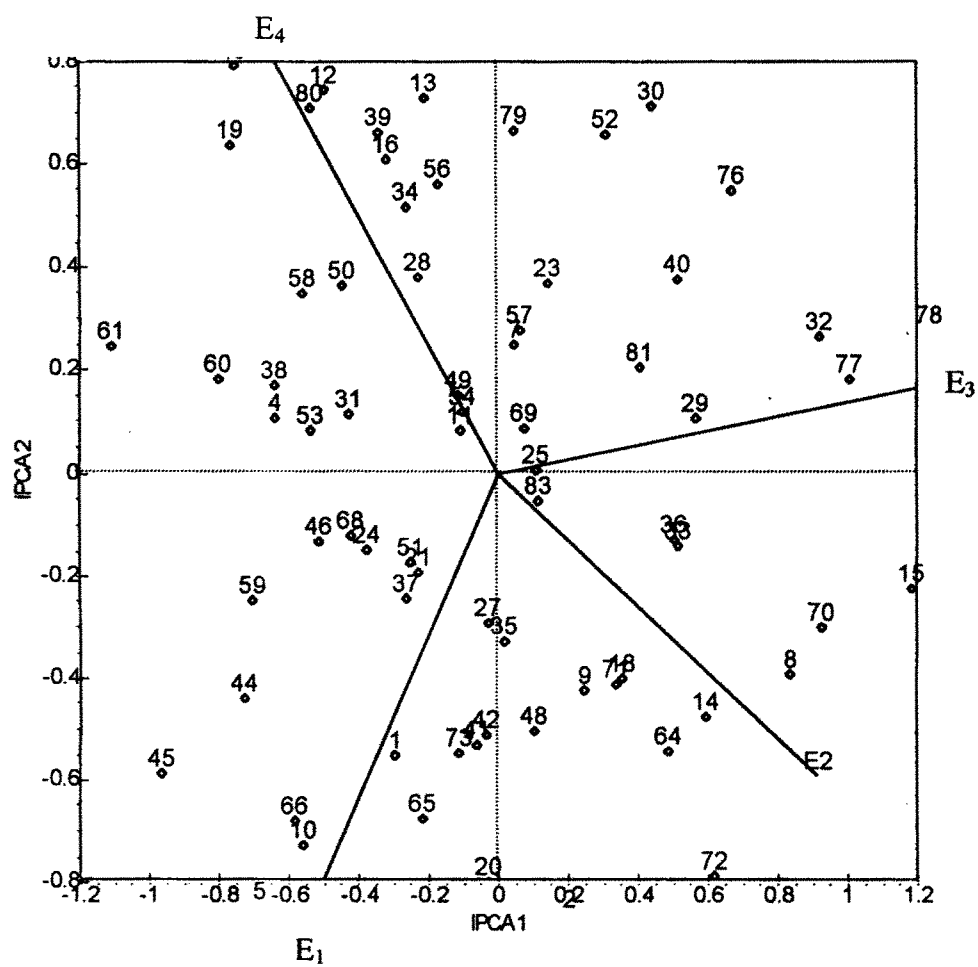


Fig 4. Interaction biplot for the AMMI 2 model for green fodder yield per plot



4.15. Stability analysis II.

Out of the 109 genotypes evaluated, 16 hybrids were found to persist even after four cuts and their fifth harvest was also taken up and the data for all the five cuts was subjected to stability analysis to find out the best among them. The results are given in Tables 26 to 31.

The mean square (MS) due to genotypes (G), environments and Genotypes $\times$ environments tested against MS due to pooled error were highly significant for all the characters, thus satisfying the requirement of stability analysis and as such stability analysis was carried out on the seven characters.

The variance due to G $\times$ E partitioned into its components viz., variance due to G $\times$ E (linear) and that due to pooled deviation (non-linear) revealed that linear component of G $\times$ E interaction as well as the non-linear component when tested against pooled error were highly significant for all the characters. High magnitude of E (linear) effect in comparison to G $\times$ E (linear) for all the characters was observed.

The MS due to genotypes when tested against MS due to pooled deviation was found to be highly significant for all the characters while MS due to G $\times$ E (linear) when tested against pooled deviation was not significant for all the characters except days to 50 per cent flowering.

The ratio of non-linear to linear component of variance ranged from 1:0.49 (plant height) to 1:2.62 (days to 50 per cent flowering). The magnitude of linear component was more than unity except for plant height and dry fodder yield, where the non-linear component was high.

From the analysis of variance tables, the genotypic variance (σ^2_g) and G $\times$ E variance (σ^2_{gn}) were worked out for all the characters. The σ^2_g was more than σ^2_{gn} for all the characters except dry fodder yield. The ratio of σ^2_g to σ^2_{gn} ranged from 1:0.19 (crude

Table 26. ANOVA for stability parameters for different characters

Source of variation	df	Plant height	Days to 50 per cent flowering	Number of tillers	Crude protein	Dry fodder yield	Green fodder yield per plant	Green fodder yield per plot
Genotypes	15	1500.74**	67.64**	0.6641**	3.6581**	2251.18**	47284.04**	60.992**
Env.+ (Var.* Env.)	64	1494.04**	100.54**	0.3525**	0.5237**	1407.35**	19225.93**	50.026**
Environments	4	20430.22**	1484.04**	2.6591**	6.2478**	15953.81**	214456.81**	659.827**
Genotypes * Env.	60	231.63**	8.31**	0.1987**	0.1421**	437.59**	6210.53**	9.373**
Environments (Linear.)	1	81720.89**	5936.15**	10.6363**	24.9913**	63815.25**	857827.23**	2639.306**
Var.* Env.(Linear.)	15	123.80**	14.97**	0.2298**	0.1885**	243.79**	6247.62**	13.368**
Pooled Deviation(Non linear)	48	250.85**	5.71**	0.1766**	0.1187**	470.80**	5810.79**	7.539**
Pooled Error	150	9.51	0.32	0.1385	0.0113	29.69	25.62	0.402
Non linear : Linear		1:0.49	1:2.62	1:1.38	1:1.59	1:0.52	1:1.08	1:1.77
σ^2_g		258.82	11.87	0.09	0.70	362.72	8214.7	10.32
σ^2_{gn}		222.12	7.99	0.06	0.13	407.90	6184.91	8.971
$\sigma^2_g: \sigma^2_{gn}$		1:0.86	1:0.67	1:0.67	1:0.19	1:1.20	1:0.75	1:0.87

* Significant at 5 per cent level

** Significant at 1 per cent level

protein) to 1:1.12 (dry fodder yield). The G x E component was maximum for dry fodder yield and exceeded the unity of genotypic variance.

4.16. Environmental index:

Environmental indices for seven characters namely, plant height, days to 50 per cent flowering, number of tillers, crude protein, dry fodder yield, green fodder yield per plant and green fodder yield per plot are presented in Table 27. The environmental index (I_j) for plant height ranged from -57.63 (E_5) to 30.52 (E_4) followed by -8.479 (E_4) to 15.125 (E_1) for days to 50 per cent flowering. The range for number of tillers was from -0.42 (E_1) to 0.501 (E_3) followed by -0.71 (E_5) to 0.82 (E_3) for crude protein. For dry fodder yield, the range was from -41.48 (E_5) to 43.109 (E_3) followed by -170.312 (E_5) to 99.097 (E_3) for green fodder yield per plant. The environmental index (I_j) for green fodder yield per plot ranged from -9.898 (E_5) to 5.60 (E_2).

4.17. Stability parameters:

The mean performance of the 16 genotypes and stability parameters b_i and S^2_{di} for the seven characters are presented in Tables 28 to 31. Based on the nearness to 1.0 the b_i values were ranked and S^2_{di} values were ranked based on their nearness to 0.

4.17.1. Days to 50 per cent flowering:

Among the sixteen hybrids, four had recorded positive significant values for b_i and one genotype (2219 A x 68726) recorded both non-significant S^2_{di} and b_i values. The hybrid 2219A x FS 9401 was the earliest to flower (55.73 days) followed by 2219A x 44003 (55.87) (Table 28).

4.17.2. Plant height:

Among the sixteen genotypes only two viz., 2219 A x FS 9603 and 2219 A x 68724 had recorded positive significant b_i values and 2219 A x FS 9603 and 2219 A x 68716 recorded non-significant S^2_{di} values. The hybrid 2077 A x SS 020 recorded the highest mean of 238.60 cm (Table 28).

Table 27. Environmental indices for seven different characters

Environment	Plant height	Days to 50 per cent flowering	Number of tillers	Crude protein	Dry fodder yield	Green fodder yield per plant	Green fodder yield per plot
E ₁	10.303	15.125	-0.42	-0.059	-14.423	-69.639	2.054
E ₂	-9.031	3.521	0.067	0.412	-1.335	73.428	5.6
E ₃	25.834	-3.313	0.501	0.82	43.109	99.097	4.923
E ₄	30.521	-8.479	0.26	-0.465	14.129	67.427	-2.68
E ₅	-57.627	-6.854	-0.407	-0.708	-41.48	-170.312	-9.898

Table 28. Stability parameters for days to 50 per cent flowering and plant height

Characters	Days to 50 per cent flowering				R ²	Mean	Plant height			
	Genotypes	Mean	b _i	Rank	S ² _{di}	Rank	b _i	Rank	S ² _{di}	Rank
	2219A x FS205	56.33	0.912	6	2.26**	5	1.227	14	128.50**	8
	2219A x FS9401	55.73	0.883	8	3.65**	8	1.071	6	77.61**	7
	2219A x SS003	55.87	0.879	9	2.63**	6	1.096	8	275.71**	12
	2219A x SS020	57.40	0.884	7	3.77**	9	1.040	3	287.91**	13
	2219A x FS9603	56.73	0.869	10	1.50**	4	1.084**	7	-9.74	2
	2219A x 68724	58.13	1.260*	12	3.79**	10	0.826*	13	18.41	3
	2219A x 68726	56.33	0.942	5	0.35	1	1.097	9	8.09	1
	2077A x FS9401	60.00	0.732**	13	1.39**	3	0.882	10	435.50	14
	2077A x SS020	62.13	0.730*	14	5.88**	12	0.990	1	765.58**	15
	2077A x 68724	64.40	1.445**	16	3.11**	7	0.672	16	153.31**	9
	2077A x 68726	57.53	1.005	1	8.11**	14	0.725	15	1084.04**	16
	111A x 68814	66.73	1.184	11	12.63**	15	1.160	12	71.66**	6
	111A x FS9401	59.40	0.983	2	1.29**	2	0.987	2	49.08**	5
	111A x SS020	65.13	1.032	3	23.42**	16	1.057	4	232.51**	10
	111A x 68724	64.27	1.298*	15	5.18**	11	1.143	11	258.61**	11
	111A x 68726	60.53	0.963	4	7.13**	13	0.943	5	19.60*	4
Population mean		59.79	1.000				1.000			
SE		1.95	0.124				0.222			
							210.95			
							7.92			

* Significant at 5 per cent level

** Significant at 1 per cent level

4.17.3. Number of tillers:

2077 A x 68726 and 111 A x 68726 recorded higher mean values and recorded non-significant b_i and S^2_{di} values (Table 29).

4.17.4. Dry fodder yield:

Among the sixteen hybrids, four (2077 A x 68724, 2077 A x 68726, 111A x 68814 and 111 A x 68726) had recorded higher mean values and non-significant b_i values, but all their S^2_{di} values were significant. 2219 A x FS 205 alone-recorded non-significant S^2_{di} and significant b_i values but its mean value was low (Table 29).

4.17.5. Green fodder yield per plant:

Five genotypes viz., 2077A x 68724, 2077 A x 68726, 111 A x 68814, 111 A x 68724 and 111 A x 68726 recorded higher mean values. The hybrid 2077 A x FS 9481 had the highest rank for b_i values and 2219 A x FS 205 had the highest rank for S^2_{di} values (Table 30).

4.17.6. Green fodder yield per plot:

For green fodder yield, the highest value (20.12 kg) was recorded by 111A X 68726, while 2219 A x SS203 and 111 A x 68724 recorded the first rank for b_i and S^2_{di} values respectively (Table 30).

4.17.7. Crude protein:

Thirteen genotypes recorded non-significant b_i values and among these six genotypes recorded higher mean values. Seven genotypes had recorded non-significant S^2_{di} values with top ranking of 2219 A x 68724 both for b_i and S^2_{di} values (Table 31).

4.18. Association between stability parameters:

The correlation coefficients between stability parameters for seven characters are presented in Table 32. Significant positive correlations were observed between mean and b_i

Table 29. Stability parameters for number of tillers and dry fodder yield

Characters Genotypes	Mean	Number of tillers				R ²	Dry fodder				Yield	
		b _i	Rank	S ² _{di}	Rank		Mean	b _i	Rank	S ² _{di}		Rank
22219A x FS205	1.97	0.410*	12	-0.10	9	0.451	54.90	0.672**	12	-12.91	1	0.975
22219A x FS9401	2.24	1.450	9	-0.08	6	0.883	72.47	1.113	4	121.55**	6	0.917
22219A x SS003	2.04	0.048	15	0.13	14	0.002	59.60	1.046	2	244.05**	9	0.842
22219A x SS020	1.85	1.078	1	-0.03	3	0.707	68.30	1.224	11	434.00**	13	0.812
22219A x FS9603	2.00	0.661	6	0.27*	16	0.193	62.36	0.615	16	252.95**	10	0.642
22219A x 68724	2.19	-0.261*	16	0.09	8	0.061	68.63	0.649*	13	47.19*	2	0.881
22219A x 68726	2.54	1.475**	11	-0.12	12	0.960	70.46	1.172	7	154.61**	7	0.909
2077A x FS9401	2.22	1.284	4	-0.09	7	0.876	82.63	1.019	1	110.27**	5	0.909
2077A x SS020	2.03	0.902	2	0.26*	15	0.311	69.17	0.644*	14	72.49**	4	0.845
2077A x 68724	2.42	1.348	7	0.12	11	0.610	104.82	0.842	6	276.54**	11	0.756
2077A x 68726	2.89	1.277	3	0.03	2	0.681	130.52	0.888	3	2339.56**	16	0.307
1111A x 68814	2.60	1.443	8	0.00	1	0.766	106.57	1.206	9	1515.67**	15	0.556
1111A x FS9401	2.09	1.472**	10	-0.12	13	0.965	76.62	1.210	10	322.72**	12	0.847
1111A x SS020	1.77	0.350	13	0.06	4	0.121	68.52	1.135	5	218.71**	8	0.874
1111A x 68724	2.29	1.312	5	0.07	5	0.647	88.51	1.201	8	55.16**	3	0.958
1111A x 68726	3.08	1.752	14	0.10	10	0.739	107.87	1.365	15	926.46**	14	0.722
Population mean	2.26	1.000					80.75	1.000				
SE	0.21	0.52					10.85	0.345				

* Significant at 5 per cent level

** Significant at 1 per cent level

Table 30. Stability parameters for green fodder yield per plant and green fodder yield per plot

Characters Genotypes	Green fodder			Yield per plant			Green fodder			Yield per plot		
	Mean	b _i	Rank	S ² _{di}	Rank	R ²	Mean	b _i	Rank	S ² _{di}	Rank	R ²
2219A x FS205	257.33	0.659**	11	347.78**	1	0.954	8.40	0.704*	11	0.43	2	0.971
2219A x FS9401	285.79	0.884	6	982.62**	2	0.933	12.49	1.171	7	3.83**	5	0.947
2219A x SS003	261.76	0.851	8	2377.98**	4	0.843	11.51	0.958	1	4.38**	6	0.914
2219A x SS020	280.68	0.926	4	7949.54**	12	0.658	13.63	1.129	3	16.09**	15	0.810
2219A x FS9603	257.84	0.348**	15	3358.37**	9	0.390	10.12	0.845	5	6.41**	8	0.852
2219A x 68724	305.57	0.751	10	2416.14**	5	0.805	12.58	0.919	2	6.93**	9	0.864
2219A x 68726	313.04	0.857	7	2554.87**	6	0.836	15.71	1.208	9	8.67**	12	0.899
2077A x FS9401	354.80	1.004	1	2355.14**	3	0.883	10.47	0.830	6	1.70**	3	0.948
2077A x SS020	336.98	0.808	9	3229.89**	8	0.782	10.19	0.756	10	2.78**	4	0.908
2077A x 68724	437.15	1.044	3	5410.46**	11	0.782	11.59	0.845	4	12.92**	13	0.747
2077A x 68726	555.59	1.382**	13	849.22**	16	0.621	9.32	0.549*	15	7.34**	10	0.682
111A x 68814	514.81	1.726**	16	3977.35**	15	0.792	17.87	1.395	13	7.42**	11	0.932
111A x FS9401	347.55	0.923	5	2636.96**	7	0.851	12.10	1.186	8	4.96**	7	0.935
111A x SS020	335.69	0.990	2	336.59**	14	0.628	11.42	0.644	12	14.24**	14	0.609
111A x 68724	455.97	1.474**	14	4513.11**	10	0.895	18.98	1.460*	16	-0.15	1	0.998
111A x 68726	484.93	1.374	12	9247.45**	13	0.784	20.12	1.402	14	16.33**	16	0.866
Population mean	361.59	1.000					12.91	1.000				
SE	38.11	0.329					1.37	0.214				

* Significant at 5 per cent level

** Significant at 1 per cent level

Table 31. Stability parameters for crude protein

Characters Genotypes	Mean	Crude		protein		R ²
		b _i	Rank	S ² _{di}	Rank	
2219A x FS205	9.92	1.195	9	0.02	7	0.964
2219A x FS9401	9.65	1.041	2	-0.01	3	0.998
2219A x SS003	8.43	1.735	16	0.70**	16	0.687
2219A x SS020	9.57	1.195	10	0.02	6	0.964
2219A x FS9603	9.04	0.894	6	0.03**	8	0.907
2219A x 68724	9.22	0.998	1	0.00	1	0.986
2219A x 68726	9.36	0.447	14	0.17**	14	0.364
2077A x FS9401	7.55	1.238	11	0.04**	10	0.938
2077A x SS020	7.77	0.360*	15	0.12**	12	0.341
2077A x 68724	8.78	0.554	13	0.40**	15	0.278
2077A x 68726	7.97	1.082**	4	-0.01	4	0.998
111A x 68814	8.40	0.833	8	0.07**	11	0.817
111A x FS9401	7.11	1.094*	5	-0.01	2	0.996
111A x SS020	9.92	1.392	12	0.16**	13	0.855
111A x 68724	9.04	0.894	7	0.03**	9	0.907
111A x 68726	9.13	1.049	3	-0.01	5	0.998
Population mean	8.80	1.000				
SE	0.17	0.275				

* Significant at 5 per cent level

** Significant at 1 per cent level

Table 32. Correlation between stability parameters of seven characters

Characters	X vs $\bar{b}_i$	X vs $\bar{S}_{di}^2$	b_i vs S_{di}^2
Plant height	-0.5612*	0.6890**	-0.3954
Days to 50 per cent flowering	0.5244*	0.6223*	0.1839
Number of tillers	0.5920*	-0.0600	-0.3396
Crude protein	0.0978	-0.0608	0.2248
Dry fodder yield	0.2846	0.8136**	0.1977
Green fodder yield per plant	0.8824**	0.7685**	0.6643**
Green fodder yield per plot	0.8976**	0.2871	0.0733

* = Significant at 5 per cent level

** = Significant at 1 per cent level

$\bar{X}$ = Mean

b_i = Regression coefficient

S_{di}^2 = Deviation from regression coefficient

for days to 50 per cent flowering, number of tillers, green fodder yield per plant and green fodder yield per plot and plant height showed negative correlation. Regarding the correlation between mean and S^2_{di} values plant height, days to 50 per cent flowering dry fodder yield, and green fodder yield per plant had positive association.

The correlation between b_i and S^2_{di} indicated that only green fodder yield per plant recorded positive association.

4.19. AMMI analysis II:

Sixteen hybrids that performed well upto five cuts were selected and subjected to AMMI analysis for two characters and the results are presented in Tables 33 and 34. Analysis of variance for the two characters revealed that genotypes, environments and genotype x environment interaction were highly significant for these two characters. The interaction components of AMMI 1 and AMMI 2 were significant for green fodder yield per plant and AMMI 1 alone was found to be significant for green fodder yield per plot.

4.19.1. Green fodder yield per plant:

AMMI 1 biplot (Fig.5) showed that 2077 A x 68724 and 2219 A x 68724 as 111 A x 68724 differed from the main effects and interaction effects. AMMI biplot II (Fig.6) depicts that 111 A x 68814, 2219 A x FS 205, 2219 A x FS 9401 and 111 A x FS 9401 did not differ much for interaction effects.

4.19.2. Green fodder yield per plot:

AMMI 1 biplot (Fig.7) showed that 111 A x SS020, 2219 A x SS003, 111 A x FS 9401, 2219 A x FS 941, 111 A x 68814 did not differ much from the main abscissa. AMMI 2 biplots (Fig.8) indicated that 111 A x 68726, 2077 A x FS 9401 and 2077 A x SS020 were found to disperse all along the main abscissa. All other hybrids were mostly dispersed both from abscissa and ordinate axis.

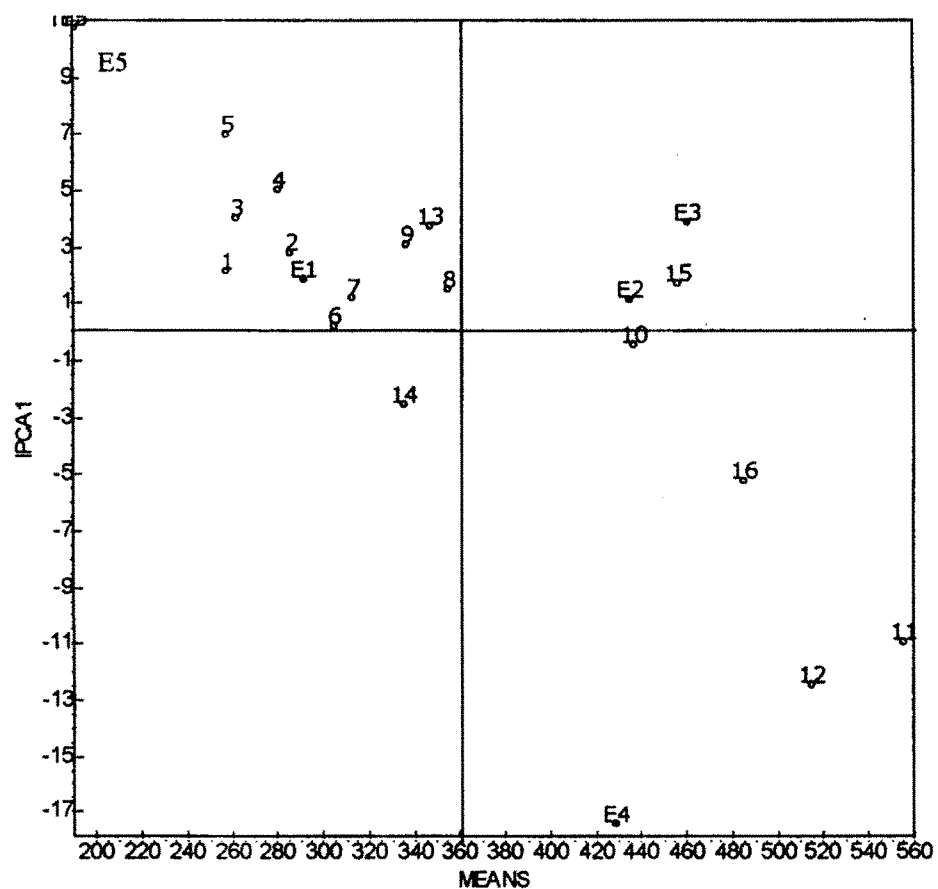
Table 33. Analysis of variance for the AMMI model for green fodder yield per plant

Source of variation	df	Sum of square	Per cent of treatment SS	Per cent of G x E SS	Per cent of RMS
Treatments	79	1939720			
Genotypes	15	709261			
Environments	4	857828			
Genotypes x Environments	60	372631			
AMMI component 1	18	194313	90.80	52.14	
AMMI component 2	16	111013	96.53 (5.73)	29.79	40.82
AMMI component 3	14	49972	99.11 (2.58)	13.41	29.00
Residual	12	17332	100 (0.89)	4.65	14.72

Table 34. Analysis of variance for the AMMI model for green fodder yield per plot

Source of variation	df	Sum of square	Per cent of treatment SS	Per cent of G x E SS	Per cent of RMS
Treatments	79	416.9			
Genotypes	15	914.9			
Environments	4	2639.6			
Genotypes x Environments	60	562.3			
AMMI component 1	18	294.2	93.49	52.33	
AMMI component 2	16	137.7	96.84 (3.35)	24.50	1.83
AMMI component 3	14	81.34	98.82 (1.98)	14.46	1.28
Residual	12	48.9	100 (1.18)	8.69	0.78

Fig 5. AMMI 1 biplot main effects and interactions for green fodder yield per plant



126

Fig 6. Interaction biplot for the AMMI 2 model for Green fodder yield per plant

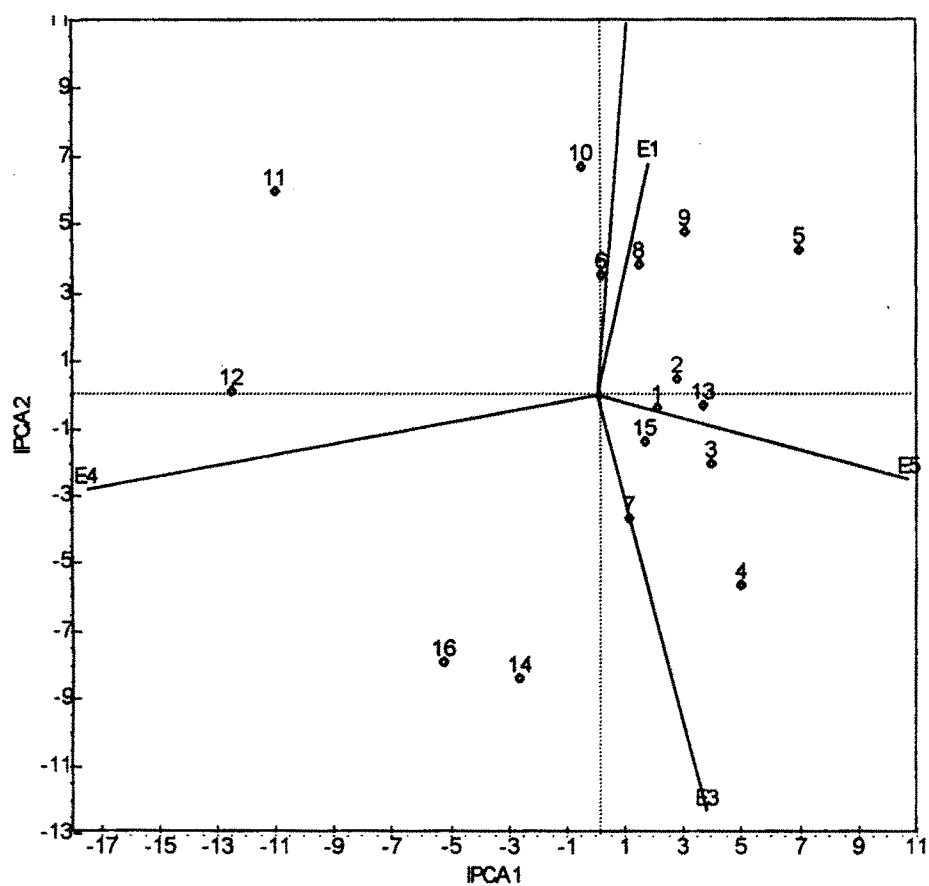


Fig 7. AMMI 1 biplot of main effects and interactions for green fodder yield per plot

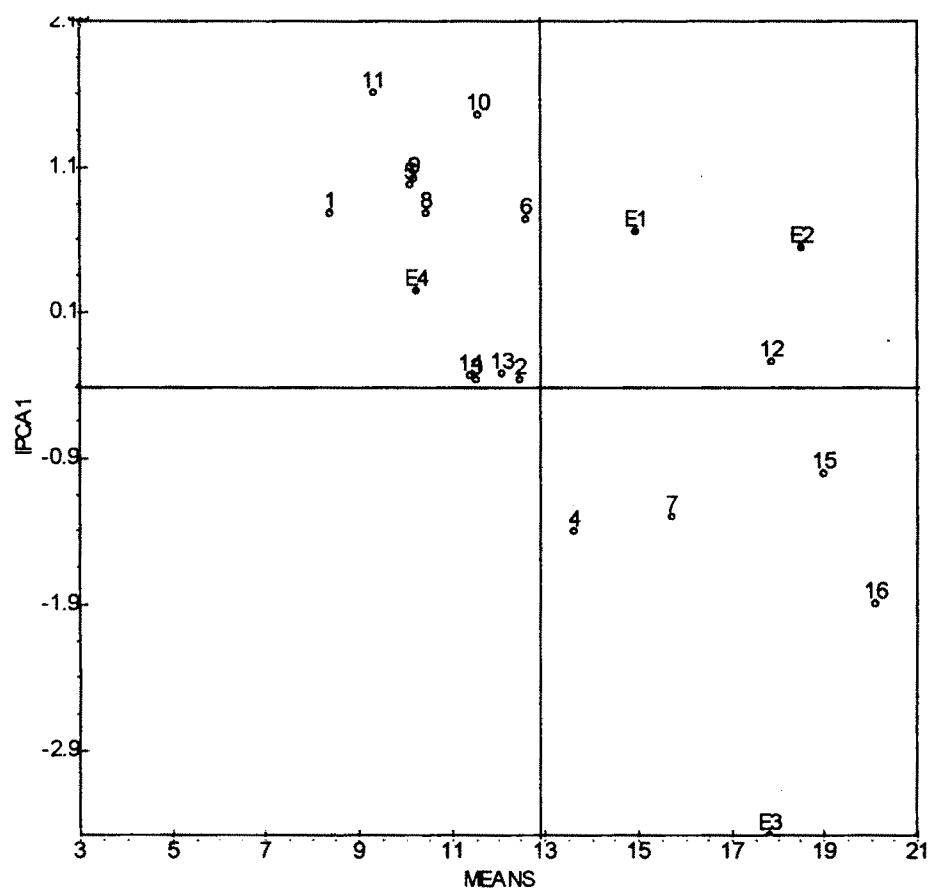
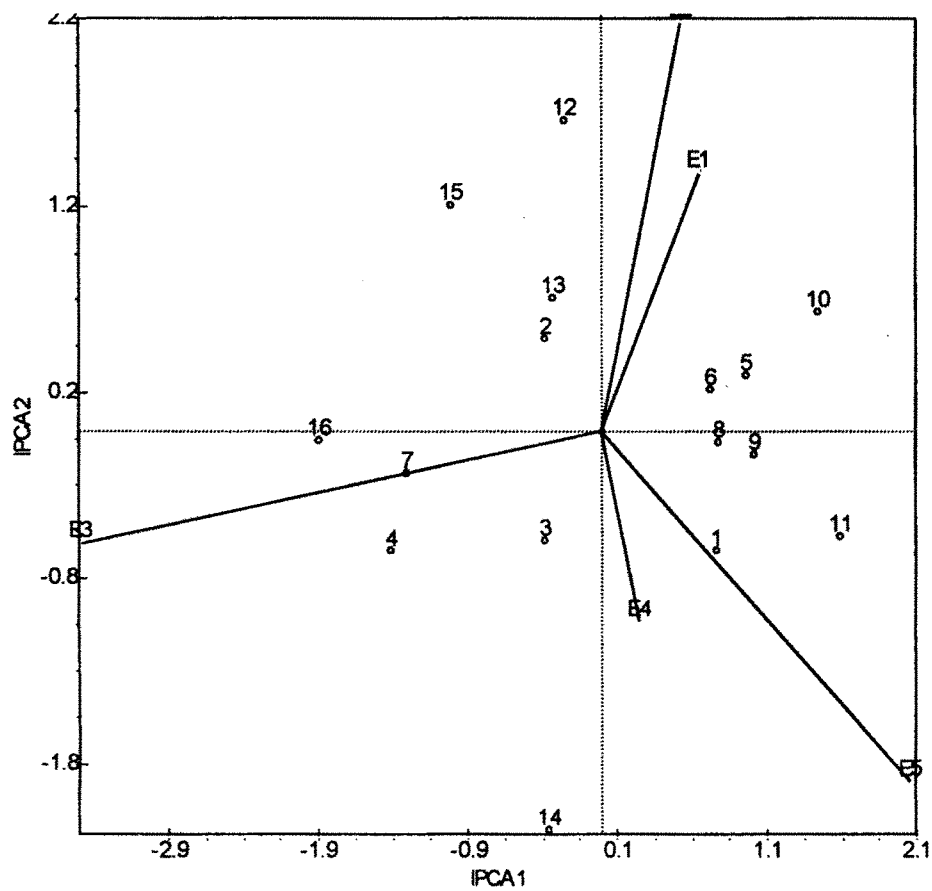


Fig 8. Interaction biplot for the AMMI 2 model for green fodder yield per plot



4.20. Score charts:

Mean performance and *gca* effects of parents were given scores of 0, -1 and 1 according to their non-significant, negatively significant and significant nature respectively for all the characters. The total scores were also worked out and their status (high or low) is presented in Table 35. Similarly, mean performance, *sca* effects and standard heterosis of hybrids were also tabulated. The results indicated that among the parents, the line 111A recorded significant *per se* performance for four characters and positive significant *gca* effects for six characters followed by 2077A for three and seven characters respectively. Among the testers, 68726 recorded significant *per se* for six characters and *gca* effects for nine characters followed by 68786 for five and nine characters respectively.

Among the hybrids, 111A x FS9605 recorded significant *per se* and *sca* for eight characters and significant heterosis for ten characters followed by 111A x 68726 for seven, four and nine characters respectively. 2077A x 68814 recorded significant *per se* and *sca* effects for six characters and standard heterosis for ten characters followed by 111A x 68814 for six, four and nine characters respectively. 2219A X 68716 recorded significant performance for more than five characters

Table 35. Score chart of mean and gca values for parents for pooled data over environments

characters	Days to 50 per cent flowering	Plant height	Number of tillers	Number of leaves	Leaf length	Leaf breadth	Leaf stem ratio	Stem thickness	Hydrocya nic acid	Total soluble	Crude protein	Df/y/plant	Green fodder yield per plant	Green fodder yield per plot	Total score	Status	All	stat us
Genotypes	̄ x gca	̄ x gca	̄ x gca	̄ x gca	̄ x gca	̄ x gca	̄ x gca	̄ x gca	̄ x gca	̄ x gca	̄ x gca	̄ x gca	̄ x gca	̄ x gca	̄ x gca			
296A	0 0 -1	-1 -1 0	-1 0 -1	0 -1 -1	0 0 -1	0 1 -1	1 1 1	0 0 0	1 -1 -1	-1 1 1	-1 -1 -1	-1 -1 -1	-1 -1 -1	0 -1 -1	-4 -4 -1	L L L	-8	L
2219A	1 1 -1	-1 -1 0	-1 0 -1	-1 -1 -1	-1 -1 -1	-1 -1 -1	-1 -1 -1	-1 -1 -1	-1 1 1	0 1 1	-1 -1 -1	-1 -1 -1	-1 -1 -1	-1 -1 -1	-11 -1 -1	L L L	-12	L
2077A	1 -1 -1	1 1 0	0 0 -1	1 0 1	0 1 0	-1 0 1	-1 -1 -1	1 1 1	-1 1 1	0 -1 0	1 -1 -1	0 1 1	1 1 1	-1 -1 -1	-4 2 1	L H H	-2	L
111A	-1 -1 -1	1 1 0	0 0 0	0 1 0	0 0 0	0 1 0	-1 -1 -1	0 0 0	1 -1 -1	0 0 0	-1 -1 -1	0 1 1	1 1 1	1 1 1	1 2 1	H H H	3	H
68716	0 -1 1	1 1 1	-1 0 -1	0 0 -1	0 0 0	-1 0 0	0 0 0	-1 0 0	1 -1 -1	-1 1 1	0 0 0	-1 1 1	-1 1 1	-1 -1 -1	-6 1 1	L H H	-5	L
68740	-1 -1 1	1 1 0	0 0 -1	1 1 1	-1 0 0	-1 0 0	0 1 0	-1 0 0	1 -1 -1	-1 1 1	-1 1 1	1 1 1	1 1 1	0 1 1	-3 6 1	L H H	3	H
68918	-1 0 -1	-1 -1 0	-1 -1 0	1 1 1	-1 0 0	0 1 0	1 1 1	0 1 1	1 -1 -1	0 1 1	-1 1 1	-1 -1 -1	-1 -1 -1	-1 -1 -1	-6 0 1	L H H	-6	L
68786	0 -1 1	1 1 0	0 -1 0	1 0 1	0 1 0	0 0 0	0 1 0	0 1 0	1 1 1	-1 1 1	-1 -1 -1	1 1 1	1 1 1	1 0 1	3 6 1	H H H	9	H
68814	-1 -1 1	1 1 -1	-1 1 0	1 0 1	0 1 0	0 0 0	1 1 1	-1 0 0	1 1 1	-1 0 0	0 1 1	-1 1 1	-1 1 1	0 1 1	-3 9 1	L H H	6	H
FS211	1 1 -1	-1 -1 0	1 0 1	0 1 0	-1 0 0	0 0 0	-1 -1 -1	0 0 0	1 -1 -1	1 1 1	-1 0 0	-1 -1 -1	-1 -1 -1	-1 -1 -1	-4 -2 1	L L L	-6	L
FS205	1 -1 -1	1 1 -1	-1 0 0	1 1 1	-1 -1 -1	0 1 0	0 0 0	0 0 0	1 1 1	0 0 0	-1 1 1	0 -1 -1	-1 -1 -1	-1 -1 -1	-4 0 1	L H H	-4	L
FS9401	1 1 1	1 1 0	0 0 0	0 0 0	0 0 0	0 0 0	0 -1 0	0 0 0	1 0 0	1 -1 -1	-1 -1 -1	0 0 0	-1 -1 -1	-1 -1 -1	2 -1 1	L L L	1	H
SS003	0 1 -1	-1 -1 -1	-1 -1 -1	-1 0 0	0 0 0	0 0 0	0 0 0	-1 0 0	1 1 1	-1 -1 -1	-1 -1 -1	-1 -1 -1	-1 -1 -1	-1 -1 -1	-7 -4 1	L L L	-11	L
SS012	1 1 -1	-1 -1 -1	-1 -1 -1	-1 0 0	-1 -1 -1	0 0 0	-1 -1 -1	-1 0 0	1 -1 -1	-1 0 0	0 1 1	-1 -1 -1	-1 -1 -1	-1 -1 -1	-8 -6 1	L L L	-14	L
SS020	1 -1 1	1 1 0	0 -1 0	0 0 0	0 1 1	-1 0 0	-1 -1 -1	0 0 0	0 1 1	-1 0 0	-1 0 0	-1 -1 -1	-1 -1 -1	1 0 0	-3 0 1	L H H	-3	L
SRV605	-1 -1 0	-1 -1 -1	-1 -1 -1	0 -1 0	-1 0 -1	-1 -1 -1	-1 -1 -1	0 0 0	1 -1 -1	-1 -1 -1	0 -1 -1	-1 -1 -1	-1 -1 -1	0 -1 -1	-6 -12 1	L L L	-18	L
FS9604	1 -1 -1	-1 -1 -1	-1 -1 -1	-1 0 -1	-1 -1 -1	0 0 0	-1 -1 -1	-1 0 0	-1 -1 -1	1 1 1	0 1 1	-1 -1 -1	-1 -1 -1	-1 -1 -1	-8 -5 1	L L L	-13	L
FS9605	0 1 1	1 1 0	0 0 -1	0 0 -1	0 1 -1	-1 -1 -1	0 0 0	-1 -1 -1	1 1 1	0 1 1	1 0 0	-1 -1 -1	-1 -1 -1	-1 -1 -1	-2 3 1	L H H	1	H
FS9601	1 1 0	1 0 0	0 0 -1	-1 -1 -1	-1 -1 -1	-1 -1 -1	-1 -1 -1	-1 0 0	-1 -1 -1	-1 1 1	-1 -1 -1	-1 -1 -1	-1 -1 -1	-1 -1 -1	-10 -1 1	L L L	-11	L
FS9603	1 1 -1	-1 -1 0	0 1 -1	-1 -1 -1	0 -1 -1	-1 -1 -1	0 0 0	-1 0 0	-1 -1 -1	-1 0 0	1 -1 -1	0 1 1	-1 -1 -1	-1 -1 -1	-4 -4 1	L L L	-8	L
68710	-1 -1 -1	-1 -1 -1	-1 1 -1	-1 -1 -1	0 1 0	0 0 0	1 -1 0	0 0 0	-1 1 1	0 1 1	-1 -1 -1	-1 -1 -1	-1 -1 -1	-1 -1 -1	-8 0 1	L H H	-8	L
68724	0 -1 -1	-1 1 0	1 0 1	-1 1 -1	-1 1 -1	-1 -1 -1	0 -1 0	-1 0 0	-1 -1 -1	0 1 0	1 0 1	0 1 1	1 1 1	1 1 1	-4 6 1	L H H	2	H
68728	1 1 1	1 1 1	1 1 1	-1 0 0	0 0 0	-1 -1 -1	-1 1 -1	-1 -1 -1	-1 1 1	0 1 1	-1 -1 -1	1 1 1	1 1 1	1 1 1	0 6 1	H H H	6	H
Co27	1 1 -1	-1 -1 0	-1 0 0	-1 0 -1	-1 0 -1	-1 -1 0	0 0 0	0 0 0	-1 1 1	-1 1 1	1 1 1	0 0 0	-1 -1 -1	-1 -1 -1	-6 2 1	L H H	-4	L
SS032	0 1 -1	-1 -1 0	0 0 0	0 0 0	0 -1 0	0 0 0	0 -1 0	0 1 1	1 1 1	0 1 1	1 0 1	1 0 1	1 0 1	1 0 1	4 1 1	H H H	5	H

H=High

L=Low

0 = Non-significant

1 = Positively significant

-1 = Negatively significant

Table 35 (contd...) Score chart of mean, sca and standard heterosis values for hybrids for pooled data over environments

characters	Days to 50 per cent flowering	Plant height	Number of tillers	Number of leaves	Leaf length	Leaf breadth	Leaf stem ratio	Stem thickness	Hydrocyanic acid	Total soluble	Crude protein	Df/plant	Green fodder yield per plant	Green fodder yield per plot	Total score	Status	st at us
	x sca diiii	x sca diiii	x sca diiii	x sca diiii	x sca diiii	x sca diiii	x sca diiii	x sca diiii	x sca diiii	x sca diiii	x sca diiii	x sca diiii	x sca diiii	x sca diiii	x sca diiii	x sca diiii	
Genotypes	-1 0 -1	-1 -1 -1	-1 -1 -1	-1 0 0	-1 -1 0	-1 0 1	-1 0 -1	-1 0 0	-1 -1 -1	-1 0 -1	1 1 1	-1 -1 -1	-1 -1 -1	-1 -1 0	-6 -4	L L L	-22
296A x 68716	1 1 0	-1 -1 0	-1 0 0	-1 0 0	-1 0 0	-1 0 1	0 0 0	0 0 0	-1 -1 -1	0 0 0	0 -1 1	-1 0 1	-1 1 1	-1 1 1	-8 -2 4	L L H	-6
296A x 68740	1 1 0	-1 0 -1	-1 0 -1	0 0 1	-1 0 0	1 1 1	0 0 0	0 0 1	-1 1 1	-1 0 0	0 1 1	-1 0 0	-1 1 1	-1 1 1	-6 6 5	L H H	5
296A x 68918	-1 -1 -1	-1 0 0	-1 0 -1	-1 0 0	0 0 0	-1 0 1	0 0 0	0 0 0	-1 -1 0	-1 1 0	-1 -1 1	-1 -1 0	-1 -1 -1	-1 -1 -1	-5 0	L L H	-17
296A x 68786	-1 0 -1	-1 0 0	-1 -1 -1	0 0 1	0 0 1	0 0 1	1 1 1	0 0 0	-1 -1 1	0 1 1	1 1 1	-1 -1 0	-1 -1 1	-1 -1 0	-5 -2 6	L L H	-1
296A x 68814	0 -1 -1	-1 1 -1	-1 0 0	-1 0 0	0 0 0	0 0 1	0 -1 0	0 0 1	-1 1 1	0 0 1	0 1 1	-1 0 0	-1 1 1	-1 1 1	-7 4 4	L H H	1
296A x FS211	-1 -1 -1	-1 0 0	-1 0 0	-1 0 0	-1 0 0	0 0 1	-1 0 -1	0 0 0	0 0 1	0 0 0	-1 -1 0	-1 0 0	-1 0 1	-1 1 0	-1 1	L L H	-10
296A x FS205	1 -1 0	-1 1 0	-1 0 0	-1 1 0	0 0 0	0 0 1	0 0 0	-1 0 0	-1 -1 0	-1 -1 1	1 1 1	-1 0 0	-1 0 1	0 1 1	-6 1 3	L H H	-2
296A x FS9401	1 -1 0	-1 1 -1	-1 0 0	-1 0 0	-1 0 0	0 0 1	0 -1 -1	-1 0 0	1 1 1	0 0 0	-1 -1 1	-1 0 0	-1 1 1	-1 1 1	-7 2 3	L H H	-2
296A x SS003	1 0 1	-1 -1 -1	-1 0 -1	-1 0 0	-1 0 0	0 0 1	-1 -1 -1	0 0 0	-1 -1 -1	-1 -1 0	1 1 1	-1 -1 -1	-1 -1 0	-1 0 0	-9 -5 -2	L L L	-16
296A x SS012	1 1 0	0 1 1	-1 0 0	-1 0 0	-1 0 0	0 0 1	-1 -1 -1	0 0 1	1 1 1	0 1 1	-1 -1 1	-1 1 0	-1 1 1	-1 -1 -1	-6 4 6	L H H	4
296A x SS020	-1 0 -1	-1 -1 -1	0 0 0	-1 0 0	0 0 0	-1 0 1	1 1 0	0 0 0	-1 -1 -1	0 0 0	0 1 1	-1 1 0	-1 1 1	-1 -1 -1	-7 1 -1	L H L	-7
296A x SRV605	-1 -1 -1	-1 1 -1	-1 0 0	0 0 1	-1 0 0	0 0 1	0 0 0	0 0 1	-1 -1 -1	-1 -1 0	-1 -1 1	0 1 1	1 1 1	-1 -1 -1	-7 0 2	L H H	-5
296A x FS9604	0 0 0	-1 0 0	-1 0 0	-1 0 0	0 0 0	-1 0 0	-1 -1 -1	-1 0 0	1 1 1	0 -1 0	-1 -1 -1	-1 -1 0	-1 -1 1	-1 0 1	-9 -4 1	L L L	-13
296A x FS9605	1 -1 0	-1 0 0	0 0 0	-1 0 0	0 0 0	-1 0 1	-1 0 -1	-1 0 0	-1 -1 1	1 1 1	1 1 1	0 1 1	-1 1 1	1 1 1	-3 3 6	L H H	6
296A x FS9601	1 0 0	-1 1 -1	0 0 0	-1 0 0	0 0 0	-1 0 1	0 0 0	-1 0 0	-1 0 -1	0 0 0	-1 1 1	-1 0 1	-1 1 1	-1 -1 -1	-8 4 1	L H H	-3
296A x FS9603	0 1 0	-1 1 0	0 0 0	-1 0 0	0 0 0	0 0 1	-1 0 -1	-1 0 0	1 1 1	1 1 1	-1 -1 -1	0 0 1	-1 1 1	-1 1 1	-3 5 5	L H H	7
296A x 68710	1 1 1	-1 0 1	0 0 0	-1 -1 0	0 0 1	-1 0 1	-1 -1 -1	-1 0 0	-1 0 1	1 1 1	0 0 1	1 1 1	-1 1 1	-1 0 1	-3 2 9	L H H	8
296A x 68724	1 0 1	-1 -1 -1	1 1 1	-1 -1 0	-1 0 0	-1 0 0	-1 -1 -1	-1 0 0	1 0 1	0 -1 0	-1 -1 0	1 1 1	1 1 1	-1 -1 -1	-3 -3 2	L L H	2
296A x 68726	1 0 1	-1 -1 -1	-1 0 0	-1 0 0	0 0 1	0 0 1	0 0 0	-1 0 0	-1 -1 -1	0 0 1	1 1 1	-1 0 1	-1 1 1	-1 1 0	-5 -1 6	L L H	0
296A x Co27	1 0 0	-1 -1 -1	0 0 0	-1 0 0	0 0 0	0 0 1	0 0 0	-1 0 0	-1 -1 -1	0 0 1	1 1 1	-1 0 1	-1 1 1	-1 1 0	-4 3 3	L H H	2
296A x SS032	1 1 1	1 1 1	0 0 0	-1 0 0	0 0 1	-1 0 0	0 -1 -1	0 0 0	0 1 1	0 0 0	-1 -1 1	1 1 1	1 1 1	1 1 1	-2 6 9	L H H	17
2219A x 68716	1 0 1	0 0 1	0 0 0	-1 0 0	-1 0 0	-1 0 0	0 -1 0	0 0 0	-1 0 1	0 0 0	-1 0 1	-1 0 1	-1 1 1	0 1 1	-6 1 7	L H H	2
2219A x 68740	1 1 1	-1 0 -1	0 0 0	-1 0 0	-1 0 0	-1 0 1	0 -1 0	0 0 0	-1 0 0	-1 0 0	-1 -1 1	-1 0 1	-1 1 1	0 1 1	-6 3 3	L H H	0
2219A x 68918	1 1 0	0 0 1	-1 0 0	-1 -1 0	-1 0 0	-1 0 0	0 0 0	0 0 0	-1 -1 0	-1 0 0	1 1 1	-1 1 0	-1 1 1	1 1 1	1 1 7	H H H	9
2219A x 68768	1 1 1	-1 -1 1	0 0 0	-1 -1 0	0 0 1	-1 0 0	0 -1 0	-1 0 0	1 1 1	0 0 0	-1 -1 1	-1 -1 1	-1 -1 1	1 0 1	-2 -4 8	L L H	2
2219A x 68814	1 0 1	-1 0 -1	0 0 0	-1 0 0	0 0 1	-1 0 0	-1 0 -1	-1 0 0	-1 -1 -1	0 -1 0	1 0 1	-1 0 0	-1 -1 1	1 0 -1	-8 -2 1	L L H	-9
2219A x FS211	1 1 1	0 0 1	-1 0 0	-1 0 0	-1 0 0	-1 0 0	-1 0 -1	-1 0 0	-1 -1 -1	0 1 1	1 1 1	-1 0 -1	-1 1 1	-1 -1 0	-5 3 5	H H H	3
2219A x FS205	1 0 1	-1 -1 0	-1 0 0	-1 0 0	-1 0 0	-1 0 0	0 1 0	-1 0 0	0 -1 1	-1 0 0	1 1 1	-1 1 1	-1 1 1	-1 1 1	-5 2 6	H H H	3
2219A x FS9401	1 0 1	-1 -1 0	-1 0 0	-1 0 0	-1 0 0	-1 0 0	0 1 0	-1 0 0	0 -1 1	-1 0 0	1 1 1	-1 1 1	-1 1 1	-1 1 1	-5 2 6	H H H	3

H=High

L=Low

0 = Non-significant

1 = Positively significant

-1 = Negatively significant

Table 35. (contd ...)

characters	Days to 50 per cent flowering	Plant height	Number of tillers	Number of leaves	Leaf length	Leaf breadth	Leaf stem ratio	Stem thickness	Hydrocyanic acid	Total soluble	Crude protein	Df/plant	Green fodder yield per plant	Green fodder yield per plot	Total score	Status	ai	St at us
	x sca diii	x sca diii	x sca diii	x sca diii	x sca diii	x sca diii	x sca diii	x sca diii	x sca diii	x sca diii	x sca diii	x sca diii	x sca diii	x sca diii	x sca diii	x sca diii	x sca diii	x sca diii
Genotypes	1 1 1	1 1 1	0 0 1	0 0 1	0 0 1	-1 0 0	-1 0 -1	-1 0 0	1 0 1	0 0 0	-1 -1 0	1 1 1	1 1 1	-1 -1 1	0 2 8	H H H	10	H
2077A x 68726	1 1 1	1 1 1	0 0 0	0 0 1	0 0 1	0 0 1	-1 0 -1	0 1 1	1 0 1	0 1 0	-1 -1 1	1 1 1	1 1 1	-1 -1 -1	2 3 8	H H H	13	H
2077A x Co27	1 1 1	1 1 1	-1 -1 -1	0 0 1	-1 0 0	0 0 1	-1 0 -1	0 0 1	1 1 1	-1 -1 -1	-1 -1 0	-1 -1 -1	-1 -1 -1	-1 -1 -1	-5 -3 0	L L H	-8	L
2077A x SS032	-1 -1 -1	1 0 1	-1 0 0	0 0 1	0 0 1	0 0 1	-1 0 -1	0 0 0	0 1 1	-1 0 0	-1 -1 0	-1 -1 1	-1 -1 1	-1 -1 1	-5 -4 6	L L H	-3	L
111A x 68716	-1 -1 -1	1 1 1	-1 -1 -1	0 1 1	0 0 1	0 0 1	0 0 0	-1 0 0	-1 1 1	-1 0 -1	1 1 1	0 -1 1	-1 -1 1	0 -1 1	-4 -1 6	L L H	1	H
111A x 68740	-1 -1 -1	1 1 1	-1 -1 -1	0 1 1	0 0 1	0 0 1	-1 -1 -1	0 0 0	0 1 1	-1 0 0	-1 -1 1	-1 0 0	-1 -1 1	0 -1 1	-9 -3 3	L L H	9	H
111A x 68918	-1 -1 -1	1 0 1	0 0 0	0 0 1	0 0 1	0 0 1	0 0 0	0 0 1	1 1 1	-1 0 -1	0 1 1	1 0 1	1 -1 1	0 -1 1	3 1 8	H H H	12	H
111A x 68786	-1 -1 -1	1 0 1	0 0 0	0 0 1	0 0 1	0 0 1	0 0 0	0 0 1	1 1 1	-1 0 -1	-1 -1 1	1 1 1	1 1 1	0 -1 1	1 0 6	H H H	7	H
111A x 68814	1 1 1	-1 -1 -1	-1 0 0	0 0 1	0 0 0	0 0 1	-1 -1 -1	0 0 0	1 1 1	-1 -1 -1	-1 -1 1	0 0 1	0 0 1	0 -1 1	-2 -3 6	L L H	11	H
111A x FS211	0 1 -1	1 0 1	-1 0 0	0 0 1	-1 0 0	0 0 1	-1 0 -1	0 0 0	1 1 1	0 1 0	-1 -1 1	0 0 1	-1 -1 1	0 1 0	-2 1 6	L H H	5	H
111A x FS205	1 1 0	1 0 1	0 0 0	0 0 1	0 0 0	0 0 1	-1 0 -1	0 0 0	0 0 1	0 1 0	-1 -1 1	0 -1 1	-1 -1 1	0 -1 1	-1 -1 5	L L H	3	H
111A x FS9401	1 1 1	-1 -1 -1	-1 0 -1	-1 0 0	-1 0 0	0 0 1	-1 0 -1	0 0 1	1 0 1	-1 0 0	-1 1 1	-1 -1 0	-1 -1 1	0 -1 1	-7 -2 4	L L H	-5	L
111A x SS003	1 1 0	-1 0 -1	-1 0 -1	0 1 1	-1 0 0	0 0 1	-1 0 -1	0 0 0	0 1 1	-1 0 0	-1 -1 1	-1 -1 0	-1 -1 1	0 -1 1	-7 0 3	L H H	-4	L
111A x SS012	-1 -1 -1	-1 0 1	-1 0 -1	0 0 1	0 0 1	0 0 1	0 0 1	0 0 0	1 -1 1	-1 -1 -1	1 1 1	-1 -1 0	-1 -1 1	0 -1 1	-4 -5 5	L L H	-4	L
111A x SS020	-1 0 -1	-1 0 1	0 0 0	-1 0 0	-1 0 0	-1 0 0	-1 0 -1	-1 0 0	-1 -1 0	-1 -1 -1	1 1 1	-1 -1 0	-1 -1 1	1 1 1	-11 1 3	L H H	-7	L
111A x SRV605	-1 1 -1	-1 -1 -1	0 0 0	0 0 1	0 0 0	0 0 1	0 0 0	0 0 0	1 1 1	0 1 1	1 1 1	0 1 1	0 1 1	1 1 1	2 6 6	H H H	14	H
111A x FS9804	1 1 0	1 1 1	-1 1 0	0 0 1	0 0 1	0 0 1	-1 -1 -1	-1 0 0	1 0 1	1 1 1	1 1 1	1 1 1	1 1 1	1 1 1	5 7 9	H H H	21	H
111A x FS9805	1 1 1	1 1 1	-1 0 0	0 0 1	-1 0 0	0 0 1	-1 0 -1	-1 0 0	1 -1 1	-1 -1 0	-1 -1 1	0 -1 1	0 0 1	1 -1 1	-2 -3 6	L L H	1	H
111A x FS9801	0 0 0	-1 0 1	1 1 1	-1 0 0	-1 0 0	0 0 1	0 1 -1	0 0 0	-1 -1 1	0 0 0	-1 -1 1	1 1 1	1 1 1	-1 -1 1	-3 1 1	L H H	-1	L
111A x FS9803	-1 0 -1	-1 -1 -1	0 0 0	-1 -1 0	0 0 1	0 0 1	-1 -1 -1	0 0 0	-1 -1 0	0 0 1	-1 1 1	1 0 1	1 1 1	-1 -1 -1	-5 -3 4	L L H	-4	L
111A x 68710	-1 -1 -1	1 0 1	0 0 0	0 0 1	0 0 1	0 0 1	-1 0 -1	0 0 0	-1 -1 1	0 0 0	-1 1 1	1 0 1	1 1 1	1 1 1	0 0 7	H H H	7	H
111A x 68724	-1 -1 -1	1 0 1	0 0 0	0 0 1	0 0 1	0 0 1	-1 0 -1	0 0 0	-1 -1 1	0 0 0	0 1 1	1 -1 1	1 -1 1	1 1 1	4 2 8	H H H	14	H
111A x 68726	1 0 0	1 0 1	1 0 1	0 0 1	0 1 1	-1 0 0	-1 -1 -1	-1 0 0	1 0 1	0 0 0	0 1 1	1 -1 1	1 -1 1	1 -1 1	-2 -2 8	L L H	4	H
111A x Co27	-1 -1 -1	0 0 1	-1 0 0	0 0 1	0 0 1	0 0 1	-1 0 -1	0 0 0	1 1 1	0 0 0	0 1 1	0 -1 1	-1 -1 1	1 -1 1	0 4 7	H H H	11	H
111A x SS032	0 -1 -1	0 1 1	0 1 0	0 0 1	-1 0 0	0 0 1	-1 0 -1	0 0 1	-1 -1 1	0 0 0	0 1 1	1 1 1	1 1 1	1 1 1	0 4 7	H H H	11	H

H=High L=Low

0 = Non-significant

1 = Positively significant

-1 = Negatively significant

Discussion

V. DISCUSSION

Though India has the largest cattle population of the world, our milk and meat production is dismally low. One of the main reasons is the low availability of quality green fodder throughout the year. Even though many perennial fodder grasses are available, their green fodder yield potential is low, both under irrigated and rainfed situations. Some perennial high yielding forages like Bajra-Napier hybrid are suitable for only irrigated conditions, since their drought resistance capacity is low. Sorghum on the other hand is the only fodder crop that gives good economic returns both under irrigated and rainfed situations. The genus Sorghum includes several strains or types like (1) forage sorghum (2) grain sorghum (3) sudangrass (4) sweet sorghums (5) sorghum sudangrass hybrids (Harlan and Dewet, 1972) etc.

Sorghum is a warm temperate and tropical cereal with C_4 photosynthetic pathway, highly versatile and adopted to drought conditions. Botanically speaking, sorghums are perennial but, due to their lack of winter hardiness, they are, agronomically in practical application an annual in temperate regions or sub tropical regions. However, it can be harvested many times in tropical areas where the climate is highly conducive for sorghum.

Many fodder sorghum varieties have been released throughout India, but most of them are either single cut types or at the best one or two ratoons can be taken. This implies periodical sowings at regular intervals throughout the year for continuous availability of fodder, however this enhances the cost of production. Hence the farmers demand a multicut variety which will stand throughout the year in the field. An ordinary variety will have only limited stability compared with a hybrid. Hence an attempt was made to produce a number of fodder sorghum hybrids with desirable quality parameters and compare them for their yield potential, combining ability, heterosis, stability etc.

Good forage quality can be associated with a high leaf- stem ratio (Hoveland and Monson, 1980). This ratio can be manipulated by the introduction (usually through backcrossing) of one or more dwarfing genes, which shortens the stem internodes without

therwise altering the plant. Plant height and dry matter yields were reduced, but leaf percentage, IVDMD and crude proteins got increased (Burtón *et al.*, 1969). The concentration of energy and protein in the forage is significantly increased (Hoveland and Monson, 1980). Increasing stem diameter and non-lignified cellulose (more pith parenchyma) may also be used to increase IVDMD of sorghum (Burns *et al.*, 1970). The reduced yields can be compensated for somewhat, by developing hybrids and taking advantage of hybrid vigour with perenniality for continuous supply of green fodder yield throughout the year.

Majority of varieties bred so far in most of the cereal fodder's are single cut types and their average forage yield is not high. Even the multicut types released so far in India hardly yield 140 – 180 q per ha of dry matter. For improvement of such an important crop, the most important prerequisite is the selection of suitable parents, which could combine well and produce desirable hybrids and segregants. Sorghum is highly amenable to both heterosis and recombination breeding programmes. In formulating an appropriate programme for heterosis or recombination breeding for the selection of suitable parents, knowledge on the genetic architecture and the nature of inheritance for desirable traits is necessary (Simmonds, 1979).

Line x Tester analysis helps to find out the combining ability for different yield attributes and also the gene action involved. Further, the extension of Line x Tester analysis over environments allows prediction of genetic components and their interaction across the environments. Investigation on the magnitude of heterosis helps to identify promising hybrid combinations for exploitation. Green fodder yield is quantitatively inherited and there is considerable interaction between Genotype x Environment. The average responsiveness and yielding ability in each cut of some of the multicut types already available is not high. Hence, a study on stability of genotypes for development of multicut types also becomes necessary.

Yield is a complex character collectively influenced by various components. The genotypic correlation coefficients coupled with path coefficient estimates provide information on the relative importance of the components of yield.

To achieve these objectives an investigation was carried out in sorghum to study the general and specific combining abilities, gene action, magnitude of heterosis, variability, correlation and path and stability analysis for different characters in 25 parents and 84 hybrids studied for multicut habit over four cuts (environments). The results obtained are discussed below. The present investigation may prove useful in identifying high yielding multicut hybrids with average responsiveness in each cut for green fodder yield and their related characters.

Analysis of variance:

Analysis of variance indicated that the selected parental genotypes were highly significant and satisfied the requirement of sufficient variability among the genotypes. The parental differences were highly significant for all the characters except stem thickness in E_2 and E_3 . Differences among lines were also very high for all the characters except number of tillers, which were non-significant in all the environments. Stem thickness in E_1 , E_2 and E_3 , number of leaves and leaf length in E_2 was also non-significant. The variability was very high among the testers for all the characters in all the environments except for stem thickness. Line vs tester variances were highly significant for all the characters in all the environments except for leaf breadth in E_2 and E_4 , for stem thickness in E_2 and E_3 , for hydrocyanic acid in E_2 and for total soluble solids in E_2 and pooled data. Significant line vs tester variance indicated that line mean and tester mean was highly divergent. In the present study line mean exceeded that of the tester for leaf breadth, leaf- stem ratio, stem thickness, hydrocyanic acid, total soluble solids and crude protein. Tester means were greater for all other yield contributing characters indicating that testers were highly divergent from lines.

The interaction variance of parents vs crosses which is a pointer towards average heterosis, was significant for all the characters except for number of tillers in E_1 , E_2 and E_4 , for number of leaves in E_4 , for leaf length in E_4 , for stem thickness in E_2 and for hydrocyanic acid in pooled data. This indicated the presence of considerable amount of average heterosis in the hybrids for the individual characters in different environments.

The significant values of environmental variance indicated that there was sufficient variability between the environments for most of the characters viz., plant height, number of leaves, leaf length, leaf breadth, leaf- stem ratio, stem thickness, crude protein, dry fodder yield, green fodder yield per plant and green fodder yield per plot indicating differential response of environment on each character. Significance of environments vs genotypes, environments vs parents, environments vs lines, environments vs testers, environments vs (line x tester) and environments vs (parents vs crosses) for all the characters except stem thickness was observed. Significance of all these parameters indicated that there were sufficient environmental interactions present on each of the components.

Combining ability:

Information on combining ability is necessary to develop a sound-breeding programme, and to assess the nature the potentiality of the parents in hybrid combinations. When the character is unidirectionally controlled by a set of alleles and additive effects are more important, choice of parents on the basis of *per se* performance would be effective. However, in cases when non-allelic interactions are more important, the combining ability estimates would provide a better guide for parental choice (Sharma and Chauhan, 1985)

Variances of combining ability and genetic components:

Significant differences among hybrids for all the characters except for number of leaves in E₂ and for stem thickness in E₃ and E₄ were observed. Line effects showed significant differences for all the characters except number of tillers in all the environments, leaf length in E₃, leaf- stem ratio and total soluble solids in E₂.

Variation in hybrids contributed by lines (female parent) was high for all the characters except number of tillers where the contribution by lines ranged from 0.92 per cent in pooled data (lowest) to the tune of 4.96 per cent in E₃. Among the different characters studied, the contribution by lines was maximum for leaf breadth at 61.69 per cent in E₁ and on an average it recorded 51.69 per cent in the pooled data. Line vs tester effects were

significant for almost all the characters except stem thickness in all the environments. Line x tester interaction component was to the tune of 70.62 per cent in E_1 for total soluble solids followed by that of crude protein around 60 per cent in all the environments. Leaf- stem ratio and stem thickness recorded more than 50 per cent of contribution. Among the different characters the contribution by line x tester interaction was the lowest for plant height. Highly significant line x tester variance indicated that specific cross combinations were differentially superior over others. In other words, the lines did not appear to behave consistently over different testers and vice versa. Differences among lines with respect of such contribution were significant.

The significant tester effect indicated that among testers there was sufficient variability with respect to their contribution except for that in a few characters like number of leaves, leaf breadth, leaf- stem ratio, stem thickness, dry fodder yield, green fodder yield per plot and for crude protein in some specific environments.

Among the significant tester effect the contribution was more for leaf length in E_1 (67.61 per cent) and pooled data over (64.73 per cent) followed by number of tillers (59.35) per cent in pooled data. Significant interaction of all the sources with environment for all the characters except stem thickness, hydrocyanic acid, and dry fodder yield for environment vs tester effect; leaf breadth and stem thickness for environment vs (line x tester effects) indicated that there was a differential performance of each character in different environments.

The narrow sense heritability estimates (Table 5) revealed that all the characters had more than 30 per cent of heritability except leaf-stem ratio, number of tillers, leaf length and crude protein. High heritability (> 30 per cent) in narrow sense indicated that the traits were largely governed by additive genes and selection for improvement of such characters would be rewarding. The medium heritability (10-30 per cent) of characters shows that there was a preponderance of non-additive gene action and heterosis breeding may be useful (Robinson 1965).

Among the different characters, green fodder yield per plant recorded the highest genetic advance more than 100 per cent in all the environments (E₁, E₂, E₃ and P) and more than 200 per cent in E₄ (4th cut) followed by plant height, dry fodder yield and hydrocyanic acid. High genetic advance indicated that additive genes governed these characters and selection will be rewarding for improvement of such traits.

All the remaining characters recorded low genetic advance indicating non-additive genes governed the characters and heterosis breeding may be useful.

Relationship between heritability and genetic advance:

Heritability and genetic advance are the important selection parameters. Heritability is the ratio of additive genetic variance to the phenotypic variance (narrow sense). Heritability estimates are influenced by the type of genetic material, sample size, method of sampling and effect of linkage.

Genetic advance refers to the improvement in the mean genotypic value of selected individuals over the parental population. It is highly influenced by the genetic variability and heritability. In the present study, high heritability accompanied with high genetic advance for green fodder yield per plant, dry fodder yield and plant height indicated that the characters with high heritability may be due to additive gene effects and selection for such traits may be effective.

The characters like days to 50 per cent flowering, number of leaves, leaf length, leaf breadth, crude protein and green fodder yield per plot recorded high heritability with low genetic advance. It was indicative of non-additive gene action.

Low heritability accompanied with low genetic advance was observed for number of tillers and leaf- stem ratio indicating that the characters were highly influenced by environmental effects and selection would be ineffective (Singh and Narayanan, 1993).

Combining ability variances and gene action:

The estimates of *GCA* and *SCA* variances are useful to infer the type of gene action and the relative importance of the character in a breeding programme. In addition, the ratio between *GCA* and *SCA* variances helps to find out the extent of additive gene action.

The estimates of combining ability variances showed higher values of *GCA* variances than *SCA* variances for plant height, number of leaves, leaf length, leaf breadth and stem thickness in all the environments and pooled data over environments which indicated that predominance of additive gene action in the control of these characters. *GCA* variance was higher than *SCA* variance for days to 50 per cent flowering in E_1 and for total soluble solids in E_1 and E_2 . Regarding the pooled data over environments, all the characters except number of tillers, crude protein and green fodder yield per plot recorded higher *GCA* variances than the *SCA* variance indicating predominance of additive gene action for these characters. Predominance of *GCA* variances for days to flowering, number of leaves and grain yield had been reported by Hussain Sahib *et al* (1988), by Patel and Desai (1990) for number of leaves and plant height, and for days to 50 per cent flowering, plant height, stem diameter, leaf-stem ratio, brix value and HCN content by Jeyamani (1991).

Dry fodder yield recorded both additive and non-additive gene action (1: 1.083 *GCA*: *SCA* variance) in the pooled data. Shah and Joshi (1996) reported both additive and non-additive gene action for days to 50 per cent flowering, green fodder yield and plant height.

Predominance of *SCA* variance was observed for number of tillers, crude protein and green fodder yield per plot indicating that these traits are mainly controlled by non-additive gene action as reported by Paroda *et al.* (1978). Jeyamani (1991) reported similar findings for green fodder yield per plant and crude protein

In general, though the different environments had varied effect on gene action, based on the pooled analysis it can be said that most of the traits are controlled by additive gene action except number of tillers, crude protein and green fodder yield per plot which recorded higher non-additive gene action.

Evaluation of parents:

***Per se* performance of parents:**

The success of any crop-breeding programme also depends to certain extent on the choice of parents based on *per se* performance (Anita and Stephen Dorairaj, 1990). The selected genotypes can be used either for the exploitation of heterosis or for recombination breeding. Parents with good *per se* performance are expected to yield desirable recombinants in the segregating generation and the potentiality of such genotypes will also reflect in the performance of the hybrids. In the present study, 111 A recorded high mean for all the characters except leaf- stem ratio, days to 50 per cent flowering and crude protein. Among the testers, 68786 had recorded higher mean for all the characters except total soluble solids and crude protein. The tester 68726 recorded high mean for eight characters viz., plant height, days to 50 per cent flowering, number of tillers, leaf length, total soluble solids, dry fodder yield, green fodder yield per plant and green fodder yield per plot. The tester SS032 recorded high mean for crude protein, dry fodder yield, green fodder yield per plant and green fodder yield per plot.

Based on the number of times a genotype occurred as one of the parents in the hybrids that recorded high values, those genotypes were identified as donors for different plant attributes. In that sense, 111 A followed by 2077A were the best for almost all the characters. The line 2219 A can be considered as the best for days to 50 per cent flowering. Among the testers 68814 can be used in breeding programmes for incorporation of desired traits like leaf- stem ratio and low hydrocyanic acid in addition to yield contributing characters.

GCA effects:

Studies on *gca* effects of parents revealed that the line 111 A recorded significant positive effect for most of the characters except number of tillers, leaf length, leaf stem ratio, stem thickness, total soluble solids and crude protein. The line 2077 A exhibited high *gca* effect for most of the characters except number of tillers, leaf-stem ratio, leaf breadth, green fodder yield per plot and crude protein.

The tester 68814 recorded highly significant positive effect for all the characters except leaf breadth, stem thickness, total soluble solids and crude protein. It also recorded highly significant negative *gca* effect for hydrocyanic acid which is in the desirable direction. The tester 68726 recorded high *gca* effect for ten characters in the desirable direction except for number of leaves, leaf breadth, stem thickness and crude protein. The tester 68724 also recorded high *gca* for eleven characters except leaf-stem ratio, leaf breadth and days to 50 per cent flowering. The testers 68740, 68786, 68724 and 68726 recorded high *gca* effects for more than six traits. Based on the over all *gca* effects it was concluded that the lines 111 A and 2077A and the testers 68814, 68726, 68724, 68740 and 68786 could be the best for improving the fodder yield in sorghum with desirable attributes.

***Per se* performance and *gca* effect:**

The knowledge of combining ability coupled with *per se* performance of parents would be of great value in selecting suitable parents for hybridization programme. Sprague and Tatum (1942), Simmonds (1979) and Dabholkar (1992) stated that *gca* effect is an intrinsic value of the parents for a trait due to additive effects of genes and is fixable. Hence, general combining ability of the parents is reckoned as a factor in predicting the performance of a cross combination.

It has not been fully established that there exists a relationship between *gca* of parents and the performance of hybrids and segregants from the cross. It is still a debatable subject among the breeders. However, a majority of the published literature lends support to the view that *gca* may be related with the performance of progenies of the cross predicted on the

basis of combining ability effects. Singh and Hari singh (1985) expressed the view that parents with high *gca* effects would produce transgressive segregants in F₂ and later generations.

In the present study association between *per se* performance and *gca* effects was evident for 111 A for all the characters except hydrocyanic acid where *gca* effect was positive. Among the testers 68786 recorded high *per se* values and *gca* effects in the desirable direction for all the characters except number of tillers, crude protein and days to 50 per cent flowering. It also recorded higher *gca* effect and lower mean values for total soluble solids.

The tester SS 032 with high *per se* performance for most of the characters recorded significant positive *gca* effect for all the characters except plant height, number of leaves, leaf- stem ratio, crude protein, leaf length, green and dry fodder yields.

For green fodder yield, the lines 2077 A and 111 A and the testers 68740, 68786 and 68724 recorded higher *per se* values along with significant *gca* effects. The parents 68724 and 68726 recorded high *per se* values coupled with high *gca* effect for green fodder yield per plot. Among the lines and testers, 296 A, 68918, 68814 recorded high *per se* values and high *gca* effects for leaf- stem ratio in the pooled data. The above results pointed towards a positive relationship between *per se* performance and *gca* effects. Probably these parents may have more number of additive genes and could contribute for the accumulation of favorable genes in a varietal development programme.

For characters like hydrocyanic acid, number of leaves, leaf length, leaf breadth, stem thickness, total soluble solids and crude protein, most of the parents had either low mean with high *gca* effect or vice versa except in a few cases like 68786, 68814, FS 205, FS 9401, SS 003, FS9605 and SS 032 for hydrocyanic acid, FS 9604 for total soluble solids and SRV605 for crude protein. The lack of correspondence between *gca* effects of some of the parents and their *per se* performance indicated that in these parents the particular trait was probably under the influence of non-additive gene action.

On overall consideration based on the *gca* and high mean values, the parents 111A and 68786 could be the best for developing almost all the forage characters with multicut habit. Chawla and Gupta (1982) indicated that such parents could produce transgressive segregants in the F₂ as well as in later generations. 68726 and SS 032 recorded high *per se* and high *gca* values for most of the characters. The remaining parents can be used in recombination breeding.

The results of the present study also indicated that it would be desirable to develop multiple crosses to select desirable segregants for yield and favorable associated traits in the advanced generations, as no parent was a good general combiner for all the traits as reported by Reddy and Joshi (1993), Sankarapandian *et al.* (1994), Gururaja Rao *et al.* (1994) and Pooran Chand (1996) especially for limited harvests or single cut types.

Evaluation of hybrids:

***Per se* performance of hybrids:**

The primary criteria used for the evaluation of hybrids was the *per se* expression of characters by the hybrids for different traits. In the present study 111 A x 68726 ranked first for green fodder yield per plot and recorded high *per se* values for most of the characters except leaf breadth, leaf-stem ratio and stem thickness. The next best hybrid was 111 A x 68724 which recorded high mean values for all the characters except days to 50 flowering, leaf- stem ratio and stem thickness. In this hybrid quality parameters like crude protein (9.24) and total soluble solids (7.83) were high and the hydrocyanic acid content was also low (86.25). The hybrid 111A x SS032 which ranked third for green fodder yield per plot recorded higher mean values for most of the traits except for leaf length and leaf- stem ratio. Hydrocyanic acid content was reported to be a hereditary character, influenced by environmental condition (Boyd *et al.*, 1938). In the present study, since all the hybrids recorded the HCN level below 200 ppm all of them can be recommended as good quality forages (Gillingham *et al.*, 1969).

111 A x 68814 recorded high mean values for plant height, number of tillers, number of leaves, leaf length, leaf breadth and low hydrocyanic acid, ranked third for green fodder yield per plant and fourth for green fodder yield per plot.

Among the other hybrids, 2219 A x 68716, 111 A x SRV 605, 2219 A x 68726, 111A x SRV 605 and 111A x FS9605 recorded high mean values for green fodder yield per plot and also for most of the yield contributing characters.

For green fodder yield per plant 2077 A x 68786 recorded the highest *per se* performance but the performance of green fodder yield per plot was on par with the hybrid mean. It showed that the ratooning ability of this hybrid was comparatively low and it could not maintain enough population in subsequent cuts but it had an average performance in each cut. Generally most of the hybrids recorded lower yield in the fourth cut.

Among the different hybrids, 111 A x 68726 recorded high mean values in the fourth cut and it also had average responsiveness in all other cuts. Hence, it exceeded the other hybrids in pooled mean over different cuts.

SCA effects:

Specific combining ability is defined as the deviation from the mean performance, predicted on the basis of general combining ability (Allard, 1960) and specific combining ability is due to non-additive genetic interaction (Sprague and Tatum 1942). Rojas and Sprague (1952) observed that specific combining ability not only involved dominance and epistasis, but also a considerable amount of Genotype x environment interaction.

Narendra Kumar and Hari-Har Ram (1987) suggested that when non-allelic interactions are prevalent, the specific combining ability estimate is considered to be the best criterion for choice of hybrids. Hayman and Mather (1955) referred *gca* and *sca* effects to the properties of individual genotypes rather than the properties of genes in particular cross combinations.

The *sca* value of any cross is helpful in predicting the performance of the hybrids far better than the *gca* of parents (Jain Ying Peng and Virmani, 1990).

Among the eightyfour hybrids, 46 hybrids for green fodder yield per plant and 49 hybrids for green fodder yield per plot recorded *sca* effects in the desirable direction. The *sca* effects were high for most of the other characters also, thus suggesting that there is a preponderance of non-additive gene action for most of the traits.

A consideration of the *sca* effects for green fodder yield vis-à-vis the *sca* effects for other yield components, revealed that no cross combination was consistently superior for all the traits under study. However, the hybrid 111 A x FS 9605 possessed significant *sca* effects for plant height, number of tillers, total soluble solids, crude protein, days to 50 per cent flowering, dry fodder yield per plant, green fodder yield per plant and green fodder yield per plot. The performance of 2219 A x 68716 and 111 A x FS 9605 was similar except for total soluble solids, crude protein and leaf-stem ratio.

The hybrid 296 A x SS 020 recorded highly significant *sca* effects for plant height, day to 50 per cent flowering, hydrocyanic acid, stem thickness, total soluble solids, green fodder yield per plant and green fodder yield per plot. 111 A x FS 9604 recorded significant positive *sca* effect for seven characters viz., leaf-stem ratio, plant height, days to 50 per cent flowering, hydrocyanic acid, total soluble solids, crude protein and green fodder yield per plot.

The hybrids 2077 A x 68740, 111 A x SS 032, 296 A x 68710, 296 A x FS 211 and 296 A x 68918 recorded significant *sca* effect for more than five characters including green fodder yield per plot.

In general, based on the over all performance as discussed above, the hybrids 111 A x FS 9605, 2219 A x 68716, 296 A x SS 020, 111 A x FS 9604, 2077 x 68740, 296 A x 68710, 296 A x FS 211 and 296 A x 68918 can be considered as the best.

The *sca* effects along with *per se* performance of the hybrids can give an idea about the practical utility of the hybrid combinations for heterosis breeding as was reported by Pooran Chand (1996). For example hybrids like 111A X FS 9605 which had high *per se* performance also recorded with high *sca* effects for plant height, days to 50 per cent flowering, total soluble solids, dry fodder yield, green fodder yield per plant and green fodder yield per plot. Similarly 2219 A x 68716 recorded high *per se* and *sca* effects for plant height, days to 50 per cent flowering dry fodder yield, and green fodder yield per plot.

While considering green fodder yield per plant and green fodder yield per plot as the main criteria, the hybrids 111 A x 68740 111 A x 68726, 111 A x SS 032 and 111 A x FS 9604 could be the best for commercial exploitation since they had high green fodder yield.

Relationship between *sca* effects of hybrids and *gca* effects of parents:

Hayman and Mather (1955) referred *gca* and *sca* effects to the properties of individuals rather than the properties of genes in particular cross combinations. The *sca* value of any cross is helpful in predicting the performance of the hybrids far better than the *gca* of parents (Jain Ying Peng and Virmani, 1990).

An examination of *gca* effects of parents and the *sca* effects of the resultant hybrids (Table 35) revealed that it may not be possible to find a definite trend for all the traits in all the hybrids. However, in the present study, when both the parents possessed significant positive *gca* effects, positive *sca* effects were discernible in the hybrids involving them in atleast a few hybrids. This could be exemplified by the hybrids, 2077A x 68814 for plant height, number of leaves, dry fodder yield and crude protein; by 111 A x FS 9605 for plant height and green fodder yield per plot while with 111 A x 68726 for green fodder yield and with 2077 A x 68740 for plant height. Parents with high x high *gca* effects suggest the presence of additive x additive type of gene action between favorable alleles contributed by the two parents which was considered to be fixable type by Subba Rao and Aruna (1997).

Hence, pedigree type of breeding can be employed for exploiting such hybrids. Thus the above hybrids would be very much useful for further testing.

Significant positive *gca* effect in any one of the parents and negative or non-significant *gca* effect of the other parent resulting in significant positive *sca* effects in the hybrids could be observed for all the traits except for crude protein in 111 A x 68726 and 111A x 68786, and for hydrocyanic acid and days to 50 per cent flowering in 111 A x FS 9604, where low x low cross combinations recorded high *sca* effects. It was probably due to non additive gene action and hence, heterosis breeding can be employed for such hybrids.

The top ranking hybrids for *sca* effects with negative or non-significant *gca* effects in their parents were 111 A x FS 9605 for number of tillers, total soluble solids, days to 50 per cent flowering, green fodder yield, 2219 A x 68716 for plant height, days to 50 per cent flowering, number of tillers, leaf- stem ratio, dry fodder yield per plant, green fodder yield per plant and green fodder yield per plot, 111 A x SS 032 for plant height, number of tillers, days to 50 per cent flowering, crude protein, green fodder yield per plant and green fodder yield per plot, 111 A x 68726 for leaf- stem ratio and leaf length.

In the hybrids 111 A x FS 9604 and 2077 A x 68740 with significant *sca* effects, for most of the traits, parents with high x low or low x high *gca* effects were involved indicating the presence of additive x dominance or vice versa type of gene interaction. In general, the study indicated that combination good general combiners need not necessarily be the best cross combinations or was a low x low cross always resulted in a poor combination. Badhe and Patil (1997) and Subba Rao and Aruna (1997) reported similar results. Hence, adoption of biparental mating in these crosses would increase variability and may produce transgressive segregants. Further exploitation of these segregants would result in lines possessing differential performance for that particular trait. Therefore, the above crosses could throw desirable segregants since additive genetic systems which are present in one general combiner and complementary epistatic effects in the other may act in the same direction to maximize the desirable plant attributes as suggested by Fasoulas, (1980).

Manifestation of heterosis:

Scope for the exploitation of hybrid vigour will depend on the high mean performance of the hybrids over the standard variety or local check, the magnitude of heterosis and the biological feasibility for large-scale production of hybrid seeds. In crops like sorghum with the availability of a large number of diversified cytoosteriles, exploitation of heterosis for high yield potential is very easy.

Knowledge on the magnitude of heterosis for various characters is essential to locate better combinations to exploit them through heterosis breeding. Over dominance is attributed towards heterobeltiosis, while commercial superiority of the hybrid may be assessed by evaluating with a standard commercial check (Swaminathan *et al.*, 1972). Rather than mid parent heterosis and heterobeltiosis the standard, useful or economic heterosis reflecting the actual superiority over the best existing cultivar to be replaced appears to be more relevant and practical (Basu *et al.*, 1995). Therefore heterosis over standard check Co27 was chosen as the best criterion for the present study.

By and large the present study revealed that distribution of significant heterosis was both in positive and negative direction for all the traits except green fodder yield per plant, number of tillers, leaf length, leaf breadth, stem thickness and dry fodder yield per plant. For heterobeltiosis, leaf breadth and stem thickness recorded positive heterosis. In standard heterosis, number of leaves, leaf length, leaf breadth and stem thickness recorded positive heterosis. Similar findings were reported by Sankarapandian *et al.* (1994) and Ganesh *et al.* (1996). The negative expression of heterosis in different crosses in the present study might be attributed to the considerable disharmony between gene combinations in the parents involved.

Relationship between *per se* performance and heterosis:

The potentiality of a hybrid might be judged by comparing the *per se* performance and heterotic vigour. Earlier workers opined that while making selection among crosses *per*

se performance which is a realised value should be given preference over heterosis, which is an estimate (Vashir, 1982). Close association between *per se* performance of hybrids and heterosis was observed for almost all the traits, suggesting that the selection of the crosses based on *per se* performance would also be more realistic in sorghum as reported by Reddy and Joshi (1993).

In the present study, many hybrids displayed conspicuous heterosis over standard variety Co 27 for all the traits. Even the hybrids that recorded low mean values for many traits were found to show positive standard heterosis. It was mainly because of higher ratooning ability of the hybrids over the standard check variety Co 27.

On comparison of pooled data over four cuts, all the hybrids exceeded the standard check variety Co 27. However, the direction and magnitude of heterosis varied from cross to cross.

The highest expression of positive heterosis for plant height was recorded in 2077 A x SS 020, 2077 A x 68814, 2077 A x 68716 and 2077 A x 68726. The hybrids 2219 A x FS 9601, 2219 A x FS 211 and 2219 A x FS 9401 recorded the highest negative heterosis for days to 50 per cent flowering. The highest expression of negative heterosis for days to 50 per cent flowering was observed in crosses involving in 2219A indicating the maternal effect of this particular parent.

The top ranking four hybrids for number of tillers were 296 A x 68726, 2077 A x 68726, 111 A x FS 9603 and 111 A x 68726. The hybrids 2077 A x 68814, 2077 A x 68786, 111 A x SS 003 and 111 A x 68740 recorded high heterosis for number of leaves. The maximum standard heterosis for leaf length in pooled data was recorded by 111 A x 68814, 2077 A x 68814, 2077 A x SS 020, 111 A X 68724 and 2077 A x 68710. For leaf breadth 296 A x 68918, 2077 A x 68918 and 111 A x 68786 recorded highest standard heterosis.

The hybrids 296 A x 68814 and 2077 A x 68918 recorded positive significant heterosis for leaf- stem ratio. The hybrids 2077 A x Co 27, 2077 A x 68786 and 296 A x FS 9604 recorded highest heterosis for stem thickness in pooled data over environments.

For total soluble solids 296 A x FS 9601, 111 A x FS 9605 and 2219 A x 68726 recorded highest heterosis, and the hybrids 111 A x FS 9604, 2219 A x FS 9604 and 111 A x SS 020 recorded high heterosis for crude protein. Among the different hybrid combinations 2077 A x 68726 recorded maximum of 111.41 per cent of standard heterosis for dry fodder yield followed by 2077 A x 68814 and 2077 A x 68918.

For green fodder yield per plant the top ranking four hybrids for standard heterosis were 2077 A x 68786, 2077 A x 68726, 2077 A x 68814 and 111 A x 68814. The hybrids 111 A x 68726, 111 A x 68814 were the most superior for green fodder yield per plot.

Among the eighty four hybrid combinations, 111 A x 68814 recorded highest heterosis for green fodder yield per plot in addition to positive heterosis for green fodder yield per plant, plant height and leaf length. Similarly the hybrids 2077 A x 68786, 111 A x 68724 and 111 A x SS 032 recorded significant heterosis for more than one yield contributing character in addition to that of green fodder yield per plant and per plot. Thus, heterosis for yield was reflected in the simultaneous heterosis of yield attributing traits. This was in close agreement with the findings of Nandanwankar (1990) and Reddy and Joshi (1993). In the present study, based on the *per se* performance and significant heterosis for green fodder yield per plot with high multicut habit, the above hybrids were identified as the best. Hence, they could be exploited for commercial cultivation after assessing the synchrony of flowering and stability over different environments.

Relationship between *per se*, *sca* effects and heterosis:

A comparison of hybrids for their standard heterosis and their *sca* effects indicated that there is an association between heterotic response of a cross combination and its corresponding *sca* effect. A critical appraisal of the magnitude and direction of heterosis of

the different hybrids and their *sca* effects (Table 35) for the traits under study brought out the following points.

The cross combination 111 A x FS 9605 showed high heterosis and high *sca* effects for different characters viz., plant height, high total soluble solids, crude protein, dry fodder yield, green fodder yield per plant and green fodder yield per plot followed by 2219 A x 68716 for plant height, days to 50 per cent flowering, dry fodder yield, green fodder yield per plant and green fodder yield per plot. The hybrid 111 A x SS 032 recorded high heterosis for plant height, crude protein, dry fodder yield, green fodder yield per plant and green fodder yield per plot followed by 111 A x 68814 for plant height, leaf length, dry fodder yield and green fodder yield per plant. These two hybrids also recorded high *sca* effects for the characters noted above.

Thus there was a close correspondence between high heterosis and *sca* effects in the above hybrids. *Sca* effects represented dominance and epistatic interaction, which could be related with heterotic vigour in sorghum. Similar views were also expressed by Sankara pandian *et al.* (1994).

Instances were also found in which hybrids with significantly negative or non-significant *sca* effect displayed conspicuous heterosis over standard check variety as in the cross combination 111 A x 68726 for plant height, number of tillers, number of leaves, hydrocyanic acid, dry fodder yield and green fodder yield per plant or by 2077 A x 68814 for leaf length, leaf breadth, stem thickness, low hydrocyanic acid and green fodder yield per plot. Similarly 2077 A x 68726, recorded positive heterosis for green fodder yield per plot but its *sca* effect was negative for the characters.

Such results might be attributed to the poor performance of parents in comparison with their hybrids. Even when the mean performance of the parents was higher and the amount of heterosis was the same, the *sca* effects may be lower as reported by Sankara pandian *et al.* (1994).

Hence, the best crosses selected on the basis of *per se* performance, *sca* effects and standard heterosis put together may be very useful, rather than selection based on individual parameters. So the evaluation of the hybrids based on all the parameters was done based on scores assigned for the significance of each characters as presented in Table 35. The hybrid 111A x FS 9605 showed highest total score (pooled score of *per se*, *sca* and standard heterosis) of 21 followed by 2077A x 68814 (18) and 2219A x 68716 (17). These hybrids have recorded high *per se*, *sca* and standard heterosis for most of the characters and they can be considered as the best hybrids as they recorded significant values for all the yield contributing characters. Though they recorded significant nature for all the traits, while considering green fodder yield per plot as the main criterion they were ranked as eighth, eighteenth and fifth respectively. Hence, three other hybrids viz., 111A x 68726, 111A x 68724 and 111A x SS032 were selected as the best with the total score of fourteen, seven and eleven respectively. The low score of these genotypes could be due to the negative significant effect of the other yield contributing characters but it would be compensated by the high performance of yield itself.

Selection based on the *per se*, *sca* effects and standard heterosis in relation to their parental status can also give some idea about the nature of gene action involved in the cross and to develop an appropriate breeding methodology for developing such hybrids as it was evident that high x high general combiners produced hybrids with high *per se* performance with significant *sca* effects and substantial heterosis. This was observed in the crosses of 111A x 68814 and 111 A x 68724 for green fodder yield per plant and per plot.

The hybrids that recorded positive heterosis, high *per se* and *sca* effects for green fodder yield per plot were 111 A x FS 9605 and 111 A x 68726 while 2077 A x 68726, 2077A x 68786, 2077 A x 68814 recorded high *per se*, *sca* effects and heterosis for green fodder yield per plant. This nature of hybridity indicates the importance of additive x additive gene action, which could be exploited to derive recombinant homozygous lines through standard selection procedures.

The hybrids 111 A x 68726 and 111 A x 68786 for crude protein and 111 A x FS9604 for low HCN content, showed high *per se* performance and significant *sca* effects with desirable heterosis but with low general combiners, indicating dominance x dominance (epistatic) type of gene action and the above said crosses for the above characters could also be utilized in the production of high yielding homozygous lines as viewed by Reddy and Joshi (1993) and Sankarapandian *et al.* (1994) because of the non availability of optimum level of different attributes in any of the parents.

The high x low or low x high crosses with top ranks for green fodder yield per plant as the major criteria 111A x SS 032, 111 A x FS 9605, 2219 A x 68716 also recorded higher heterosis and *sca* effects followed by 111 A x FS 9605, 2219 A x 68716, 2077 A x 68740 and 111 A x FS 9604 for dry fodder yield. The hybrids 2077 A x 68786, 2077 A x 68726, 2077 A x 68814, 111 A x SS 032, 2219 A x 68716 and 111 A x FS 9604 recorded high heterosis for green fodder yield per plot. The above crosses were of great interest, as such combinations could result in desirable transgressive segregants as additive effect of one parent and complementary epistatic effect of the other parent act in the same direction for maximum expression of plant attributes under selection (Fasoulas, 1980 and Sankarapandian *et al.*, 1994).

In conclusion on the basis of *per se* performance, *sca* effects and heterosis, five hybrids viz., 111A x 68814, 111 A x 68724, 2077 A x 68814, 111 A x FS 9605 and 2219 A x 68716 could be acclaimed as the best hybrids for green fodder yield per plant and green fodder per plot and for more than six other yield contributing characters. However, where green fodder yield per plot is the main concern, 111 A x 68726 exceeded all the other hybrids and it could be used for further direct exploitation.

Correlation and path analysis:

Correlation provides information on the nature and extent of relationships among characters. Selection for yield will be effective when it is based on its contributing components rather than relying on yield alone (Grafius, 1960). When the selection pressure is applied for a trait, the population being improved for that trait also gets improved in respect of all the other characters associated with it. Thus, a correlation study facilitates simultaneous improvement of two or more characters. Knowledge of the relationship among yield components is essential for the formulation of breeding programmes aimed at achieving the desired combinations of various components of yield.

The estimates of correlation coefficients among the different characters indicate the extent of direction of association. The correlation coefficients provide a reliable measure of association among the characters and help to differentiate vital associations useful in breeding from those of the non-vital ones (Falconer, 1981).

In the present investigation, correlation co-efficients were worked out between fourteen characters for each cut (environment) and also for the pooled data. In pooled data over environments, all the characters except hydrocyanic acid, total soluble solids and crude protein had positive significant association with green fodder yield per plant. Hence, selection for these characters will help in selecting genotypes with high green fodder yield per plant. A strong correlation with yield indicated that simultaneous improvement of both the characters is possible.

Hussain and Khan (1973) reported a positive correlation of fodder yield with tiller number, plant height and leaf number. Sood and Ahluwalia (1989) reported a positive correlation of green fodder yield with leaf breadth and number of leaves per plant. Manickam and Vijendradas (1995) reported positive association of plant height, number of tillers, number of leaves, leaf area per plant, dry matter yield and crude protein with green fodder yield per plant.

Total soluble solids recorded a negative significant correlation with green fodder yield. This was in close agreement with Jeyamani (1991) while Sun *et al.* (1996) reported that grain yield of the hybrids is negatively correlated with sugar content. Hydrocyanic acid and crude protein recorded non-significant association with green fodder yield per plant. However, the crude protein had significant positive association with green fodder yield in E₁ (first cut).

Regarding inter correlations between different characters, plant height had positive correlation with leaf length, dry fodder yield and number of leaves. Number of tillers had positive association with leaf length and dry fodder yield. Leaf length had highest positive association with dry fodder yield and green fodder yield per plant. Dry fodder yield had positive association with green fodder yield per plot.

Path analysis partitions the total correlation coefficient into direct and indirect effects and measures the relative importance of the causal factor individually (Dewey and Lu, 1959). In the present study, green fodder yield was considered as dependent character and other characters were taken as independent characters. The component of residual effect of path analysis in the pooled data was 0.228. The lower residual effect indicated that the characters chosen for path analysis were adequate and appropriate. Plant height contributed maximum direct effect to green fodder yield per plant followed by leaf breadth and leaf-stem ratio. Number of tillers and stem thickness also exerted positive direct effect on green fodder yield. The characters leaf length, number of leaves and hydrocyanic acid had a negative influence on green fodder yield. Among these the direction of hydrocyanic acid is a desirable one ,

The indirect positive effect of leaf length and dry fodder yield via plant height was maximum followed by that through number of leaves and number of tillers. The highest negative indirect effect on green fodder yield was recorded by for leaf- stem ratio via plant height. Hence, selection for either one of the components will have an adverse effect on the other and lead to decrease in yield. Stem thickness had negative indirect effect via number of leaves on green fodder yield, while it had positive indirect effect through leaf breadth.

The direct and indirect effects of number of tillers, plant height and number of leaves were positive. Thus improvement of any of these traits would simultaneously improve green fodder yield per plant because of correlated response of yield by applying strong selection on these traits.

Stability analysis:

Breeders usually evaluate a number of genotypes in different locations and years in order to select the genotypes with high stability for yield. But, the significant Genotype x Environment (G x E) interaction often complicate the breeders work, because the yield is not predictable on the basis of simple genotype and environment means. Moreover, ranking of genotypes differs from one environment to another.

Becker and Leon (1988) indicated the basic cause of differences between genotypes in their yield stability to the wide occurrence of Genotype x Environment interactions. To assess the nature, magnitude and extent of Genotype x Environment interactions, the analysis of variance and joint regression methods were proposed first by Yates and Cochran (1938), and modified later by Finlay and Wilkinson (1963) and further improved by Eberhart and Russel (1966). The model proposed by Eberhart and Russell was later modified by Perkins and Jinks (1968) and Freeman and Perkins (1971). Allard and Bradshaw (1964) suggested that a breeder should aim to produce varieties that are adopted to withstand unpredictable transient environmental variations, since these well buffered varieties can adjust their life processes to maintain productivity at high level despite unpredictable fluctuations of the environments. Lin and Binns (1988) stated that the environmental effect on genotype depends on soil and weather.

In the present study, twenty-five parents and eighty-four hybrids of forage sorghum were raised during January 2000. The crop was harvested at 50 per cent flowering and the same was allowed for its regrowth and the second harvest was taken at 50 per cent flowering and the crop was allowed for subsequent growth to study its ratooning ability. In total, a maximum of four harvests were taken and since each harvest had a different growing season

each cut was taken as an individual environment. Thus stability analysis was carried out to assess the average responsiveness of parents and hybrids over four different environments (cuts) and also to find out the yield distribution pattern in each environment.

Based on the significance of Genotype x Environment interaction, the stability parameter S^2_{di} and parameter of response b_i were worked out for seven selected characters viz, plant height, days to 50 per cent flowering, number of tillers, crude protein, dry fodder yield, green fodder yield per plant and green fodder yield per plot using Eberhart and Russel's model (1966). Pooled analysis of variance showed highly significant differences among genotypes (G) for all the seven characters, and significant differences among the environments (E) for all the characters when tested against G x E, indicating the presence of genetic variability among the genotypes in the broad spectrum of environments.

The G x E interaction was highly significant for all the characters when tested against pooled error, satisfying the requirement of stability analysis (Eberhart and Russel, 1966) and also indicating considerable interaction of the genotypes with environments exhibiting a different phenotypic expression (Sood and Saini, 1989).

The two variance components of G x E interaction viz., G x E (linear) and pooled deviation when tested against pooled error, were highly significant for all the seven characters indicating significant differences among the genotypes in their linear response to environments (b values) and non-linear response to environments (Young and Virmani, 1990); thus, both predictable (linear) and non - predictable (non-linear) components contributed significantly to the differences in stability among the genotypes (Sastry *et al.*, 1989). However the ratio of non-linear to linear component of variance for different characters showed that a major portion of contribution was of linear type except for green fodder yield per plant where non-linearity exceeded, the linear component. E (linear) component was highly significant for all the characters. The high magnitude of E (linear) effect in comparison to G x E (linear) for all the characters suggested the existence of considerable differences among environments and their predominant effects on these traits.

Highly significant differences among the genotypes for all the characters when tested against pooled deviation indicated that the genotypes differed widely among themselves. The $G \times E$ (linear) was highly significant against pooled error, but not significant against pooled deviation, whereas pooled deviation was highly significant against pooled error, suggesting the predominant role of non-linear component as compared to linear component (Sood and Saini, 1989) for all the characters.

The magnitude of genotypic variance (σ^2_g) was more than that of $G \times E$ variance (σ^2_{gn}) for all the traits except days to 50 per cent flowering and dry fodder yield. Higher magnitude of genotypic variance indicated the predominance of genetic variability among the genotypes than their interaction with environmental conditions.

The environmental indices for the seven characters indicated that E_1 had a high negative effect on days to 50 per cent flowering and green fodder yield per plant and E_2 had a negative effect on plant height, green fodder yield per plant. E_3 had a positive influence on days to 50 per cent flowering and green fodder yield per plant. E_4 was almost similar to that of E_1 .

Relationship between mean performance and stability parameters:

A number of methods are available for assessing the stability of performance of different crop varieties. Lewis (1955) measured the phenotypic stability in terms of a stability factor based on mean performance in the highest yielding environment with that in the lowest yielding environment. Finlay and Wilkinson (1963) used linear regression as a quantitative measure of phenotypic stability to describe varietal adaptability on a range of environments. The absolute phenotypic stability of a genotype was expressed by $b=1$, and an ideally adopted genotype was said to be the one having maximum yield potential in the most favourable environment and also maximum phenotypic stability. Ebberhart and Russel (1966) suggested that both linear (b_i) and non-linear (S^2_{di}) components of the genotype environment interaction should be considered in judging the phenotypic stability of a

particular genotype. Thus a genotype with high mean ($\bar{x}$), unit regression coefficient ($b_i=1$) and least deviation from regression ($S^2_{di}=0$) is considered as an ideal, widely adapted and stable genotype. Paroda and Hays (1971) and Jatasra and Paroda (1980) emphasized that linear regression could simply be regarded as a measure of response of a particular genotype whereas the deviation around the regression (S^2_{di}) as the most suitable measure of stability and genotypes with least deviation around the regression line being the most stable and vice versa.

A simultaneous consideration of the three parameters (mean, b_i and S^2_{di}) of the individual genotypes for the characters (Table 79) plant height revealed that five hybrids viz., 2077 A x 68740, 2077 A x 68814, 2077 A x SRV 605, 2077 A x FS 9601 and 111 A x 68726 were having high mean values with either low average or high responsiveness.

Among the parents 2077 A and SS 020 had low mean values for days to 50 per cent flowering with high and low responsiveness respectively. Among the hybrids 2219 A x 68716, 2219 A x FS 9605, 2219 A x Co 27 and 111 A x FS 9601 had high mean, with high responsiveness in addition to the higher stability. 2219 A x FS 9603 recorded average responsiveness but had high mean and high stability for days to 50 per cent flowering. A high response is indicative of adaptability to high input environment (favourable environment). For number of tillers only one hybrid viz., 111 A x FS 9603 recorded higher mean value and had high responsiveness and high stability.

The hybrids 2077 A x 68716, 2077 A x 68724 and 111 A x SS 032 were found to record high mean values and high responsiveness for dry fodder yield in addition to high stability. For green fodder yield per plot 2219 A x 68786 followed by 111 A x FS 9401 recorded high mean and average responsiveness with high stability. 111 A x Co 27 recorded high mean with high responsiveness to the environment with high stability.

For crude protein, thirteen hybrids recorded high mean with high stability and all the hybrids had recorded average responsiveness except two viz., 2219 A x SS 012 and 2077 A x

Table 36. Stable genotypes with high mean and non significant s^2_{d1} value for different characters

Characters	Genotypes
Plant height	2077A x 68740, 2077A x 68814, 2077A x SRV605, 2077A x FS9601 and 111A x 68726
Days to 50 per cent flowering	2077A/B, SS020, 2219A x 68716, 2219A x FS9605, 2219A x FS9603, 2219A x CO27 and 111A x FS9601
Number of tillers	111A x FS9603
Crude protein	296A x 68814, 296A x FS9401, 2219A x 68740, 2219A x 68814, 2219A x FS9401, 2219A x SS012, 2077A/B and 2077A x 68740
Dry fodder yield	2077A x 68716, 2077A x 68724 and 111A x SS032
Green fodder yield/plot	2219A x 68786, 111A x CO27 and 111A x FS9401

FS 9605 where the response was very low and hence they will be suitable for poor environment.

Relationship between the R^2 and stability:

R^2 is referred as the squared correlation between residuals from the main effects and the site index. Higher the R^2 value indirectly indicates an increase in the stability of the concerned genotype and it is also considered as one of the stability parameters for assessing the adaptiveness of the genotypes (Gauch, 1992). In the present study the genotypes that recorded higher stability with higher mean and high responsiveness for most of the traits had R^2 values more than 0.995. However, the hybrids 2077 A x 68814 (0.208) for plant height and 2077 A x 68724 (0.786) for dry fodder yield had recorded lower R^2 values indicating that even though they had higher responsiveness, the interaction was more which resulted in the genotypes becoming unstable. Hence R^2 values also have to be considered while determining the stability. For green fodder yield per plant most of the genotypes had recorded low stability. Since, the genotype x environment (linear) component was found non-significant when tested against pooled deviation indicating the preponderance of non-linear component the prediction for responsiveness to environments for most of the genotypes is difficult for green fodder yield per plant. Manivannan (1999) also reported similar results in Blackgram.

Correlation between mean performance and stability parameters:

Significant positive correlations were observed between the mean values and b_i for all the characters except plant height. The positive relationship between the means and b_i implied that selection for increased values of the said characters would simultaneously increase the b_i values. Finlay and Wilkinson (1963), Eberhant and Russel (1966) and Meenakshi Ganesan (1998) also reported positive correlation between the mean values and b_i for grain yield, where as Gama and Hallauer (1980) suggested that selection based on yield would not enhance stability for yield. Becker (1981) reported that different stability parameters are closely related to each other in a wide range of crop species.

The results also showed that high yielding hybrids brought about genetic improvement, but tended to show higher non-linear response to environments and thus low stability, as indicated by the significant positive correlation between the mean values and S^2_{di} for all the characters except plant height and crude protein.

Significant positive correlation between b_i and S^2_{di} for number of tillers, green fodder yield per plant and green fodder yield per plot implied that by increasing the responsiveness of hybrids to environmental changes would also result in instability of their performance. Thus, these genotypes would be useful for specific adaptability and to overcome the problem of potential genetic vulnerability associated with general adaptability.

Significant positive correlation between all the three parameters for number of tillers, green fodder yield per plant and green fodder yield per plot revealed that selection for higher mean values for these traits would simultaneously increase the b_i and S^2_{di} values, thereby resulting in low stability, this means that selection based on mean values would not enhance stability for these traits, and the resultant hybrids would be useful for specific environments.

Stability analysis II:

In the present study, in continuation of the stability analysis, the 16 hybrids that performed well upto five cuts were selected and stability analysis was again carried out to identify the most superior ones..

Pooled analysis of variance showed almost the same results except that for days to 50 per cent flowering the $G \times E$ (linear) component when tested against pooled deviation recorded a significant difference indicating that among these sixteen genotypes, the linear component was predominant than the non-linear component. Regarding the magnitude of variance, only dry fodder yield recorded more of $G \times E$ interaction while in the previous stability analysis days to 50 per cent flowering and dry fodder yield have both recorded higher amount of $G \times E$ interaction. It indicated that both number of genotypes and number of environments had direct influence on the estimation of genotypic and genotype x environment variance.

The environmental indices for the seven characters showed that environment 5 had negative effect on all these characters indicating probably low fertility gradient of the environment. Among the different environments E_3 had maximum effect on dry fodder yield, green fodder yield per plant and green fodder yield per plot. Environment 4 had favourable effect for plant height. As far as days to 50 per cent flowering was concerned E_4 had favourable negative effect.

Relationship between mean performance and stability parameters:

In general, none of the hybrids recorded higher stability for all the characters in consideration coupled with high mean and average responsiveness. However, taking green fodder yield per plot as the main criteria, 111 A x 68724 had recorded high mean with high responsiveness and high stability.

For plant height and days to 50 per cent flowering 2219 A x 68726 recorded high mean with average responsiveness. The hybrid 111 A x 68726 recorded high mean and average responsiveness for number of tillers followed by 2219 A x FS 205 for dry fodder yield with high responsiveness. 2219A x 68724 recorded high mean with average responsiveness for crude protein. Hence these hybrids could be useful for the specific traits in the concerned environments. For green fodder yield per plant 111A x FS9601 had recorded fairly high yield with highest stability. However it had a high b_i value. For green fodder yield per plot, 111A x Co 27 was the most superior for stability with more than average yield.

Correlation between mean performance and stability parameters:

Significant positive correlations were observed between the mean values and b_i for days to 50 per cent flowering number of tillers, green fodder yield per plant and green fodder yield per plot indicating that higher fodder yield would increase the b_i values. The significant positive correlation between mean and S^2_{di} for plant height, days to 50 per cent flowering, dry fodder yield and green fodder yield indicated that high yielding genotypes showed higher non-linear response to environments and thus low stability. Significant

positive correlation between b_i and S^2_{di} for green fodder yield per plant indicated that increasing the responsiveness of hybrids to the environmental changes would also result in instability of their performance. Such genotypes would be useful for specific adaptability.

Additive Main effects and Multiplicative Interaction model:

The main causes of non-linearity may be due to various genetical, physiological or other causes. An important factor leading to non linear interaction seems to be presence of yield thresholds in which each genotype has an upper limit of its performance, beyond which further improvement in the environment will evoke no further response. A second cause of non linear interaction would be the presence of "environment specific genes" in the genotypes and it can be envisaged that response in contrasting environments are controlled by distinct set of genes. A third factor may be due to the presence of large non-allelic gene interactions (Prabhakaran and Jain, 1992). Hence, another statistical method called additive main effects and multiplicative interaction effects (AMMI) developed by Zobel *et al.* (1988) was attempted and the genotypes were grouped for their average responses.

AMMI combines ANOVA and principle component analysis (PCA) into a single analysis with both additive and multiplicative parameters. First, the additive part of the AMMI model uses ordinary ANOVA. The grand mean μ is estimated by $\bar{Y}$, the genotype deviation from the grand mean α_g by $Y_g - \bar{Y}$ and the environment deviation β_e by $Y_e - \bar{Y}$. ANOVA leaves a non-additive residual, the interaction. Second, the multiplicative part of the AMMI model uses PCA to differentiate the interaction into PCA axes 1 to N, and a residual, called as interaction PCA scores (IPCA). The member of the AMMI family with 1 IPCA axis (while relegating all higher axes to the residual) is denoted AMMI 1, while AMMI 2 retains IPCA axes, and so on. In general, AMMI N denotes the AMMI model with IPCA axes 1 to N. AMMI 0 has no IPCA axes and is identically ANOVA. The full model with minimum (G-1, E-1) IPCA axes, is denoted AMMI F and equals the treatment means model. AMMI has advantages over Eberhart and Russel's model and fit data more closely by changing the competition between environment and replication and it recovers more of the interaction sum of squares than does linear regression (Gauch, 1992).

Analysis of variance of AMMI for green fodder yield per plant and green fodder yield per plot was highly significant for genotype x environment interaction indicating the importance of interaction. Most of the treatment sum of squares were accounted by the first IPCA axis (84.48 per cent for green fodder yield per plant and 9.04 per cent for green fodder yield per plot) followed by IPCA 2 axis (10.08 per cent for green fodder yield per plant and 6.34 per cent for green fodder yield per plot). The percentage of the treatment sum of squares accounted by an AMMI 1 biplot is a useful statistic for assessing the overall goodness of fit of the AMMI model 1. The AMMI 1 model left a residual sum of squares of 992223 from green fodder yield per plant and 1322.064 for green fodder yield per plot which, implied a root mean square residual of 54.34 g per plant and 1.98 kg per plot or 13.71 and 16.03 per cent of grand mean.

The root mean square (RMS) residual is also a useful summary statistic regarding the model fit. It is equal to the square root of the quantity of the residual sum of squares divided by the number of observations (namely, GER). This quantity is a simple arithmetic average of the residuals, except that the RMS places somewhat more weight on the larger residuals and hence is somewhat larger. Obviously, the higher order AMMI models, having more parameters can fit the data more closely. In the present study AMMI 2 model fitted closely leaving only 32.19 g per plant and 1.19 kg per plot or 8.12 and 9.60 per cent of RMS and accounting for 94.56 and 96.38 per cent of treatment sum of squares respectively.

AMMI biplot 1 has a clear agricultural interpretation (Zobel *et al.*, 1988) and tremendously informative, showing both main and interaction effects for both genotypes and environments. Nevertheless, sometimes, there is interest in more than just the first IPCA axis, accordingly AMMI biplot 2 is also taken into account. Unlike, the preceeding AMMI biplot1, the biplot 2 does not show the additive main effects; but by showing two IPCA axes, it accounts 81.57 per cent for green fodder yield per plant and 81.38 per cent for green fodder yield per plot of the interaction (compared with 47.32 per cent for green fodder yield per plant and 48.50 per cent for green fodder yield per plot by AMMI 1).

When IPCA 2 is large and significant, such a graph is a useful supplement to the usual biplot. Kempton (1984) gives interpretive principles for the IPCA 1 and IPCA 2 biplot graph. Basically, points near the origin have little interaction (fit well by the additive sub model), and points near each other have similar interaction patterns while points distant from each other are different. But care should be taken for selecting genotypes based on biplot 2 because interactions rather than yield were analyzed here and IPCA 2 does not have any apparent agriculture meaning. Hence, a combination of both AMMI 1 and AMMI 2 biplot has to be interpreted.

In the present study based on AMMI biplot 1, 2077 A x FS 9401, 2077 A x SS003, 2077 A x FS 9603, 111 A x FS 9601 and 2077 A x 9604 were found to be above average and nearer the abscissa axis and did not differ for both main and interaction effects for green fodder yield per plant. 111 A x 68786 and 111 A x 68724, 2077 A x 68710 and 111 A x SS032 were found to have higher mean and differed only for main effects from the above group of genotypes. AMMI biplot 2 indicated that none of the above hybrids fell in the vicinity of zero indicating that these genotypes were highly interacting with each environment. Hence, prediction of performance in each environment is not possible. AMMI biplot 2 indicated that there were more of outliers (in the sense of poor fit for their average performance). However genotypes suitable for specific environments can be predicted. For example 111 A x 68724 and 2077 A x 68710 which were nearer to the environment 3 (3rd cut) indicated that among the total green fodder yield per plant (total of four cuts), the green fodder yield per plant distribution was maximum in third cut (3rd environment) for these genotypes.

AMMI biplot 1 for green fodder yield per plot indicated that 296 A x FS 211, 2219 A x FS 9601, 2077 A x FS 9601, 296 A x Co27 and 2219 A x FS 211 did not differ for their main effect as well as interaction effect and had average mean and average performance. 111A x FS 211, 111 A x Co 27, 2219 A x 68786, 2077 A x 68814, 2219 A x Co 27 and 2219A x Co 27 recorded high mean and low interactions and they differed from the earlier

group in their main effects. AMMI 2 biplot depicted that 111 A x FS 211, 2219 A x 68786 and 111 A x Co 27 recorded low interaction and fell in the vicinity of zero. Based on the over all performance (AMMI 1 and AMMI 2), 111 A x FS 211, 2219 A x 68786 and 111 A x Co 27 could be selected as the best hybrids for their average performance in each cut for green fodder yield per plot.

AMMI analysis II:

The sixteen hybrids that performed well upto five cuts were taken separately and subjected to AMMI analysis. Analysis of variance for both the characters indicated that there were highly significant differences for genotype x environment interaction. Here also most of the treatment sum of square were accounted by the first IPCA axis (90.80 per cent for green fodder yield per plant and 93.49 per cent for green fodder yield per plot) followed by IPCA 2 axis (5.73 per cent for green fodder yield per plant and 3.35 per cent for green fodder yield per plot).

The AMMI 1 model left a residual sum of squares of 178318.4 for green fodder yield per plant and 268.92 for green fodder yield per plot which implied a root mean square residual of 40.82 g per plant and 1.83 kg per plot or 11.28 and 14.18 per cent of grand mean. The percentage of treatment sum of squares accounted by AMMI 1 and 2 and their respective residual mean squares indicated that AMMI 2 model fitted more closely by leaving only 29 g per plant and 1.28 kg per plot or 8.02 and 9.91 per cent of RMS and accounting 96.53 per cent and 96.84 per cent of treatment sum of squares respectively.

Regarding the IPCA axis 1 and 2, IPCA 2 captures 81.93 per cent for green fodder yield per plant and 76.83 per cent for green fodder yield per plot of the interaction (compared with 52.14 and 52.33 per cent respectively in AMMI 1). Hence both AMMI 1 and AMMI 2 biplot have to be taken into account.

Based on AMMI 1 biplot for green fodder yield per plant, 111 A x 68724 and 2077A X 68724 recorded high mean and low interaction. AMMI 2 indicated that only 111 A x

68724 was recording low interaction and hence, it could be selected as the stable genotype across environments. Regarding green fodder yield per plot, AMMI 1 showed that 2219A x SS003, 111 A x SS020, 111 A x FS 9401 and 2219 A x FS 9401 recorded below average performance and differed from 111 A x 68814 whose mean performance was high but AMMI 2 indicated that 2219 A x FS9401, 111A x FS 9401 and 2219A x SS003 were the low interacting genotypes. 111 A x 68814 was found to have high interaction with environments. On comparison of both biplots, by sacrificing the high yielding genotype (because of poor adaptability), 2219 A x FS 9401, 2219 A x SS003 and 111 A x FS 9401 could be selected as the stable genotypes with average yield (at the maximum of five cuts) through out the year.

On comparison of both the linear regression and AMMI model in total, it was evident that 2219 A x 68786, 111 A x Co 27 and 111A x FS 9401 could be regarded as the most stable genotypes for green fodder yield with average performance throughout the year. From this study it showed that high yielding genotypes would not necessarily be the best adopted one and that is why for selecting the best adopted genotypes we should seek more than one stability model.

Summary

SUMMARY

The present study on Sorghum (*Sorghum bicolor* (L.) Moench) was undertaken to develop hybrids with multicut habit having multitillering nature and perennially. As the first part of biometric study, attempts were made with a view to assess the performance of certain selected genotypes, their F_1 s to estimate the extent of heterosis for green fodder yield and its component traits and to determine the combining ability of parents. In addition, the study was also aimed to understand the genetic architecture of green fodder yield and other related biometric traits that will help to identify suitable breeding methodology for attempting rapid crop improvement. Association of characters that are correlated to green fodder yield at the genotypic level was also worked out and direct and indirect effects of different metric traits in determining the green fodder yield was also computed.

In the second part, stability analyses were carried out to select the stable genotypes that performed well in all the four cuts with average response in each environment. In addition to the stability analysis, the hybrids that performed well upto five cuts were also separately subjected to stability analysis to identify the most superior ones.

Four cytoplasmic male sterile lines were crossed with twenty-one selected restorers in a Line x Tester fashion. The hybrids were evaluated for their multicut habit from January 2000 for eleven quantitative traits viz., days to 50 per cent flowering, plant height, number of tillers, number of leaves, leaf length, leaf breadth, stem thickness, leaf stem ratio, dry fodder yield, green fodder yield per plant and green fodder yield per plot. Three quality parameters viz., total soluble solids, hydrocyanic acid and crude protein content were also estimated.

The results obtained are summarized here under.

1. The selected parental genotypes were highly significant indicating sufficient variability among genotypes and the testers were highly divergent from lines and the interaction variances for parents, hybrids and environment were also significant indicating the presence of sufficient environmental interaction for the component characters. The

variations in hybrids were contributed more by lines for all the characters except leaf length and number of tillers for which the tester contribution was more. Highly significant nature of line x tester variance indicated that specific cross combinations were differentially superior over others i.e. the lines did not appear to behave consistently over different testers and vice versa. Differences among lines with respect of such contribution were significant.

2. The *GCA* variance was greater in magnitude than *SCA* variance for all the traits except number of tillers, crude protein and green fodder yield per plot indicating the preponderance of additive gene action. Among the different parents studied 111A, 2077A, 68726, 68786, SS032 and 68814 might be utilized as potential parents since they possessed high *per se* with significant *gca* effects for most of the traits.
3. Crosses, which recorded high *per se* performance also, registered high *sca* effects in general. The *sca* effects were very high for seven hybrids viz., 111 A x FS 9605, 2219 A x 68716, 111 A x FS 9604, 2077 A x 68814, 111 A x SS 032, 111 A x 68814 and 111 A x 68724 for green fodder yield per plant and green fodder yield per plot. By and large the study indicated that crossing of good general combiners does not necessarily result in best cross combinations. On the basis of *per se* performance, *sca* effects and heterosis put together, seven hybrids viz., 111 A x 68726, 111 A x 68724, 111 A x 68814, 2077 A x 68814, 111 A x SS 032, 111 A x FS 9605 and 2219 A x 68716 were identified as the best crosses for most of the economic traits besides their higher performance for green fodder yield and could be used for further exploitation.
4. Association study indicated that all the traits were positively correlated with green fodder yield per plant. Among these traits dry fodder yield exhibited high correlation (0.953) coefficient with green fodder yield per plant followed by leaf length, plant height and number of leaves. Plant height exerted the highest direct effect on green fodder yield followed by leaf length and breadth and leaf stem ratio. Hence selection for any of these traits might result in simultaneous improvement in the yield. The results of the correlation

and path analysis indicated that due importance should be given for plant height because of its significant correlation and high direct effect, apart from its high indirect effect through dry fodder yield.

5. Analysis of variance for stability indicated that both predictable (linear) and non-predictable (non-linear) components contributed towards significant differences in stability among the genotypes for all the characters. The ratio of non-linear to linear component of variance for different characters showed that a major portion of contribution was of linear type except for green fodder yield per plant where non-linearity exceeded the linear component. The magnitude of genotypic variance (σ^2_g) was more than that of $G \times E$ variance (σ^2_{gn}) for all the traits except days to 50 per cent flowering and dry fodder yield indicating the predominance of genetic variability among genotypes than their interaction.
6. The environmental indices for the seven selected characters indicated that E_1 had a high negative effect on days to 50 per cent flowering and green fodder yield per plant and E_2 had a negative effect on plant height and green fodder yield per plant. E_3 had a positive influence on days to 50 per cent flowering and green fodder yield per plant and E_4 was almost similar to that of E_1 .
7. A simultaneous consideration of the three parameters (mean, b_i and S^2_{di}) indicated that the hybrids 2219 A x 68786 and 111 A x FS 9401 were the best with high mean, average responsiveness and high stability for green fodder yield per plot. 111A x Co 27 recorded high mean and high responsiveness to the environment with high stability. Significant positive correlation between mean and b_i , mean vs S^2_{di} and b_i vs S^2_{di} for number of tillers, green fodder yield per plant and green fodder yield per plot revealed that selection for higher mean values for these traits would simultaneously increase the b_i and S^2_{di} values, thereby resulting in low stability.

8. Out of the 84 hybrids tested, sixteen were identified as the most persistent and suitable for upto five harvests. In the stability analysis II, regarding the magnitude of variance, only dry fodder yield recorded more of G x E interaction while in the previous stability analysis days to 50 per cent and dry fodder yield have both recorded higher amount of G x E interaction. It indicated that number of genotypes and number of environments both had direct influence on the estimation of genetic and genotypic x environment variance. Relationship between mean performance and stability parameters indicated that none of the hybrids recorded higher stability for all the characters. However, taking green fodder yield per plot as the main criteria 111 A x 68724 had recorded high mean with high responsiveness and high stability.
9. AMMI analysis indicated that both IPCA 1 and IPCA 2 have to be taken into account for determining the stability of genotypes because of high interaction. AMMI analysis I indicated that 111 A x FS 211, 2219 A x 68786 and 111 A x Co 27 could be selected as the best hybrids for their average performance in each cut for green fodder yield per plot. AMMI analysis II indicated that by sacrificing the high yielding genotypes (111 A x 68814 and 111 A x 68724 because of poor adaptability as indicated by AMMI biplot 2) 2219 A x FS 9401, 2219 A x SS 003 and 111 A x FS 9401 could be selected among the 16 hybrids as the most stable genotypes with average yield (at the maximum of five cuts) throughout the year.
10. On comparison of both the linear regression model and the AMMI model, it was evident that 2219 A x 68786, 111A x Co 27 and 111A x FS9401 could be acclaimed as the most stable genotypes with average yield performance throughout the year.

References

REFERENCES

- Alam, S., and P.C. Sandal. 1967. Inheritance of cytoplasmic male-sterility in Sudangrass. **Crop Sci.**, 7: 668-669.
- Allard, R.W. 1960. **Principles of plant breeding**, John Wiley and Sons, Inc. New York.
- Allard, R.W. and A.D. Bradshaw. 1964. Implication of genotype environmental interactions in applied Plant Breeding. **Crop Sci.**, 4: 503-508.
- Anita, N. and M. Stephen Dorairaj. 1990. *Per se* performance of parents and hybrids in sesame. **Madras Agric. J.**, 77: 401-405.
- Antohe, I., I. Draghici, M. Negriila, O. Vasile, M., Mladin, V., Heban, D., Vlaiescu and D. Tancu. 1994. New Sorghum x Sudangrass hybrids for green matter and silage. *Analele - Institutului - de - Cercetari - oebtree - cereals - si - plante - tehnice - Fundulea*. 61: 65-82.
- AOAC, 1970. Official methods of analysis (11th ed.). Association of Agricultural chemists, Washington, D.C.
- Badhe, P.L. and H.S. Patil. 1997. Line x tester analysis in sorghum. **Ann. Agric. Res.** 18(3): 281-284.
- Bakhert, B.R. 1990 a. Variability and correlations in grain sorghum genotypes under drought conditions at different stages of growth. **J. Agron. Crop Sci.** 164 (5): 355-360.
- Bakhert, B.R. 1990 b. Performance, phenotypic and genotypic stability for green fodder and leafiness in sorghum under different nitrogen fertilization levels. **Assiut. J. Agrl. Sci.** 21 (1): 65-77.
- Bangarwa, K.S., R.P.S., Grewal, G.P., Lodhi, and N.K. Thakral. 1989. Association analysis for some quantitative traits in forage sorghum. **Indian J. Hered.**, 20(1-2): 25-28.
- Basnayaka, J.M. Cooper, M.M. Lud low and R.G. Henzell. 1994. Combining ability for osmotic adjustment among a selected range of grain sorghum lines. **Field crops Res.**, 38 (3): 147-155.

- Basu, A.K., S.S. Narayanan and N.G. Bhat. 1995. Hybrid cottons: Historical development, present status and future perspectives in Indian context. In: **Hybrid research and development eds.:** M.Rai and S. Mauria. Indian Society of Seed Technology, pp: 63-80.
- Bazzocchi, R., C. Moretti and S. Conti. 1997. Study on combining ability of broomcorn lines and grain sorghum male sterile lines for the development of fibre sorghum hybrids. **Sementi-Elette**, **43 (6):** 13-20.
- Becker, H.C. and I. Leon. 1988. Stability analysis in plant breeding. **Plant Breed.**, **101:** 1-23.
- Becker, H.C. 1981. Correlations among some statistical measures of phenotypic stability, **Euphytica**, **30:** 835-840.
- Bhadouriya, N.S. and M.K. Saxena. 1997. Combining ability studies in sorghum through diallel analysis. **Crop Res. (Hissar)**, **14(2):** 253-256.
- Bhagmal and U.S. Mishra. 1985 a. Transgressive segregation in the three way cross F_2 in forage sorghum. **Sorghum Newsl.**, **28:** 7-8.
- Bhagmal and U.S. Mishra. 1985 b. Hybrid vigour for culm and leaf characters in forage sorghum. **Sorghum Newsl.**, **28:** 6-7.
- Boora, K.S. and G.P. Lodhi. 1981. Combining ability analysis in forage sorghum. **Forage Res.**, **7:** 19-25.
- Boyd, F.T., O.S. Aamodt, G. Bebstedt and E. Truog. 1938. Sudangrass management for control of cyanide poisoning. **J. Amer Soc. Agron.**, **30:** 569-582.
- Burns, J.C., R.F. Barnes, W.F. Wedin, C.L. Rhykerd and C.H. Noller. 1970. Nutritional characteristics of forage sorghum and sudangrass after frost. **Agron. J.** **62:** 348-350.

- Burton, G.W., W.G. Monson, J.C. Johnson, R.S. Lowrey, H.D. Chapman and W.H. Merchant. 1969. Effect of the d2 dwarf gene on the forage yield and quality of pearl millet. **Agron. J.** **61** : 607-612.
- Chandrashekhara, K. 1987. Studies on heterosis and lines x tester analysis of combining ability in grain and forage sorghum crosses. **Mysore J. Agric. Sci.**, **21** (1): 92.
- Chapman, S.C., M. Cooper, D.G. Butler and R.G. Henzell. 2000. Genotype by environment interaction affecting grain sorghum. I. Characteristics that confound interpretation of hybrid yield. **Aus. J. Agric. Res.**, **51** (2): 197-207.
- Chawla, H.S. and V.P. Gupta. 1982. Seasonal effects on combining ability in pearl millet. **Indian J. Genet.**, **42**: 137-142.
- Cheng, B.C., Q.Y. Liu, H. Jiang and R. Liul. 1986. Analysis of genetic effects for sugar content in sorghum stems. **Acta Agronomica Sinica**, **12** (1): 39-42.
- Chisi, M., P.J. Bramel - Cox, M.D. Witt, M. Claassex and D.J. Andrews. 1996. Breeding for grain yield stability using full-sib family recurrent selection in sorghum. **Crop sci.**, **36** (5): 1083-1087.
- Conner, A.B. and R.E. Karper. 1927. Hybrid vigour in sorghum. **Texas-Agri. Exp. Sta. Bull.**, 359.
- Dabholkar, A.R. 1992. Elements of Biometrical Genetics. Concept publishing company, New Delhi. Pp 326-365
- Dangi, O.P., Hetram and G.P. Lodhi. 1980. Line x Tester analysis for combining ability in forage sorghum. **Sorghum Newsl.**, **23**: 8-9. X
- Desai, S.A., Singh, R. and P.K. Shrotria. 1999. Heterosis and correlation in Sorghum x Sudangrass interspecific crosses. **J. Maharashtra Agric. Univ.** **24** (2): 138-142.
- Dewey, D.R. and K.H. Lu. 1959. A correlation and path co-efficient analysis of components of crested wheat grass seed production. **Agron. J.**, **51**: 515-518.

- Diaz, W. M. And H. J. Viera. 1987. Evaluation of yield stability of cultivars of sorghum in different environments. **Agronomia Tropical**, **37**: 5-17.
- Eberhart, S.A. and W.A. Russel. 1966. Stability parameters for comparing varieties. **Crop Sci.**, **6**: 36-40.
- Eli-itriby, H.A., Selim, A.R. and A.H. Shehata. 1981. Genotype x Environments interaction from combining ability estimates in maize Egypt. **J. Genet. Cytol.**, **10**: 175-186.
- El-shouny, K.A., A.R. Rammah and I.M. Ahmed. 1990. Production and evaluation of some forage sorghum hybrids. Proceedings of the 3rd conference of Agricultural Development Research, held at Ain Shams University, Cairo, Egypt, on 22-24 Dec. **Annals. Agril. Sci. Cairo. Special issue.** 37-50.
- Falconer, D.S. 1981. Introduction to Quantitative Genetics. Second Edition. Longman, New York.
- Fasoulas, A. 1980. Principles and methods of plant breeding. Pub. Number of.11. Dept. of Genetics and plant breeding, Aristotellian, Univ. of Tessaioniki, Greece.
- Finlay, K.N. and G.N. Wilkinson. 1963. The analysis of adaptation in plant breeding programme. **Aust. J. Agric. Res.**, **14**: 742-754.
- Francis, T.R. and L.W. Kannenberg. 1978. Yield stability studies in short-season maize. I.A.. descriptive method for grouping genotypes. **Can. J. Plant Sci.**, **58**: 1029-1034.
- Freeman, G.H. and J.M. Perkins. 1971. Environmental and genotype - environmental components of variability. VIII. Relations between genotypes grown in different environments and measure of these environments. **Heredity**, **26**: 15-23.
- Frey, K.J. and T. Horner 1966. The effect of Genotype x Environment interaction on the expression of phenotype. **Agron. J.**, **49**: 59-62.
- Ful Pagare, Y.G., A.P., Deshmukh, I.G., Chavan, and J.S. Desale. 1983. Prediction of IVDMD of sorghum fodder from various chemical constituents. **J. Maharashtra Agric. Univ.**, **8 (1)**: 84.

- Gama, E. E.G., and A.R. Hallauer. 1980. Stability of hybrids produced from selected and unselected lines of maize. **Crop Sci.**, 20: 623-626.
- Ganesh, S., A.K. Fazulallah khan and N. Senthil. 1996. *Per se* performance of parents and hybrids in Sweet Sorghum for grain yield characters. **Madras Agric. J.**, 84(6): 323-325.
- Gauch, H.G. 1992. Statistical analysis of regional yield traits. AMMI analysis of factorial designs. Elsevier, science Publishers, Netherland.
- Gauch, H.G. and R.W. Zobel, 1996. Identifying mega- environments and targetting genotypes. **Crop Sci.**, 37: 311-326.
- Gillingham, J.T., M.M. Shiver, J.J. Starnes, N.R. Page and E.F. Mc Glain. 1969. Relative occurrence of toxic concentrations of cyanide and nitrate in varieties of Sudangrass and Sorghum Sudangrass hybrids. **Agron. J.**, 61: 727-730.
- Girko, V.S. 1985. Heterosis and inheritance of Characteristics in Sorghum - Sudangrass hybrids. Nauki, Moscow. USSR. No.9: 85-90.
- Goulden, C.H. 1952. Methods of statistical analysis. John Wiley and Sons. Inc., New York.
- Grafius, J.E. 1960. Does over dominance exist for yield in Corn. **Agron J.** 52: 361.
- Griffing, B. 1956. Concept of general and specific combining ability in relation to diallel crossing systems. **Aus. J. Biol. Sci.**, 9: 463-493.
- Gupta, V.P., A.S. Khehra and K.S. Bains. 1977. Concepts in stability analysis. In: Genetics and Wheat improvement (Ed.) A.K. Gupta. pp 143-152. Oxford and IBH Pub. Co., New Delhi.
- Gururaja Rao, M.R., S.J. Patil and R. Parameshwarappa. 1994. Combining ability analysis of some panicle characters Rabi Sorghum. **Karnataka J. Agric. Sci.**, 7(1): 1-5.
- Harlan, J.R. and J.M. J. Dewet 1972. A simplified classification of cultivated sorghum. **Crop Sci.** 12: 172-176.

- Hayman, B.I. and K. Mather. 1955. The description of genetic interaction in continuous variation. **Biometrics**, 11: 69-82.
- Henderson, C.R. 1952. Specific and general combining ability. In: Heterosis. Ed. J.W. Gowen. Iowa state college press, Ames, Iowa, pp. 352-370.
- Hiremath, S.M. and S.R. Parvatikar. 1985. Growth and yield analysis in sorghum identification of genotypes with low leaf area and high dry matter production. **Sorghum Newsl.**, 28: 108.
- Hogg, P.G. and H.L. Ahlgren. 1942. A rapid method for determining hydrocyanic acid content of single plants of Sudan grass. **J. Amer. Soc. Agron.**, 34: 199-200. ✓
- Hoveland, C.S. and W.G. Monson. 1980. Genetic and environmental effects in forage quality. In: **Crop quality, storage and utilization**. pp. 139-168. Amer. Soc. Agron. And Crop Sci., Soc. Amer., Madison. WI. ✕
- Humphires, E.C. 1956. Mineral components and ash analysis. Modern methods of plant analysis. Springer-Verlag. Berlin. 468-502.
- Hussain, M.K. and M.A. Khan. 1973. Correlation studies in sorghum Sudan grass hybrid forage. **SABRAO Newsl.**, 5: 51-53.
- Jain Ying Peng and S.S. Virmani. 1990. Combining ability for yield and four related traits in selection to breeding in rice. **Oryza**, 27: 1-10.
- Jatasra, D.S., and R.S. Paroda. 1980. Phenotypic stability analysis for synchrony traits in wheat (*Triticum aestivum* L.). **Indian J. Genet.**, 40: 132-139.
- Jayamani, P. 1991. Heterosis, combining ability and Genotypic correlation of fodder characteristics in interspecific hybrids of *sorghum bicolor* (L.) Moench x *S. halapense* (L.) Pers. M.Sc (Agri) Thesis, Tamil Nadu Agricultural University, Coimbatore (unpublished).
- Jayamani, P. and M.S. Dorairaj. 1993. Genetic associations in interspecific hybrids of sorghum. **Sorghum - News letter**. 34: 35.

- Jayamani, P. and M.S. Dorairaj. 1995. Performance of interspecific hybrids of *sorghum bicolor* x *S. halapense* for fodder quality characters. **Madras Agric. J.**, **82** (2): 73-75.
- Jayamani, P. and M.S. Dorairaj. 1997. Heterosis in interspecific hybrids of fodder sorghum. **Indian J. of Genetics and Plant Breeding**. **54** (2): 155-157.
- Jeyaprakash, P., S. Ganapathy, and M.A. Pillai. 1997. Correlation and path analysis in sorghum. **Annals of Agricultural Res.** **18**(3): 309-312.
- Katsuba, Z., H. Nakagawa, M. Maeda, Y. Doi, Y. Furudi, T. Tsuchiyai, I. Endo, Y. Miura and M. Matsuura. 1998. A new sudangrass line 2098-2-4-4, as a pollen parent for developing hybrid sorghum cultivars. **Bulletin of the Hiroshima Prefectural Agriculture research Centre**, **66**: 15-23.
- Kaushik, V.S. and R.P.S. Grewal. 1988. Correlation and path analysis in forage sorghum. **Forage Res.**, **14** (2): 107-111.
- Kempthorne, O. 1957. An introduction to Genetical statistics. John Willey and Sons. Inc. New York.
- Kempton, R.A. 1984. The use of biplots in interpreting variety by environment interaction. **J. Agric. Sci.**, **103**: 123-135.
- Khan, A.K.F. 1992. Yield stability of single three way and double cross hybrids. **Sorghum Newsl.**, **33**: 59.
- Khatri, R.S., G.P. Lodhi and Ram avtar. 1998. Genetic component studies on sugars in forage sorghum. **Haryana Agric. Univ. J. Res.** **28** (1): 35-37.
- Kim, D.A., U.B. Chun, C.N. Shin, J.G.D. Kim, D.E. Shin, W.H. Kim and J.K. 1998. Evaluation of the government recommended forage cultivars in Korea, IV. Forage performance and quality of sorghum-sudangrass hybrids. **J. Korean society of Grassland Sci.**, **18** (1): 1-10.
- Kim, Y.D., M.G. Shin and J.S. Chol. 1989. Studies on the productivity of forage sorghum under different cultural environments, 3. Effects of different temperatures before and

after cutting on regrowth. Yield and nutritional value of sorghum Sudangrass hybrid. Research reports of the rural development administration, **Livestock**. **31 (2)**: 31-40.

~~K~~ishan, A.G., S.T. Borikar and S.D. Choudhry. 1990. Total soluble solids contents in relation to cytoplasmic diversity in sorghum. **J. Agrl. Sci.**, **114 (3)**: 239-245. ✓

~~K~~umar, C.V. and S.V. Kumar. 1998. Combining ability analysis in interspecific hybrids of forage sorghum. **Karnataka J. Agrl. Sci.** **11 (3)**: 636-631.

~~K~~umar, M.H., T.Y. Reddy and B. Sreenivas 1999. Phenotypic stability for grain equivalent in dual-purpose sorghum. **Indian J. Agrl. Sci.** **69 (7)**: 494-496. ✓

~~L~~azanyi, J. and J. Bajaj. 1986. Combining ability for yield and forage components in diallel crosses of some male-sterile and maintainer lines of sorghum. **Acta Agronomica Hungarica.**, **35 (3-4)**: 265-270.

Lenka, D. and H. Mishra. 1973. Path Co-efficient analysis of yield in rice varieties. **Indian J. Agric. Sci.**, **43**: 376-379.

~~L~~ewis, D. 1955. Gene interaction, environment and hybrid vigour. **Rey. Soc. (London) Proc.**, **B. 144**: 178-185.

Lin, C.S. and M.R. Binns. 1988. A method of analyzing cultivar x location x year environments, a new stability parameters. **PVK Res., J.**, **76**: 425-430.

~~L~~odhi, G.P. and Arora, R.N. 1997. Genetic improvement of forages - Limitations and perspectives: In **Plant Breeding and Crop Improvement**. **1** : 148-157. ✓

~~M~~aiti, R.K., U.R. Lopej, A.P. Sandoval, and P.W. Ebeling. 1995. Forage quality of 18 glossy sorghum genotypes under rainfed conditions in Nuivo Leon, Mexico. **Int. Sorghum and Millets Newsl.**, **36**: 96-97.

Manickam, S. and L.D. Vijendra Das. 1994 a. Line x Tester analysis in forage sorghum. **Int. Sorghum and Millets Newsl.**, **35**: 79-80. ✓

- Manickam, S. and L.D. Vijendra Das. 1994 b. Combining ability analysis in forage sorghum. **Crop research. Hissar. 8 (3): 523-528.**
- Manickam, S. and L.D. Vijendra Das. 1994 c. Character association and path analysis in forage sorghum. **Mysore J. Agric. Sci. 28: 116-119.**
- Manickam, S. and L.D. Vijendra Das. 1995. Heterosis for forage yield and quality in sorghum. **Annals of agric.res., 16 (1): 111-113.** ✕
- Manivannan, N. 1999. Genotype x environment interaction in blackgram (*Phaseolus mungo*). **Indian J. Agric. Sci., 69 (8): 598-599.**
- Mathur, P.N. and B.D. Patil. 1989. Stability for seed yield in forage sorghum. **Madras Agric. J., 76: 584-587.**
- Mc Caughey, W.P., M.C. Therrien and R. Mabon. 1996. Forage Sorghum in Southern Manitoba, **Canadian J. Plant Sci., 76 (1): 123-125.**
- Meenakshi Ganesan, N. 1998. Studies on heterosis, combining ability and stability of hybrids for protein and grain yields and their related characters in Sorghum. Ph.D, Thesis, Tamil Nadu Agricultural University, Coimbatore (unpublished)
- Mehndiratta, P.D., P.V. Hooda, B.S. Sidhu, D.R. Satija, and M.M. Verma. 1993. Exploitation of hybrid vigour in interspecific forage sorghum hybrids. In Heterosis breeding in crop plants - Theory and application: short communications: Symposium Ludhiana, 22-24 Feb. Edi. Verma, M.M., Virk, .S and G.S Chahali 40-41.
- Mohamed Ali kkan, N., M. Suresh, and Sunder Daniel pawlas. 1995. Variability and character association of metric traits in yellow grained sorghum. **Madras Agric. J. 82 (11): 573-576.**
- Monk, R.L. F.R. Miller and G.G. McBee. 1985. A genetic analysis of stalk quality traits. **Sorghum Newsl., 28: 29.**

- Muhammad, B., M.S. Chaudhry and K. Hussain. 1981. Fodder yield potential in sorghum - sudangrass F₁ hybrids and their ratoon crop. **Nucleus**, **18 (3)**: 47-53.
- Nandanwankar, K.G. 1990. Heterosis studies for grain yield characters in Rabi sorghum. **Indian J. Genet.** **50(1)**: 83-85.
- Nandanwankar, K.G. and R.R. Chandan. 1990. Genetic analysis of dry fodder yield and its components in sorghum. **J. Maharashtra Agric. Univ.**, **15 (1)**: 92-93.
- Narendra Kumar, P. and Hari Har Ram, 1987. Combining ability and gene effect analysis of quantitative characters in egg plant. **Indian J. Agric. Sci.**, **57**: 89-102.
- Narkhede, B.N., M.S. Shinde and S.P. Patil. 1997. Stability analysis in kharif sorghum hybrids. **J. Maharashtra Agric. Univ.** **22 (3)**: 299-301.
- Narkhede, B.N., M.S. Shinde and S.P. Patil. 1998a. Yield stability analysis in rabi sorghum varieties on shallow soil. **J. Maharashtra Agric. Univ.** **22 (2)**: 256-257.
- Narkhede, B.N., M.S. Shinde and S.P. Patil. 1998b. Stability performance of sorghum varieties for grain and fodder yields. **J. Maharashtra Agrl. Univ.** **22 (2)**: 179-181.
- Narkhede, B.N., M.S. Shinde and S.P. Patil. 1998c. Stability performance of rabi sorghum hybrids. **J. Maharashtra Agrl. Univ.** **22 (2)**: 174-175.
- Ombakho, G.A. and F.R. Miller. 1994. Performance, stability and prediction of performance in single, three way and double cross hybrids of sorghum. **Int. Sorghum and Millets Newsl.**, **35**: 77.
- Oosterom, E.dJ., R. Jayachandran, F.R. Bidinger and Van-Oosterom. 1996. Diallel analysis of the stag-green trait and its components in sorghum. **Crop Sci.**, **36 (3)**: 549-555.
- Panse, V.G. and P.V. Sukhatme. 1961. Statistical methods for Agricultural workers. 2nd Ed., ICAR., New Delhi. pp. 381.
- Paroda, R.S. and J.D. Hayes. 1971. An investigation of genotypes x environment interactions for rate of ear emergence in spring barley. **Heredity**, **26**: 157-175.

- Paroda, R.S., G. P. Lodhi and R.P.S. Grewal. 1978. Line x Tester analysis for combining ability in forage Sorghum. **Forage Res.**, 4:31-41.
- Patel, R.H. and K.B. Desai. 1990. Combining ability analysis over environments in sorghum. **Gujarat Agrl. Univ. Res. J.**, 15: 18-22.
- Pathak, H.C. and A.K. Sanghi. 1992. Combining ability and heterosis studies in forage sorghum across environments. **Indian J. of Genetics and Plant Breeding**. 52: 185.
- Patil, D.V., V.G. Makne, and R.A. Patil. 1995. Character association and path co-efficient analysis in sweet sorghum. **PKV. Res. J.**, 19 (1): 21-24.
- Patil, F.B. and D. R. Bapat 1991. Heterosis in forage sorghum and its relationship with combining ability. **J. of Maharashtra Agric. Univ.**, 16 (3): 329-332. ✕
- Patil, H.S., B.N. Narkhede and D.R. Bapat. 1991. Stability parameters in sorghum. **J. Maharashtra Agric. Univ.**, 16 (1): 13-15.
- Patil, R.C. 1990. Inheritance of grain yield and its components in grain sorghum. **J. Maharashtra agric. Univ.**, 15: 54-57.
- Perkins, J.M. and J.L. Jinks. 1968. Environmental and genotype x environment components of variability. III. Multiple lines and crosses. **Heredity**, 23: 339-356.
- Pooran Chand. 1996. Combining ability in winter sorghum. **Madras Agric. J.**, 83: 573-575.
- Prabaharan, R. 2000. Live stock research investment crucial. **In: survey of Indian Agriculture. No. 137-140.**
- Prabhakaran, V.T. and J.P. Jain. 1992. Statistical techniques for studying genotype x environment interaction. South Asian Publishers, New Delhi.
- Rameshpal Singh, G., P. Lodhi and Rajendra Singh. 1991. Stability of parents and hybrids for grain yield and 100 grain weight in forage sorghum. **Crop Res.**, 4 (2): 234-246.

- ✓ Rathore, A.S. and D.L. Singhania. 1985. Heterosis and inbreeding depression in intervareital crosses of forage sorghum. **Indian J. Hered.**, **19 (3-4)**: 39-49.
- ✓ Raveendran, M., S.R. Sree Rangaswamy and N. Senthil 1996a. Correlation studies for biomass yield in fodder sorghum. **Madras Agric. J.**, **83 (10)**: 663.
- ✓ Raveendran, M., S.R. Sree Rangaswamy and N. Senthil 1996b. Heterosis and vegetative propagation studies in an interspecific fodder sorghum hybrid. **J. of Phytological Res.**, **9 (2)**: 133-135.
- Reddy, J. N. and P. Joshi. 1993. Heterosis, inbreeding depression and combining ability in Sorghum. **Indian J. Genet.**, **53 (2)**: 138-146.
- Robinson, H.F. 1965. Quantitative genetics in relation to breeding on the centennial of Mendelism. p. 171-187.
- Robinson, H.F., R.F. Comstock and P.H. Harvey. 1951. Genotypic and Phenotypic correlation in corn and their implications in selections. **Agron., J.** **43**: 282-287.
- ✓ Rojas, B.A. and G.F. Sprague. 1952. A comparison of variance components in corn yield trials. III. General and specific combining ability and their interaction with locations and years. **Agron. J.**, **46**: 10-15.
- ✓ Sanjari, A.G. and M. Redai. 1994. Study of the Genotype x Environment interaction and the adaptability of sorghum hybrids in Janjan region. **Seed and plant**, **10 (1-2)**: 12-19.
- ✓ Sankarapandian, R., Krishnadoss. D. and N. Subbraman. 1997. Heterosis in relation to combining ability components - a study from single and three-way cross hybrids of fodder sorghum. **Karnataka J. of Agric. Sci.**, **10 (4)**: 1013-1018.
- ✓ Sankarapandian, R., N. Subbaraman and A. Amirthadevarathinam. 1994. Genetic analysis of fodder yield and quality characters in sorghum. **Madras Agric. J.**, **81 (6)**: 302-305.

- Sankarapandian, R., J. Ramalingam, M. Arumugam Pillai and C. Vanniarajan. 1994. Heterosis and combining ability studies for juice yield related characteristics in sweet sorghum. **Ann. Agric. Res.** **15** (2): 199-204.
- Santos, J.P.O., G.A. Maciel, M.R.A. Arayo, J.N. Jabosa and M.R.A. De-Arayo. 1995. Genotype x Environment interactions in grain sorghum hybrids. **Int. Sorghum and Millets Newsl.**, **36**: 69-70.
- Sarhan, G.M.A., H.S. Qushi and H.E. El-Selemy . 1996. Evaluation of some new sorghum - sudangrass hybrids for forage yield and quality under different environmental conditions in Egypt. **Ann. Agric. Sci. (Moshtohor)**, **34** (3): 789-798.
- Sastry, E.V.D., D. Singh, K.C. Sharma, and R.K. Sharma. 1989. Stability analysis in Coriander (*Coriandrum sativum* L.). **Indian J. Genet.**, **49**: 151-153.
- Selvi, B. and S. Palanisamy. 1987. Character association in sorghum. **Indian J. Agric. Sci.** **57** (7): 498-499.
- Semenova, T.V. 1986. Inheritance of leaf number in sorghum. *Sbornik Nanchynch. Trndev. Po Prikladuo, Botanike, Genetike I selektissi.*, **105**: 84-88.
- Shah, M.A. and P. Joshi. 1996. Combining ability studies for fodder yield in Sorghum. **Agric. Sci. Digest.** **16** (1): 31-34.
- Sharma, R.L. and B.P.S. Chauhan, 1985. Combining ability in Sesame. **Indian J. Genet.**, **45**: 45-49.
- Shaug Suepea and Lo Kuoduhng. 1995. Evaluation of combining ability for chemical components of forage sorghum. **J. Taiwan Livestock Res.**, **28** (3): 207-214.
- Shaug, S.P. 1992. Combining ability effects for hydrocyanic acid potential in forage sorghum hybrids. **J. Taiwan Livestock Research.** **25** (2): 131-140.
- Shekar, V.B. and M. Ahluwalia. 1981. Heterosis and combining ability analysis of forage yield and quality in eu-sorghum species. **Forage Res.**, **7**: 105-107.

- ✓Shivanna, H., R. Parameswarappa and S.S. Patil 1992. Assessment of general combining ability of sorghum cultivars over different environments. **J. of Maharashtra Agric. Univ.**, **17 (2)**: 216-218.
- ✓Shull, G.H. 1914. Duplicate genes for capsule form in *Bursa. bursa pdastoris* Zeitschr. **Induskt. Abst. Vererb.**, **12**: 97-149.
- Simmonds, N.E. 1979. Principles of crop improvement. Longman Inc., New York. 408 p.
- ✓Singh, A. and Hari Singh. 1985. Combining ability and heterosis for seed yield, its component characters in Indian mustard sown early and late. **Indian J. Agric. Sci.**, **55**: 309-315.
- ✓Singh, P. and S.S. Narayanan, 1993. Biometrical techniques in plant breeding. Kalyani Publishers, Ludhiana, New Delhi.
- ✓Singh, R.K. and B.D. Chaudhary, 1985. Biometrical methods in quantitative genetic analysis. Kalyani Publishers, Ludhiana, New Delhi.
- Snedecor, G.N. and W.G. Cochran. 1967. Statistical methods. Oxford IBH, New Delhi.
- ✓Sood., B.C. and M. Ahluwalia. 1989. Character association studies in forage sorghum. **Forage Res.**, **15 (1)**: 16-24.
- Sood, B.C., and G.C. Saini. 1989. Stability for yield and maturity in mash (*Vigna mungo* (L.) Hepper). **Indian J. Genet.**, **49**: 309-311.
- ✓Sprague, G.F. and W.T. Federer. 1951. A comparison of variance components in corn yield trails. II. Error, year x variety, location x variety and variety components. **Agron. J.**, **42**: 535-541.
- ✓Sprague, G.P. and L.A. Tatum, 1942. General Vs Specific combining ability in single cross of corn. **J. Am. Soc. Agron.**, **34**: 923-932.
- Subba Rao, G. and C. Aruna. 1997. Line (Mutants) x tester studies in sorghum. **J. Res. ANGRAU**, **25 (1)**: 15-18.

- Sun, S.J. Wang, Y., Li, F.S., Zheng, G.C. and Y.S. Chen. 1996. Brix distribution in stem and its relation to other characteristics of sorghum hybrids. **Grassland of China**, 6: 41-45.
- Sun, S.J. Y, Wang, G.C., Zheng, Y.H. Zhang and F.S. Li. 1999. Feasibility research of breeding and application of sorghum - Sudangrass hybrids. **Acta - Prataculturae - Sinica**. 8 (3): 39-45.
- Swaminathan, M.S., E.A. Siddiq and M.S. Sharma. 1972. Outlook for hybrid rice in India. **In: Rice Breeding**, IRRI, Phillipines. PP. 109-6013.
- Thenmozhi, P. 1983. Studies on heterosis and combining ability in *Lablab purpureus* (L.) sweet. M. Sc (Ag) Thesis Tamil Nadu Agricultural University Coimbatore (Unpublished).
- Torres - Cardona, S., A. Sotomayor -Rios and L. Telek. 1983. Agronomic performance and hydrocyanic acid potential (HCN-p) of single and three - way sorghum forage hybrids and Dekalb hybrid SX - 17. **J. Agric. Univ. Puerto Rico.**, 67 (1): 39-49.
- Vashi, P.S. 1982. Combining ability analysis in sorghum. **Indian J. Genet.**, 53 (2): 138-146.
- Verma, M.M. and K.S. Gill. 1975. Genotype x Environment interaction - its measurement and significance in plant breeding. Punjab Agrl. Univ. Ludhiana. **Teaching Aid Bull. 1: 1-49.**
- Vijay Singh, Swarika Singh, Shinde and K.N. Nardeo. 1983. HCN content of varieties of fodder sorghum in relation to yield and nutritional value. **Indian J. Agric. Sci.**, 53 (6): 431-434.
- Wade, L.J., A.C.L. Douglas, D.G. Mayer, R.G. Herizeb, G. Gibson, J. Warren, G.C. Hammer and A.B. Dale. 1989. The performance of diverse sorghum hybrids in a range of different environment. **In: Proceedings of the Australian Sorghum Workshop**, Toowoomba, Queensland 28 Feb-1. March, Brisbane. Australia.

- Westcott, B. 1986. Some methods of analysing genotype environment interactions. **Heredity**, **56**: 243-253.
- Wright, S. 1921. Correlation and causation. **J. Agric. Res.**, **20**: 557-587.
- Wynne, J.C., D.A. Emery and P.W. Rice. 1970. Combining ability estimates in *Arachis hypogea* L. II. Field performance of F₁ hybrids. **Crop Sci.**, **10**: 713-714.
- Yan, W. and Hunt, L.A. 1998. Genotype by Environment interaction and crop yield. In: **Plant Breeding reviews**. **16**: 135-178.
- Yates, F. and W.G. Cochran 1938. The analysis of groups of experiments. **J. Agric. Sci.**, **28**: 556-580.
- Youngquist, J.B., D.C. Carter and W.C. Youngquist. 1990. Phenotypic and agronomic characteristics associated with yield and yield stability of grain sorghum in low rainfall environments. **Bulletin Agrl. Res. In Botanica**. **8**: 21-33.
- Yue, G. and G.H. Liang. 1990. Stability analysis of yield in grain sorghum. **Sorghum Newsletter**. **31**: 9-10.
- Zobel, R.W., M.J. Wright and H.G. Gauch 1988. Statistical analysis of a yield trial. **Agron. J.**, **80**: 388-393.

Plates

202

Plate 1. The Experimental Plot - Field View



Plate 2. Best Hybrid of Sorghum with their parents : Hybrid 1



203

Plate 3. Best Hybrid of Sorghum with their Parents : Hybrid 2

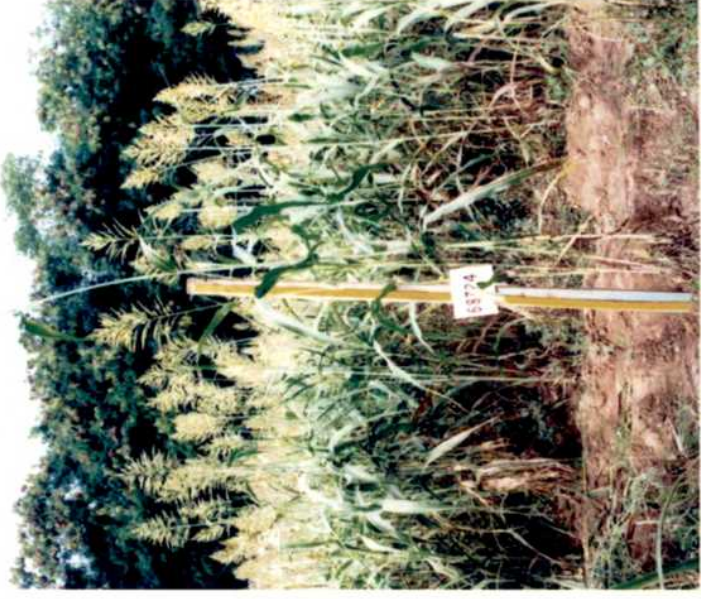
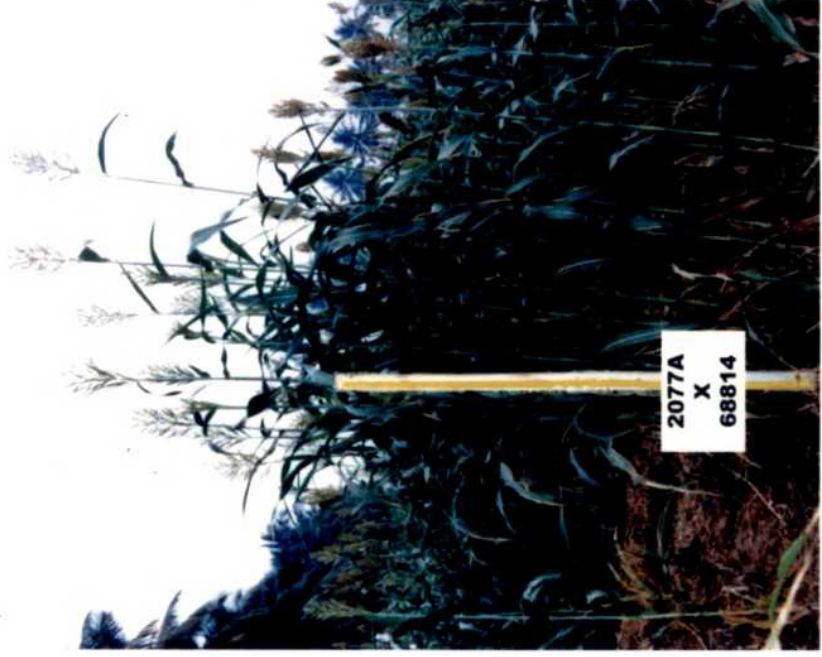


Plate 4. Best Hybrid of Sorghum with their Parents : Hybrid 3



Plate 5. Best Hybrid of Sorghum with their Parents : Hybrid 4



Appendices



Appendix 1. Mean performance of parents in individual environments and pooled data for days to 50 per cent flowering and plant height (cm)

Characters		Days to 50				Per cent		Flowering		Plant height						
Parents		E ₁	E ₂	E ₃	E ₄	P	E ₁	E ₂	E ₃	E ₄	P	E ₁	E ₂	E ₃	E ₄	P
296A		71.33	67.50	60.50*	52.67	63.00	94.04*	86.10	71.60	86.20	84.49					
2219A		63.00	67.50	59.50	51.67	60.42	83.13	69.33	85.10	86.17	80.93					
2077A		75.33*	60.50	52.50	46.67	58.75	92.56*	97.00*	100.10*	104.00	98.42					
111A		74.00*	69.50*	60.50*	52.67	64.17*	110.07*	81.25	106.70*	112.50*	102.63					
Lines Mean		70.92	66.42	58.42	53.32	61.59	94.95	83.43	90.88	97.2	91.62					
68716		72.67	73.50**	59.50	52.67	64.58	214.67	234.85**	212.60	224.02	221.54**					
68740		75.00	74.50**	59.50	52.67	65.42*	251.53**	243.80**	225.80**	199.50	230.16**					
68918		79.67**	72.50**	58.50	52.67	65.83*	181.67	185.00	190.50	189.33	186.63					
68786		75.00	67.50	63.50**	55.00	65.25	244.07**	278.70**	240.60**	250.84**	253.55**					
68814		80.00**	77.50	65.50**	58.67**	70.42**	303.46**	207.30*	216.60	225.01	238.09**					
FS211		76.33	57.50	51.50	49.67	58.75	204.00	170.30	181.66	182.17	184.53					
FS205		72.33	66.50	60.50	51.67	62.75	201.26	207.00*	215.30	202.84	206.60					
FS9401		72.00	63.50	62.50**	51.67	62.42	205.46	234.73**	231.79**	226.17	224.54**					
SS093		80.00**	60.50	61.50*	51.67	63.42	171.83	153.92	167.90	248.00**	185.41					
SS012		75.00	60.50	54.50	52.00	60.50	180.25	146.00	167.10	200.67	173.51					
SS020		73.67	63.50	57.50	52.00	61.67	216.40	187.70	272.60**	277.84**	238.64**					
SRV605		72.33	75.50	65.50**	52.00	66.33**	192.43	196.50	220.00*	233.17**	210.53*					
FS9604		75.00	57.50	54.50	51.67	59.67	166.20	158.44	176.40	176.50	169.39					
FS9605		75.00	63.50	61.50*	52.00	63.00	228.44**	211.68**	215.80	226.00	220.48*					
FS9601		76.33	57.50	52.50	51.67	59.50	217.75	198.40	229.90**	225.50	217.89					
FS9603		75.67	60.50	60.50	55.67**	63.08	194.76	164.77	214.20	218.34	198.02					
68710		96.33**	77.50**	67.50**	60.67**	75.50**	210.00	169.55	197.88	188.75	191.54					
68724		82.67**	60.50	57.50	54.67	63.83	224.73**	189.30	165.70	249.00**	207.18					
68726		76.00	60.50	54.50	53.67	61.17	245.20**	218.70**	184.20	238.67**	221.69**					
Co27		75.00	63.50	54.50	53.67	61.67	200.86	175.80	221.80**	216.00	203.62					
SS032		74.67	63.50	63.50**	53.67	63.83	181.17	194.50	220.00*	211.82	201.87					
Testers Mean		76.69	65.76	59.52	53.32	63.82	211.25	196.52	208.02	219.53	208.82					
Parental Mean		75.77	65.81	59.35	52.93	63.48	192.63	178.42	189.27	199.96	190.01					
SE(d)		0.8743	0.7996	0.784	0.744	0.802	4.856	4.8044	4.879	4.923	4.866					
CD at 5%		1.7233	1.576	1.545	1.467	1.572	9.5713	9.4695	9.617	9.703	9.537					
CD at 1%		2.2741	2.0798	2.039	1.936	2.066	12.6306	12.4962	12.691	12.804	12.534					

Appendix 1. (contd.). Mean performance of hybrids in individual environments and pooled data for days to 50 per cent flowering and plant height (cm)

Characters	Days to 50			Per cent		Flowering			Plant height						
	E ₁	E ₂	E ₃	E ₄	P	E ₁	E ₂	E ₃	E ₄	P	E ₁	E ₂	E ₃	E ₄	P
Hybrids															
296A x 68716	78.67**	71.00**	55.00	52.00	64.17*	193.52	176.33	190.63	154.33						178.70
296A x 68740	78.33**	61.00	55.00	51.00	61.33	216.50	198.62	197.85	185.00						199.49
296A x 68918	80.67**	57.00	55.00	52.00	61.17	189.42	165.87	177.70	158.89						172.97
296A x 68786	90.33**	73.00**	56.00	55.00**	68.58**	211.63	214.23**	203.47	185.00						203.58
296A x 68814	81.33**	61.00	61.33**	58.00**	65.42**	234.36**	223.53**	206.90	168.35						208.29
296A x FS211	81.33**	68.00**	53.00	51.00	63.33	215.03	186.40	194.11	169.78						191.33
296A x FS205	77.33	61.00	63.00**	55.00**	64.08*	207.46	207.00	217.65	186.44						204.64
296A x FS9401	77.33	63.00	55.00	52.00	61.83	200.93	202.20	223.21	196.67						205.75
296A x SS003	78.00*	61.00	53.00	52.00	61.00	187.68	191.10	209.87	184.11						193.19
296A x SS012	78.00*	59.00	52.00	52.00	60.25	187.92	150.30	180.01	170.00						172.06
296A x SS020	78.00	61.00	56.00	52.00	61.75	222.53*	210.30**	239.30**	214.95						221.77*
296A x SRV605	75.67	61.00	64.00**	57.00**	64.42**	169.66	179.87	179.57	203.67						183.19
296A x FS9604	76.67	71.00**	64.00**	55.00**	66.67**	153.22	194.40	216.32	180.67						186.15
296A x FS9605	76.00	61.00	59.00*	52.00	62.00	206.80	182.53	205.71	203.56						199.65
296A x FS9601	76.33	61.00	55.00	52.00	61.08	192.93	188.20	223.50	212.71						204.34
296A x FS9603	75.00	61.00	56.00	52.00	61.00	196.26	171.97	196.40	194.22						189.71
296A x 68710	78.00*	59.00	56.67	55.00**	62.17	225.40**	188.09	207.60	186.67						201.94
296A x 68724	77.00	58.00	52.00	52.00	59.75	224.68**	190.90	206.99	212.67						208.81
296A x 68726	78.00*	56.00	52.00	51.00	59.25	211.73	191.17	194.20	186.52						195.91
296A x Co27	75.67	58.00	57.00	51.00	60.42	203.43	181.27	199.09	170.17						188.49
296A x SS032	76.00	56.00	61.00**	51.00	61.00	184.83	171.73	185.60	190.00						183.04
2219A x 68716	70.00	61.00	56.00	51.00	59.50	200.55	222.03**	234.73**	240.56**						224.47*
2219A x 68740	70.33	61.00	58.00	52.00	60.33	199.97	220.40**	231.24	225.89						219.38
2219A x 68918	72.00	56.00	53.00	52.00	58.25	186.67	158.20	190.19	196.11						182.79
2219A x 68786	68.67	60.00	60.00**	55.00**	60.92	207.03	196.03	217.83	242.00**						215.72
2219A x 68814	72.00	56.00	53.00	53.00	58.50	217.60	179.61	219.27	221.43						209.48
2219A x FS211	71.00	56.00	52.00	49.00	57.00	182.90	165.25	204.01	203.67						188.96
2219A x FS205	69.67	60.00	55.00	49.00	58.42	198.90	189.25	240.16	221.22						212.38
2219A x FS9401	69.67	57.00	55.00	49.00	57.67	205.13	174.43	227.33	211.78						204.67
2219A x SS003	69.33	58.00	55.00	49.00	57.83	190.81	182.47	244.12**	241.00**						214.60
2219A x SS012	71.67	56.00	54.00	50.00	57.92	198.91	169.61	201.90	209.33						194.94
2219A x SS020	69.33	63.00	55.67	49.00	59.25	217.27	179.54	255.32**	238.89**						222.76*
2219A x SRV605	69.00	61.00	61.00**	57.00**	62.00	198.67	173.95	234.93**	209.45						204.25

Appendix 1 (contd..)

Characters	Days to 50			Per cent		Flowering			Plant height			
	E ₁	E ₂	E ₃	E ₄	P	E ₁	E ₂	E ₃	E ₄	P		
Hybrids												
2219A x FS9604	70.67	68.00**	60.00**	55.00**	63.42	177.17	156.95	225.93	193.33	188.35		
2219A x FS9605	70.00	61.00	55.00	52.33	59.58	215.67	183.73	224.91	209.67	208.50		
2219A x FS9601	69.67	57.00	52.00	49.00	56.92	210.20	183.71	224.20	216.33	208.61		
2219A x FS9603	70.67	58.00	54.00	49.00	57.92	183.51	161.91	200.01	204.78	187.55		
2219A x 68710	71.00	59.00	55.00	53.00	59.50	193.13	172.17	221.33	216.67	200.83		
2219A x 68724	78.67**	60.00	53.00	49.00	60.17	217.60	191.40	229.87	233.67**	218.14		
2219A x 68726	70.67	60.00	52.00	49.00	57.92	212.17	188.25	226.97	240.45**	216.96		
2219A x Co27	70.00	60.00	55.00	49.00	58.50	199.43	162.48	226.31	214.67	200.72		
2219A x SS032	72.67	57.00	55.00	49.00	58.42	188.93	160.23	199.71	198.57	186.86		
2077A x 68716	77.67	73.00**	55.00	52.00	64.42**	224.53**	263.03**	251.00**	256.00**	248.64**		
2077A x 68740	76.33	73.00**	58.00	52.00	64.83**	240.47**	255.83**	236.00**	243.34**	243.91**		
2077A x 68918	82.33**	61.00	53.00	52.00	62.08	204.47	207.81	205.65	196.50	203.61		
2077A x 68786	91.00**	73.00**	63.00**	57.00**	71.00**	255.92**	263.23**	236.60**	203.00	239.69**		
2077A x 68814	84.33**	73.00**	61.00**	62.00**	70.08**	252.40**	246.78**	246.77**	255.00**	250.24**		
2077A x FS211	75.67	61.00	53.00	51.00	60.17	229.73**	207.84	206.87	205.00	212.36		
2077A x FS205	72.67	68.00**	61.00**	57.00**	64.67**	228.33**	234.21**	245.60**	258.34**	241.62**		
2077A x FS9401	72.00	61.00	57.00	55.00**	61.25	232.93**	231.43**	250.93**	220.00	233.82**		
2077A x SS003	76.00	61.00	55.00	57.67**	62.42	201.99	186.73	212.07	219.17	204.99		
2077A x SS012	75.00	61.00	63.00**	55.00**	63.50	208.97	199.43	218.67	235.83**	215.73		
2077A x SS020	71.67	67.00**	61.00**	53.00	63.17	223.18*	248.31**	243.00**	298.34**	253.21**		
2077A x SRV605	71.33	71.00**	64.00**	57.00**	65.83**	225.97**	233.15**	218.20	229.67*	226.75**		
2077A x FS9604	77.00	73.00**	64.00**	55.00**	67.25**	204.20	193.67	217.50	208.30	205.93		
2077A x FS9605	77.00	62.00	59.00*	52.00	62.50	239.37**	219.45**	226.77	255.00**	235.15**		
2077A x FS9601	72.00	61.00	59.33**	54.00	61.58	229.68**	210.33**	230.13	237.33**	226.87**		
2077A x FS9603	77.00	61.00	60.00**	51.00	62.25	224.52**	198.33	232.70*	251.17**	226.68**		
2077A x 68710	83.00**	74.00**	53.00	57.00**	66.75**	233.67**	211.60**	211.80	264.34**	230.35**		
2077A x 68724	85.00**	72.00**	60.00**	52.00	67.25**	249.67**	229.80**	238.47**	238.00**	238.99**		
2077A x 68726	74.67	57.00	55.00	51.00	59.42	251.70**	236.95**	212.44	295.50**	249.15**		
2077A x Co27	75.33	59.00	52.00	52.00	59.58	223.56*	218.50**	211.84	269.12**	230.76**		
2077A x SS032	72.33	59.00	53.00	52.00	59.08	246.33**	197.13	218.47	254.00**	228.98**		
1111A x 68716	80.67**	75.00**	60.00**	53.00	67.17**	211.33	242.07**	221.51	220.44	223.84*		
1111A x 68740	78.33*	75.00**	60.00**	53.00	66.58**	262.13**	241.30**	236.60**	234.11**	243.54**		
1111A x 68918	80.67**	75.00**	58.67	60.00**	68.58**	197.87	179.61	211.16	212.39	200.26		
111A x 68786	89.67**	73.00**	64.00**	51.00	69.42**	239.30**	201.24	240.07**	216.89	224.38*		

Appendix 1 (contd.)

Characters		Days to 50			Per cent		Flowering			Plant height						
		E ₁	E ₂	E ₃	E ₄	P	E ₁	E ₂	E ₃	E ₄	P	E ₁	E ₂	E ₃	P	
Hybrids																
111A x 68814		84.67**	73.00**	58.00	60.00**	68.92**	232.53**	207.67	231.23*	252.67**	231.03**	232.53**	207.67	231.23*	252.67**	231.03**
111A x FS211		74.00	60.00	53.00	51.00	59.50	205.20	174.60	206.51	198.78	196.27	205.20	174.60	206.51	198.78	196.27
111A x FS205		74.67	68.00**	60.00**	51.00	63.42	228.00**	219.15**	235.67**	222.00	226.21**	228.00**	219.15**	235.67**	222.00	226.21**
111A x FS9401		75.00	61.00	57.00	51.00	61.00	219.80	205.27	244.97**	231.67**	225.43**	219.80	205.27	244.97**	231.67**	225.43**
111A x SS003		76.00	59.00	53.00	49.00	59.25	184.22	156.95	195.33	173.42	177.48	184.22	156.95	195.33	173.42	177.48
111A x SS012		77.67	60.00	55.00	51.00	60.92	196.53	168.42	210.08	217.33	198.09	196.53	168.42	210.08	217.33	198.09
111A x SS020		77.67	74.00**	63.00**	51.00	66.42**	235.47**	191.99	247.80**	268.26**	235.88**	235.47**	191.99	247.80**	268.26**	235.88**
111A x SRV605		71.67	73.00**	64.00**	55.00**	65.92**	211.87	182.22	233.50	207.63	208.81	211.87	182.22	233.50	207.63	208.81
111A x FS9604		78.33**	61.00	64.00**	55.00**	64.58**	155.13	178.73	221.70	215.78	192.84	155.13	178.73	221.70	215.78	192.84
111A x FS9605		74.67	61.00	61.00**	51.00	61.92	221.57*	210.85**	259.29**	252.71**	236.11**	221.57*	210.85**	259.29**	252.71**	236.11**
111A x FS9601		72.00	61.00	57.00	53.00	60.75	225.40**	232.93**	275.66**	237.38**	242.84**	225.40**	232.93**	275.66**	237.38**	242.84**
111A x FS9603		78.33**	61.00	56.00	53.00	62.08	199.87	194.93	232.29*	209.00	209.02	199.87	194.93	232.29*	209.00	209.02
111A x 68710		87.00**	61.00	55.00	55.00**	64.50**	210.20	190.66	218.02	221.28	210.04	210.20	190.66	218.02	221.28	210.04
111A x 68724		83.33**	71.00**	57.00	53.00	66.08**	236.33**	202.56	257.82**	227.00	230.93**	236.33**	202.56	257.82**	227.00	230.93**
111A x 68726		76.67	61.00	56.00	52.00	61.42	233.07**	209.49	238.13**	240.33**	230.26**	233.07**	209.49	238.13**	240.33**	230.26**
111A x Co27		75.67	70.00**	60.00**	52.00	64.42**	212.67	198.64	248.86**	209.33	217.38	212.67	198.64	248.86**	209.33	217.38
111A x SS032		78.00*	61.00	60.00**	52.00	62.75	206.53	183.55	247.85**	231.89**	217.46	206.53	183.55	247.85**	231.89**	217.46
Hybrids Mean		76.12	63.31	57.15	52.71	62.32	211.84	197.66	221.69	217.82	212.25	211.84	197.66	221.69	217.82	212.25
SE(d)		0.8743	0.7996	0.784	0.744	0.802	4.856	4.8044	4.879	4.923	4.866	4.856	4.8044	4.879	4.923	4.866
CD at 5%		1.7233	1.576	1.545	1.467	1.572	9.5713	9.4695	9.617	9.703	9.537	9.5713	9.4695	9.617	9.703	9.537
CD at 1%		2.2741	2.0798	2.039	1.936	2.066	12.6306	12.4962	12.691	12.804	12.534	12.6306	12.4962	12.691	12.804	12.534

Appendix 2. Mean performance of parents in individual environments and pooled data for number of tillers and number of leaves

Characters		Number of tillers				Number of leaves				
Parents	E ₁	E ₂	E ₃	E ₄	P	E ₁	E ₂	E ₃	E ₄	P
296A	1.00	1.00	1.20	1.17	1.09	8.40	8.40	8.00	10.67*	8.87
2219A	1.07	1.10	1.20	1.30	1.17	7.07	6.97	7.30	7.20	7.13
2077A	1.00	1.40	1.25	1.50	1.29	8.55	8.50	6.90	7.00	7.74
111A	1.00	1.60	1.60	1.17	1.34	8.70	7.21	8.60	11.34*	8.96
Lines Mean	1.02	1.28	1.31	1.28	1.22	8.18	7.77	7.7	9.05	8.18
68716	1.93	2.17	3.00	1.67	2.19	6.67	9.30	9.00	8.00	8.24
68740	2.00	3.30*	2.60	3.33	2.81	7.93	9.70	8.90	8.00	8.63
68918	1.33	1.40	1.60	1.33	1.42	9.20**	10.47	8.50	8.00	9.04
68786	1.67	3.20*	3.18	2.17	2.55	8.40	10.27	9.25	10.83**	9.69
68814	1.33	2.60	1.40	1.00	1.58	8.00	9.80	8.70	8.95	8.86
FS211	1.73	1.90	1.80	1.50	1.73	8.20	19.40**	8.80	8.67	11.27**
FS205	1.80	2.83	2.00	2.00	2.16	6.60	11.00	8.50	9.00	8.78
FS9401	2.47	1.90	2.30	2.50	2.29	6.53	10.80	9.90*	8.83	9.02
SS003	2.40	2.10	1.50	1.00	1.75	7.47	8.80	7.50	8.62	8.10
SS012	1.73	1.53	1.20	1.33	1.45	7.67	9.40	7.70	8.17	8.23
SS020	1.80	1.80	1.90	3.67*	2.29	7.60	11.20	10.20**	9.00	9.50
SRV605	2.40	1.50	2.15	2.50	2.14	5.67	10.80	10.50**	8.00	8.74
FS9604	2.33	1.69	2.00	1.67	1.92	6.27	9.40	7.40	7.84	7.73
FS9605	2.00	2.40	2.80	2.17	2.34	6.73	9.30	8.90	7.84	8.19
FS9601	2.33	1.60	3.10	3.00	2.51	7.13	9.60	8.60	7.67	8.25
FS9603	2.13	2.60	2.60	4.84**	3.04	6.42	7.90	9.30	8.17	7.95
68710	1.33	2.40	1.40	1.40	1.63	8.47	9.70	8.15	7.67	8.50
68724	1.67	3.70	2.70	4.40**	3.12	9.07**	8.90	6.80	8.34	8.28
68726	2.27	4.10**	4.20**	4.66**	3.81**	8.53	9.10	7.80	8.34	8.44
Co27	2.33	2.30	2.60	2.50	2.43	6.80	8.60	8.80	8.83	8.26
SS032	2.13	1.30	3.40	2.17	2.25	6.20	12.00	10.80**	7.84	9.21
Testers Mean	1.96	2.30	2.35	2.42	2.26	7.41	10.26	8.76	8.41	8.71
Parental Mean	1.8	2.14	2.19	2.24	2.09	7.53	9.86	8.59	8.51	8.62
SE(d)	0.3491	0.4596	0.606	0.549	0.501	0.6077	1.545	0.531	0.713	0.942
CD at 5%	0.6881	0.9059	1.195	1.083	0.981	1.1977	3.0453	1.047	1.405	1.846
CD at 1%	0.908	1.1955	1.577	1.429	1.289	1.5805	4.0187	1.381	1.854	2.426

Appendix 2. (contd.). Mean performance of hybrids in individual environments and pooled data for number of tillers and number of leaves

Characters	Number of tillers				Number of Leaves					
	E ₁	E ₂	E ₃	E ₄	P	E ₁	E ₂	E ₃	E ₄	P
Hybrids										
296A x 68716	1.67	1.73	2.40	1.44	1.81	7.47	9.60	8.73	6.89	8.17
296A x 68740	2.07	2.60	2.73	1.34	2.19	7.67	10.07	8.40	7.33	8.37
296A x 68918	1.53	2.20	1.27	2.00	1.75	8.67	10.73	8.27	8.83	9.13
296A x 68786	1.08	2.57	2.40	1.13	1.80	7.80	11.03	8.33	6.89	8.51
296A x 68814	2.07	1.87	1.93	1.67	1.88	8.60	10.80	8.33	9.17	9.23
296A x FS211	1.87	1.73	2.53	1.56	1.92	8.13	10.47	8.07	7.22	8.47
296A x FS205	2.00	1.87	2.27	2.11	2.06	6.93	11.57	9.73	7.33	8.89
296A x FS9401	1.93	2.13	2.40	2.22	2.17	7.20	10.53	9.67	7.67	8.77
296A x SS003	1.60	2.07	2.27	2.00	1.98	7.73	10.27	8.60	7.17	8.44
296A x SS012	1.47	1.87	1.93	1.00	1.57	7.80	9.93	8.00	6.78	8.13
296A x SS020	1.80	1.67	2.20	2.25	1.98	6.60	10.07	9.47	7.33	8.37
296A x SRV605	1.80	1.93	2.50	2.67	2.23	6.07	9.93	8.93	8.11	8.26
296A x FS9604	1.33	2.20	3.38	1.78	2.17	7.37	11.80	10.56**	7.45	9.29
296A x FS9605	1.73	2.53	2.40	1.50	2.04	6.67	9.80	8.13	7.00	7.90
296A x FS9601	1.73	2.53	3.33	1.66	2.32	6.53	9.33	9.00	8.00	8.22
296A x FS9603	1.60	2.67	3.87*	1.84	2.49	6.67	9.20	8.27	7.11	7.81
296A x 68710	1.87	2.67	4.07	2.99	2.90	7.73	9.87	8.33	7.50	8.36
296A x 68724	1.60	2.47	3.27	3.11	2.61	7.53	9.73	8.20	7.00	8.12
296A x 68726	2.17	6.73**	7.47**	2.78	4.79**	7.73	9.24	7.00	6.78	7.69
296A x Co27	1.87	2.20	2.33	1.33	1.93	6.73	9.87	8.80	6.61	8.00
296A x SS032	1.93	3.13*	3.80	2.00	2.72	7.13	10.07	9.27	7.33	8.45
2219A x 68716	1.87	3.07*	3.60	2.67	2.80	7.47	11.00	8.47	8.89	8.96
2219A x 68740	2.00	2.33	2.67	2.78	2.44	6.93	11.53	8.87	7.78	8.78
2219A x 68918	1.87	1.53	2.80	1.89	2.02	7.27	9.60	7.60	8.78	8.31
2219A x 68786	1.90	2.20	2.13	1.89	2.03	7.80	10.27	9.13	9.56	9.19
2219A x 68814	2.53*	2.53	2.47	3.22*	2.69	7.87	9.67	7.93	7.89	8.34
2219A x FS211	1.67	1.80	2.80	1.66	1.98	7.60	9.60	7.47	7.89	8.14
2219A x FS205	2.00	2.00	2.07	2.22	2.07	7.00	10.53	9.40	8.22	8.79
2219A x FS9401	1.73	2.40	2.73	2.89	2.44	7.53	9.87	9.27	7.56	8.56
2219A x SS003	1.53	1.67	2.20	2.11	1.88	6.93	9.93	9.67	8.33	8.72
2219A x SS012	1.93	1.80	2.33	2.11	2.05	8.00	8.87	7.87	8.33	8.27
2219A x SS020	1.73	1.73	2.67	1.89	2.01	6.87	10.40	9.27	8.00	8.63
2219A x SRV605	1.67	1.51	1.93	1.55	1.67	6.93	10.00	8.67	7.33	8.23

Appendix 2 (contd.)

Characters	Number of tillers				Number of Leaves					
	E ₁	E ₂	E ₃	E ₄	P	E ₁	E ₂	E ₃	E ₄	P
Hybrids										
2219A x FS9604	1.60	1.40	1.53	1.78	1.58	6.87	10.20	9.33	7.67	8.52
2219A x FS9605	1.93	2.13	2.73	2.11	2.23	6.93	9.67	8.07	7.33	8.00
2219A x FS9601	1.93	2.33	2.73	2.00	2.25	7.53	8.47	7.93	7.67	7.90
2219A x FS9603	1.87	2.93	2.07	1.89	2.19	7.00	9.73	7.87	7.56	8.04
2219A x 68710	1.60	1.93	2.53	2.55	2.16	8.33	9.20	8.53	7.78	8.46
2219A x 68724	1.70	2.40	1.87	2.22	2.05	8.47	10.27	9.00	8.89	9.16
2219A x 68726	2.00	2.67	3.40	2.73	2.70	7.80	9.20	8.47	8.00	8.37
2219A x Co27	2.73*	2.20	2.07	2.33	2.33	6.80	9.87	9.20	7.78	8.41
2219A x SS032	2.23	2.33	2.60	2.00	2.29	7.20	8.73	8.47	7.67	8.02
2077A x 68716	1.87	2.50	2.13	2.00	2.13	7.80	11.35	8.93	9.17	9.31
2077A x 68740	2.47	2.20	2.20	3.66**	2.63	7.40	11.87	8.20	10.23	9.43
2077A x 68918	1.47	1.60	1.92	1.20	1.55	8.93*	12.00	9.78	8.60	9.83
2077A x 68786	1.33	2.20	2.87	1.00	1.85	9.93**	12.40	10.07*	8.37	10.19
2077A x 68814	1.47	2.40	2.53	3.63**	2.51	8.80	12.27	10.00*	10.64**	10.43
2077A x FS211	1.67	2.00	3.20	1.93	2.20	8.60	10.13	8.27	10.00*	9.25
2077A x FS205	2.60*	2.13	2.33	1.50	2.14	6.93	11.20	9.77	9.00	9.23
2077A x FS9401	1.97	2.27	2.93	2.50	2.42	6.73	11.00	8.87	8.50	8.78
2077A x SS003	1.87	1.80	2.40	1.67	1.93	8.53	10.93	8.33	9.83	9.41
2077A x SS012	1.67	1.47	2.27	1.31	1.68	7.47	11.07	9.47	8.50	9.13
2077A x SS020	1.73	1.73	2.00	3.16	2.16	7.47	11.73	9.87	10.17*	9.81
2077A x SRV605	2.20	1.60	1.50	1.65	1.74	7.07	11.47	9.90	9.17	9.40
2077A x FS9604	1.40	1.13	2.00	1.66	1.55	7.60	11.07	9.60	8.50	9.19
2077A x FS9605	1.73	2.33	2.10	1.83	2.00	8.07	11.80	9.27	9.17	9.58
2077A x FS9601	2.07	1.73	2.33	2.94	2.27	7.07	11.00	8.40	7.85	8.58
2077A x FS9603	2.17	1.93	2.80	1.98	2.22	7.30	10.73	8.70	9.67	9.10
2077A x 68710	2.27	2.20	3.72	2.59	2.70	7.80	10.40	9.16	10.33**	9.42
2077A x 68724	1.80	3.13*	3.20	2.17	2.58	9.20*	11.13	9.20	9.00	9.63
2077A x 68726	2.73*	3.27*	3.53	3.00	3.13	8.73	11.33	8.03	9.98*	9.52
2077A x Co27	1.77	2.07	3.00	2.83	2.42	7.67	10.44	9.23	9.33	9.17
2077A x SS032	1.67	1.47	2.07	1.56	1.69	8.67	11.27	8.33	8.45	9.18
111A x 68716	1.67	2.33	3.07	1.67	2.18	8.60	10.87	9.13	9.60	9.55
111A x 68740	1.47	2.00	2.20	1.44	1.78	8.83	11.27	9.40	10.78**	10.07
111A x 68918	2.00	1.60	2.00	1.34	1.74	8.67	11.77	9.00	9.19	9.66
111A x 68786	1.87	2.60	2.47	2.22	2.29	9.53**	10.00	9.27	8.78	9.40

Appendix 2 (contd..)

Characters	Number of tillers				Number of Leaves					
	E ₁	E ₂	E ₃	E ₄	P	E ₁	E ₂	E ₃	E ₄	P
Hybrids										
111A x 68814	1.60	2.93	3.00	3.23*	2.69	9.13*	10.00	9.33	9.89*	9.59
111A x FS211	1.67	1.87	2.40	2.52	2.11	8.53	9.80	8.13	10.43**	9.23
111A x FS205	1.93	2.13	2.60	1.44	2.03	7.60	11.33	9.53	10.22*	9.67
111A x FS9401	1.53	2.00	2.93	2.45	2.23	7.53	11.07	9.00	8.44	9.01
111A x SS003	1.47	1.93	2.53	1.17	1.78	8.13	10.53	8.73	7.89	8.82
111A x SS012	1.47	1.47	1.87	1.50	1.58	8.47	11.40	9.40	11.45**	10.18
111A x SS020	1.47	1.20	2.07	2.11	1.71	8.00	11.27	10.27*	9.11	9.66
111A x SRV605	2.33	2.33	2.50	1.67	2.21	6.87	10.40	10.00*	7.89	8.79
111A x FS9604	1.53	1.67	2.27	3.33*	2.20	8.60	10.07	9.93	8.22	9.21
111A x FS9605	2.07	2.07	3.57	3.11	2.70	7.80	10.80	9.60	9.00	9.30
111A x FS9601	1.47	1.87	2.60	2.33	2.07	7.60	11.67	10.53**	8.67	9.62
111A x FS9603	2.27	2.73	4.60**	3.22*	3.21*	7.07	9.73	8.67	7.78	8.31
111A x 68710	1.73	3.07	3.87*	2.67	2.83	8.27	9.27	7.60	8.39	8.38
111A x 68724	1.87	2.40	3.40	2.00	2.42	9.20*	10.93	9.73	9.55	9.86
111A x 68726	2.20	2.53	4.13*	3.78**	3.16*	9.50**	10.67	8.93	8.56	9.41
111A x Co27	2.27	1.60	2.10	2.11	2.02	7.57	10.93	9.80	8.56	9.21
111A x SS032	2.27	2.73	3.40	3.00	2.85	8.07	10.00	9.53	8.67	9.07
Hybrids Mean	1.84	2.19	2.68	2.15	2.22	7.75	10.45	8.92	8.45	8.90
SE(d)	0.3491	0.4596	0.606	0.549	0.501	0.6077	1.545	0.531	0.713	0.942
CD at 5%	0.6881	0.9059	1.195	1.083	0.981	1.1977	3.0453	1.047	1.405	1.846
CD at 1%	0.908	1.1955	1.577	1.429	1.289	1.5805	4.0187	1.381	1.854	2.426

Appendix 3. Mean performance of parents in individual environments and pooled data for leaf length (cm) and leaf breadth (cm)

Characters	Leaf length				Leaf breadth					
	E ₁	E ₂	E ₃	E ₄	P	E ₁	E ₂	E ₃	E ₄	P
Parents										
296A	59.89	56.67	57.10	65.17*	59.71	7.09	5.73	5.76	5.73	6.08
2219A	51.43	48.47	48.40	42.00	47.57	4.84	5.69	5.35	4.56	5.11
2077A	67.36*	55.75	50.10	52.00	56.30	6.11	4.77	4.93	3.92	4.93
111A	57.43	51.80	61.40	55.67	56.58	7.02	6.13	6.95	6.69*	6.70
Lines Mean	59.03	53.17	54.25	53.7	55.04	6.27	5.58	5.74	5.23	5.71
68716	61.84	66.53	69.20	59.33	64.23	3.61	4.53	4.60	5.67	4.60
68740	65.93	64.16	58.10	63.33	62.88	4.37	5.13	4.28	4.50	4.57
68918	63.65	55.69	55.22	51.33	56.47	7.08*	6.30*	5.03	4.90	5.83
68786	69.06	61.30	70.44	70.84	67.91	4.95	5.64	5.94	6.14	5.67
68814	70.30	56.08	67.60	60.13	63.53	4.76	4.94	4.75	4.03	4.62
FS211	63.23	58.40	57.95	63.04	60.65	5.20	5.75	5.37	5.76	5.52
FS205	58.47	56.60	60.00	54.53	57.40	4.54	5.94	6.63**	4.69	5.45
FS9401	63.98	64.22	70.00	69.53	66.93	5.07	5.94	5.25	5.32	5.39
SS003	58.39	57.06	61.40	83.50**	65.09	5.03	5.48	5.77	5.15	5.36
SS012	57.94	49.70	60.80	65.66	58.53	5.09	6.05	5.84	5.19	5.54
SS020	67.39	50.44	72.40	76.77**	66.75	4.83	4.64	4.84	5.47	4.94
SRV605	59.01	50.49	74.82*	68.00	63.08	4.17	4.65	5.71	5.24	4.94
FS9604	59.01	48.57	62.29	59.70	57.39	5.19	5.42	5.48	5.22	5.33
FS9605	71.63	66.11	67.62	71.34	69.18	4.09	4.20	4.57	4.95	4.45
FS9601	58.57	57.14	63.72	62.55	60.50	4.49	5.04	4.71	4.64	4.72
FS9603	56.08	60.93	67.80	71.37	64.04	4.45	4.92	5.09	5.45	4.98
68710	69.93	74.04**	69.49	62.00	68.86	5.14	5.92	5.53	5.14	5.43
68724	73.13**	58.08	50.70	69.50	62.85	3.97	4.14	3.86	5.10	4.27
68726	72.68**	66.76	64.20	75.54*	69.79	3.65	3.79	4.16	4.54	4.04
Co27	61.59	58.95	58.30	69.83	62.17	4.53	5.20	5.03	5.35	5.03
SS032	62.95	59.20	66.80	66.50	63.86	4.82	6.67**	5.85	5.33	5.67
Testers Mean	64.04	59.07	64.23	66.39	63.43	4.17	5.25	5.17	5.13	5.06
Parental Mean	63.23	58.13	62.63	64.36	62.09	4.96	5.3	5.25	5.15	5.17
SE(d)	4.2185	4.7341	4.603	4.544	4.529	0.7427	0.479	0.525	0.574	0.589
CD at 5%	8.3146	9.331	9.072	8.956	8.876	1.4638	0.9442	1.036	1.131	1.154
CD at 1%	10.9723	12.3136	11.972	11.819	11.666	1.9317	1.246	1.367	1.493	1.517

Appendix 3. (contd.). Mean performance of hybrids in individual environments and pooled data for leaf length (cm) and leaf breadth (cm)

Characters	Leaf length					Leaf breadth				
	E ₁	E ₂	E ₃	E ₄	P	E ₁	E ₂	E ₃	E ₄	P
Hybrids										
296A x 68716	67.53	59.46	67.75	49.83	61.14	4.46	6.37	6.52	5.36	5.68
296A x 68740	68.27	65.78	68.19	56.33	64.65	4.43	6.61	6.66	5.41	5.78
296A x 68918	69.82	58.31	65.89	65.00	64.76	6.33	6.77	8.00**	7.75**	7.21*
296A x 68786	74.88	62.33	67.21	57.00	65.36	5.38	6.80	6.39	4.90	5.87
296A x 68814	74.83	68.00	72.42	62.00	69.31	5.77	6.19	6.87	6.02	6.21
296A x FS211	72.46	58.57	66.53	66.44	66.00	5.87	5.86	6.95	6.34	6.26
296A x FS205	63.13	59.09	74.23	56.13	63.15	6.47	6.91	7.53*	5.66	6.64
296A x FS9401	62.63	63.14	71.84	62.93	65.14	5.21	5.80	7.07	5.94	6.00
296A x SS003	67.64	62.57	68.08	60.56	64.71	5.31	6.17	7.37	5.65	6.12
296A x SS012	59.23	55.41	70.78	60.17	61.40	5.19	5.83	7.25	6.22	6.12
296A x SS020	70.17	72.76*	74.40	67.38	71.18	5.11	6.91	6.80	6.42	6.31
296A x SRV605	59.59	66.72	68.10	69.13	65.88	4.92	4.95	6.49	6.48	5.71
296A x FS9604	62.28	63.76	72.33	58.80	64.29	5.33	7.37**	7.22	6.52	6.61
296A x FS9605	66.80	63.79	72.51	63.14	66.56	4.84	5.86	5.97	4.75	5.35
296A x FS9601	65.29	60.37	71.25	69.33	66.56	4.78	5.69	6.82	5.87	5.79
296A x FS9603	66.07	59.69	72.68	64.36	65.70	4.96	5.63	6.83	5.76	5.79
296A x 68710	76.22	67.23	69.29	75.96*	72.18	6.10	6.07	6.75	6.12	6.26
296A x 68724	74.70	63.79	69.17	68.83	69.12	5.34	5.47	6.14	5.87	5.70
296A x 68726	71.45	60.77	61.08	56.35	62.41	4.95	5.30	5.49	4.70	5.11
296A x Co27	66.12	62.56	75.34	63.56	66.89	5.17	5.53	7.08	5.95	5.94
296A x SS032	60.20	64.05	63.71	56.91	61.22	5.42	6.31	7.67*	5.64	6.26
2219A x 68716	66.77	67.41	70.53	68.78	68.37	4.07	5.85	6.11	5.75	5.45
2219A x 68740	61.59	68.14	65.29	60.07	63.77	4.12	6.35	6.53	5.69	5.67
2219A x 68918	66.05	60.55	65.58	65.16	64.33	4.55	5.61	6.35	5.82	5.59
2219A x 68786	64.24	64.15	71.83	73.04	68.32	4.10	5.68	6.04	6.29	5.53
2219A x 68814	71.05	68.20	70.63	58.69	67.14	4.19	4.97	5.47	5.23	4.97
2219A x FS211	62.23	62.09	59.82	62.57	61.68	4.40	5.49	5.54	5.94	5.34
2219A x FS205	61.27	59.20	66.97	66.55	63.50	3.98	5.68	6.63	5.48	5.44
2219A x FS9401	63.09	60.43	70.64	61.80	63.99	4.94	5.68	5.92	5.87	5.60
2219A x SS003	66.02	64.77	70.38	67.27	67.11	4.62	5.59	6.06	5.88	5.54
2219A x SS012	62.20	52.82	58.16	62.11	58.82	4.49	5.53	5.79	5.62	5.36
2219A x SS020	66.80	59.73	68.49	70.89	66.48	3.75	5.90	6.33	5.98	5.49
2219A x SRV605	62.53	60.10	69.71	60.02	63.09	4.70	5.86	6.38	5.35	5.57

Appendix 3 (contd.)

Characters	Leaf length				Leaf breadth					
	E ₁	E ₂	E ₃	E ₄	P	E ₁	E ₂	E ₃	E ₄	P
Hybrids										
2219A x FS9604	65.37	53.60	71.87	67.15	64.50	4.38	6.28	7.31	5.24	5.80
2219A x FS9605	61.17	64.62	71.44	62.65	64.97	3.95	5.45	5.73	5.41	5.14
2219A x FS9601	61.50	60.22	63.55	63.87	62.28	4.21	5.21	5.25	5.41	5.02
2219A x FS9603	66.63	56.83	62.18	61.02	61.66	4.25	5.35	5.69	5.39	5.17
2219A x 68710	71.14	59.16	68.55	64.80	65.91	4.83	5.36	5.46	5.49	5.28
2219A x 68724	73.45	64.59	71.35	65.04	68.61	4.33	5.32	5.41	5.36	5.10
2219A x 68726	65.43	61.67	66.60	69.06	65.69	4.41	4.51	5.28	5.12	4.83
2219A x Co27	64.53	63.68	68.41	63.00	64.90	4.10	4.63	5.91	5.04	4.92
2219A x SS032	58.27	61.13	62.63	63.16	61.30	4.43	6.17	5.91	5.56	5.52
2077A x 68716	72.19	64.20	70.47	74.56*	70.36	5.67	6.43	6.80	6.67	6.39
2077A x 68740	63.31	67.51	69.71	62.66	65.80	5.36	7.36**	6.71	5.50	6.23
2077A x 68918	70.41	67.55	67.12	54.00	64.77	6.89*	7.28*	7.45	6.00	6.90
2077A x 68786	79.19**	73.58*	71.79	56.70	70.31	6.69	7.16*	6.12	4.45	6.10
2077A x 68814	78.51**	70.77	78.53*	69.23	74.26	6.07	6.07	7.14	5.95	6.31
2077A x FS211	74.64	68.97	65.75	67.73	69.27	6.09	6.63	6.50	5.93	6.29
2077A x FS205	65.50	60.13	74.27	58.28	64.55	5.44	5.83	7.80	5.13	6.05
2077A x FS9401	65.07	62.41	68.51	64.40	65.10	5.61	6.11	6.13	5.83	5.92
2077A x SS003	66.68	62.58	63.99	68.93	65.55	5.87	6.05	6.13	5.82	5.97
2077A x SS012	55.43	57.23	65.40	63.86	60.48	5.23	5.98	6.45	5.88	5.89
2077A x SS020	73.53	58.45	81.93**	82.62**	74.13	5.88	6.07	6.45	5.91	6.08
2077A x SRV605	61.40	58.65	74.91	59.26	63.55	5.15	6.41	6.05	5.06	5.67
2077A x FS9604	65.14	54.69	63.52	58.17	60.38	5.98	5.85	6.61	5.62	6.01
2077A x FS9605	70.36	64.62	76.28	76.23*	71.87	5.60	5.89	6.03	5.70	5.81
2077A x FS9601	66.80	64.00	66.49	68.03	66.33	5.61	5.37	5.59	5.57	5.54
2077A x FS9603	66.39	62.68	71.90	59.56	65.13	5.81	5.61	5.87	6.05	5.84
2077A x 68710	76.93*	68.29	76.22	71.57	73.25	6.29	6.58	6.07	5.20	6.04
2077A x 68724	77.87*	68.50	69.65	70.23	71.56	5.49	5.81	5.77	5.68	5.69
2077A x 68726	70.88	70.70	58.63	79.38**	69.90	5.35	5.24	5.14	5.76	5.38
2077A x Co27	67.67	66.29	59.57	74.91*	67.11	5.97	6.53	5.81	6.20	6.13
2077A x SS032	71.33	58.47	59.30	54.09	60.80	6.67	6.39	5.97	5.23	6.06
1111A x 68716	68.83	67.45	73.20	63.37	68.21	5.93	6.77	6.59	5.08	6.09
1111A x 68740	69.18	65.11	73.27	68.89	69.11	5.78	6.56	6.11	6.50	6.24
1111A x 68918	64.55	56.24	66.20	67.10	63.52	5.89	7.06*	7.09	6.47	6.63
1111A x 68786	69.69	63.31	68.93	67.71	67.41	7.16*	7.18*	6.52	6.17	6.76

Appendix 3 (contd.)

Characters	Leaf length				Leaf breadth					
	E ₁	E ₂	E ₃	E ₄	P	E ₁	E ₂	E ₃	E ₄	P
Hybrids										
111A x 68814	77.36*	70.04	76.00	79.47**	75.72*	5.74	6.01	6.29	6.50	6.14
111A x FS211	67.63	65.62	63.07	67.19	65.88	6.29	6.98	6.28	6.70	6.56
111A x FS205	61.00	61.18	65.76	67.80	63.93	5.69	7.54**	6.84	6.51	6.65
111A x FS9401	64.10	65.43	68.45	65.95	65.98	5.96	6.86	6.70	6.22	6.44
111A x SS003	65.77	56.99	62.32	65.15	62.56	6.73	6.26	6.67	6.34	6.50
111A x SS012	66.28	51.86	62.50	61.37	60.50	5.43	6.47	6.61	6.68	6.30
111A x SS020	68.93	58.02	76.81	68.40	68.04	4.88	6.27	7.00	6.21	6.09
111A x SRV605	61.24	55.69	68.47	59.28	61.17	4.56	5.97	6.99	5.69	5.80
111A x FS9604	66.54	60.47	70.93	62.94	65.22	4.92	6.19	6.78	6.32	6.05
111A x FS9605	67.41	56.93	73.25	76.40*	68.50	5.61	6.66	6.45	6.33	6.26
111A x FS9601	56.13	52.61	71.91	62.18	60.71	5.61	6.39	7.18	5.87	6.26
111A x FS9603	61.61	62.25	68.86	58.58	62.82	5.71	6.77	6.89	5.72	6.27
111A x 68710	73.90	68.87	68.09	72.33	70.80	6.33	6.48	6.33	6.51	6.41
111A x 68724	75.14	68.08	74.73	74.34*	73.07	5.85	6.31	6.31	6.41	6.22
111A x 68726	76.07*	63.05	71.73	77.26**	72.03	5.56	5.19	5.77	5.85	5.59
111A x Co27	64.75	63.02	72.85	68.05	67.17	5.65	6.41	6.80	5.77	6.16
111A x SS032	60.47	56.93	70.70	60.34	62.11	6.13	6.16	7.18	6.66	6.53
Hybrids Mean	67.22	62.51	69.04	65.18	65.99	5.31	6.09	6.44	5.83	5.93
SE(d)	4.2185	4.7341	4.603	4.544	4.529	0.7427	0.479	0.525	0.574	0.589
CD at 5%	8.3146	9.331	9.072	8.956	8.876	1.4638	0.9442	1.036	1.131	1.154
CD at 1%	10.9723	12.3136	11.972	11.819	11.666	1.9317	1.246	1.367	1.493	1.517

Appendix 4. Mean performance of parents in individual environments and pooled data for leaf stem ratio and stem thickness (cm)

Characters		Leaf stem				Stem				thickness	
Parents		E ₁	E ₂	E ₃	ratio E ₄	P	E ₁	E ₂	E ₃	E ₄	P
296A		0.40*	0.59*	0.32	0.29	0.40*	2.47	2.12	1.89	2.05	2.13
2219A		0.34	0.35	0.32	0.37*	0.35	1.94	2.06	1.91	1.48	1.85
2077A		0.29	0.43	0.40*	0.29	0.35	2.28	1.92	1.69	1.67	1.89
111A		0.30	0.40	0.34	0.35*	0.35	2.15	2.24	2.14	2.87*	2.35
Lines Mean		0.33	0.44	0.35	0.32	0.36	2.21	2.08	1.9	2.02	2.06
68716		0.23	0.29	0.30	0.23	0.26	1.40	1.73	1.60	1.72	1.61
68740		0.22	0.32*	0.30	0.27**	0.28	1.39	2.11	1.55	1.47	1.63
68918		0.28*	0.33**	0.32	0.25*	0.30**	2.14*	1.94	2.10	2.02	2.05
68786		0.28*	0.28	0.30	0.25*	0.28	1.61	2.06	1.95	1.66	1.82
68814		0.31**	0.31	0.34**	0.24	0.30**	1.58	1.70	1.71	1.96	1.74
FS211		0.26	0.23	0.21	0.26*	0.24	1.69	1.89	1.65	2.00	1.81
FS205		0.25	0.28	0.30	0.25*	0.27	1.55	1.99	1.90	1.72	1.79
FS9401		0.25	0.29	0.29	0.22	0.26	1.61	2.12	1.92	1.61	1.81
SS003		0.29**	0.29	0.25	0.24	0.27	1.58	1.88	1.72	1.90	1.77
SS012		0.23	0.23	0.27	0.23	0.24	1.77	2.09	1.88	1.37	1.78
SS020		0.23	0.24	0.22	0.20	0.22	1.61	2.05	1.94	1.58	1.79
SRV605		0.23	0.27	0.26	0.18	0.24	1.33	2.09	2.63**	1.57	1.90
FS9604		0.23	0.33**	0.25	0.16	0.24	1.46	1.98	1.68	1.53	1.66
FS9605		0.26	0.29	0.30	0.19	0.26	1.71	2.16	1.80	1.57	1.81
FS9601		0.22	0.25	0.20	0.23	0.23	1.81	1.90	1.72	1.51	1.73
FS9603		0.24	0.30	0.31	0.24	0.27	1.56	1.84	1.88	1.65	1.73
68710		0.22	0.33**	0.40**	0.34**	0.32**	1.44	2.15	2.09	1.97	1.91
68724		0.26	0.32*	0.36**	0.19	0.28	1.79	1.70	1.37	1.75	1.65
68726		0.25	0.25	0.31	0.20	0.25	1.56	1.57	1.84	1.50	1.62
Co27		0.21	0.38**	0.30	0.17	0.27	1.79	1.96	1.82	1.96	1.88
SS032		0.32**	0.27	0.26	0.21	0.27	1.72	2.50*	2.13	1.94	2.07
Testers Mean		0.25	0.29	0.29	0.23	0.26	1.62	1.97	1.85	1.71	1.79
Parental Mean		0.26	0.31	0.28	0.24	0.28	1.72	1.99	1.86	1.76	1.83
SE(d)		0.0165	0.016	0.016	0.016	0.016	0.2468	0.2409	0.302	0.244	0.260
CD at 5%		0.0325	0.0315	0.032	0.032	0.032	0.4865	0.4747	0.594	0.481	0.509
CD at 1%		0.0429	0.0415	0.042	0.042	0.042	0.642	0.6265	0.784	0.635	0.669

Appendix 4. (contd.). Mean performance of hybrids in individual environments and pooled data for leaf stem ratio and stem thickness (cm)

Characters	Leaf stem				Stem			
	E ₁	E ₂	E ₃	P	E ₁	E ₂	E ₃	P
Hybrids								
296A x 68716	0.18	0.33**	0.29*	0.16	1.90	1.95	1.89	1.93
296A x 68740	0.23	0.28	0.29*	0.29**	1.97	2.28	2.10	2.05
296A x 68918	0.22	0.30	0.22	0.27**	2.29	1.75	2.56	2.27
296A x 68786	0.21	0.24	0.30**	0.26	2.28	2.01	2.36	2.12
296A x 68814	0.25*	0.30	0.28	0.37**	2.44	1.80	2.09	2.14
296A x FS211	0.22	0.32*	0.21	0.23	2.21	1.99	2.37	2.16
296A x FS205	0.20	0.29	0.27	0.21	1.71	2.01	2.41	2.07
296A x FS9401	0.19	0.30	0.29*	0.22	1.85	1.73	2.40	2.01
296A x SS003	0.22	0.30	0.25	0.21	2.07	1.60	2.40	2.00
296A x SS012	0.18	0.31	0.20	0.19	1.94	1.73	2.30	1.98
296A x SS020	0.21	0.30	0.25	0.21	2.07	2.30	2.50	2.24
296A x SRV605	0.19	0.42**	0.24	0.29**	1.97	1.58	2.64	2.09
296A x FS9604	0.18	0.30	0.41**	0.18	2.18	2.20	2.83	2.34
296A x FS9605	0.20	0.26	0.27	0.23	1.96	1.70	2.11	1.84
296A x FS9601	0.20	0.28	0.23	0.24*	1.91	1.73	2.27	1.99
296A x FS9603	0.24	0.30	0.28	0.19	1.97	1.85	1.98	1.91
296A x 68710	0.19	0.25	0.22	0.29**	2.33	1.64	2.01	1.98
296A x 68724	0.18	0.29	0.21	0.22	2.25	1.60	1.95	1.89
296A x 68726	0.21	0.24	0.22	0.24*	2.16	1.58	1.67	1.76
296A x Co27	0.22	0.32*	0.27	0.19	2.14	1.73	2.15	1.92
296A x SS032	0.21	0.27	0.26	0.19	2.24	1.96	2.36	2.10
2219A x 68716	0.23	0.28	0.31**	0.24*	1.94	1.94	2.29	2.05
2219A x 68740	0.21	0.30	0.28	0.24*	1.63	1.87	2.29	1.91
2219A x 68918	0.24	0.34**	0.26	0.22	1.96	1.90	2.11	2.04
2219A x 68786	0.23	0.32*	0.30**	0.21	1.81	1.82	2.10	1.98
2219A x 68814	0.21	0.30	0.27	0.22	1.84	1.73	1.91	1.84
2219A x FS211	0.25*	0.28	0.22	0.21	1.74	1.80	2.02	1.91
2219A x FS205	0.26**	0.33**	0.31**	0.19	1.65	1.90	2.05	1.87
2219A x FS9401	0.24	0.31	0.30**	0.25**	1.54	1.85	2.06	1.86
2219A x SS003	0.24	0.31	0.32**	0.20	1.67	1.93	2.11	1.93
2219A x SS012	0.19	0.29	0.27	0.18	1.68	1.80	2.52	1.99
2219A x SS020	0.24	0.32*	0.30**	0.19	1.57	1.60	2.20	1.89
2219A x SRV605	0.23	0.29	0.27	0.18	1.70	1.80	2.16	1.92

Appendix 4 (contd..)

Characters	Leaf stem				Ratio	Stem				thickness	
	E ₁	E ₂	E ₃	E ₄		P	E ₁	E ₂	E ₃	E ₄	P
Hybrids											
2219A x FS9604	0.26**	0.33**	0.28	0.18	0.26	1.49	1.67	2.45	2.03	1.91	
2219A x FS9605	0.28	0.31	0.30**	0.23	0.28*	1.64	1.73	1.98	1.91	1.82	
2219A x FS9601	0.21	0.25	0.27	0.22	0.24	1.86	1.71	2.01	1.94	1.88	
2219A x FS9603	0.23	0.28	0.25	0.20	0.24	1.58	1.58	2.15	1.90	1.80	
2219A x 68710	0.23	0.33**	0.24	0.17	0.24	1.77	1.80	2.34	1.88	1.95	
2219A x 68724	0.24	0.29	0.23	0.21	0.24	1.94	1.90	1.98	2.08	1.98	
2219A x 68726	0.23	0.29	0.23	0.22	0.24	1.89	1.70	1.92	1.79	1.82	
2219A x Co27	0.26**	0.29	0.22	0.25**	0.26	1.88	1.78	2.04	2.02	1.93	
2219A x SS032	0.22	0.30	0.27	0.22	0.25	2.06	2.18	2.39	2.06	2.17	
2077A x 68716	0.25*	0.30	0.22	0.14	0.23	2.12	2.14	2.28	2.14	2.17	
2077A x 68740	0.20	0.31	0.27	0.20	0.25	2.27	2.29	2.34	1.98	2.22	
2077A x 68918	0.24	0.29	0.25	0.35**	0.28*	2.42	2.30	2.46	1.98	2.29	
2077A x 68786	0.21	0.26	0.28	0.22	0.24	2.61*	2.20	2.65	2.00	2.37	
2077A x 68814	0.23	0.30	0.32**	0.18	0.26	2.22	2.02	2.55	1.85	2.16	
2077A x FS211	0.28**	0.26	0.21	0.19	0.24	2.08	2.03	2.40	1.96	2.12	
2077A x FS205	0.21	0.32*	0.24	0.21	0.25	1.83	1.96	2.67	1.73	2.05	
2077A x FS9401	0.19	0.27	0.20	0.20	0.22	2.01	2.12	2.32	1.84	2.07	
2077A x SS003	0.23	0.29	0.22	0.17	0.23	1.75	1.99	2.33	1.67	1.94	
2077A x SS012	0.23	0.32*	0.22	0.18	0.24	1.99	1.95	2.42	1.75	2.03	
2077A x SS020	0.20	0.26	0.30**	0.29**	0.26	1.78	2.02	2.33	1.86	2.00	
2077A x SRV605	0.14	0.25	0.30**	0.18	0.22	2.07	2.18	2.51	1.63	2.10	
2077A x FS9604	0.19	0.32	0.30**	0.18	0.25	1.95	1.75	2.31	1.78	1.95	
2077A x FS9605	0.25*	0.29	0.22	0.21	0.24	1.86	2.14	2.08	1.88	1.99	
2077A x FS9601	0.21	0.28	0.26	0.24*	0.25	2.44	2.11	2.09	1.76	2.10	
2077A x FS9603	0.21	0.26	0.27	0.19	0.23	2.79**	1.97	2.16	2.01	2.23	
2077A x 68710	0.22	0.27	0.28	0.21	0.25	2.10	2.12	2.25	1.84	2.08	
2077A x 68724	0.25*	0.27	0.23	0.18	0.23	2.18	1.98	2.38	1.66	2.05	
2077A x 68726	0.16	0.25	0.26	0.21	0.22	2.11	1.93	2.03	1.77	1.96	
2077A x Co27	0.23	0.24	0.25	0.20	0.23	2.72**	2.24	2.47	2.09	2.38	
2077A x SS032	0.16	0.28	0.25	0.19	0.22	2.72**	1.64	2.38	1.95	2.17	
1111A x 68716	0.21	0.26	0.24	0.26**	0.24	1.82	2.06	2.36	1.90	2.04	
1111A x 68740	0.22	0.31	0.28	0.23	0.26	1.87	2.02	2.20	2.00	2.02	
1111A x 68918	0.27**	0.28	0.17	0.23	0.24	1.96	1.96	2.45	2.13	2.13	
1111A x 68786	0.21	0.29	0.27	0.24*	0.25	2.39	2.15	2.36	2.09	2.25	

Characters		Leaf stem					Stem					thickness	
		E ₁	E ₂	E ₃	E ₄	P	E ₁	E ₂	E ₃	E ₄	P		
Hybrids													
	111A x 68814	0.21	0.25	0.25	0.22	0.23	1.88	1.95	2.22	2.01		2.02	
	111A x FS211	0.21	0.25	0.18	0.21	0.21	1.86	2.57**	2.12	2.04		2.15	
	111A x FS205	0.23	0.26	0.28	0.18	0.24	1.79	1.97	2.32	2.04		2.03	
	111A x FS9401	0.18	0.26	0.27	0.19	0.23	1.85	1.97	2.21	1.88		1.98	
	111A x SS003	0.20	0.31	0.22	0.22	0.24	2.26	1.91	2.36	2.13		2.17	
	111A x SS012	0.21	0.28	0.20	0.19	0.22	2.09	1.95	2.10	2.38		2.13	
	111A x SS020	0.23	0.35**	0.27	0.17	0.26	1.82	1.81	2.53	2.00		2.04	
	111A x SRV605	0.19	0.29	0.29	0.18	0.24	1.75	1.82	2.51	1.72		1.95	
	111A x FS9604	0.24	0.37**	0.30**	0.18	0.27	2.22	1.71	2.32	1.99		2.06	
	111A x FS9605	0.21	0.31	0.23	0.16	0.23	1.86	1.76	2.16	1.87		1.91	
	111A x FS9601	0.19	0.23	0.30**	0.21	0.23	1.81	1.95	2.48	1.83		2.02	
	111A x FS9603	0.20	0.27	0.29*	0.22	0.25	1.81	2.18	2.36	1.80		2.04	
	111A x 68710	0.22	0.27	0.17	0.19	0.21	2.08	1.84	2.25	2.13		2.08	
	111A x 68724	0.23	0.28	0.22	0.20	0.23	1.89	1.99	2.55	2.14		2.14	
	111A x 68726	0.22	0.29	0.23	0.22	0.24	1.86	1.80	2.11	1.93		1.92	
	111A x Co27	0.23	0.28	0.25	0.19	0.24	1.67	1.93	2.72	1.79		2.03	
	111A x SS032	0.23	0.28	0.22	0.22	0.24	1.88	1.89	2.76	2.15		2.17	
	Hybrids Mean	0.22	0.29	0.26	0.21	0.25	1.99	1.92	2.28	1.95		2.03	
SE(d)													
	CD at 5%	0.0165	0.016	0.016	0.016	0.016	0.2458	0.2409	0.302	0.244		0.260	
	CD at 1%	0.0325	0.0315	0.032	0.032	0.032	0.4865	0.4747	0.594	0.481		0.509	
		0.0429	0.0415	0.042	0.042	0.042	0.642	0.6265	0.784	0.635		0.669	

Appendix 5. Mean performance of parents in individual environments and pooled data for Hydrocyanic acid (ppm) and total soluble solids (per cent)

Characters		Hydrocyanic acid					Total soluble solids				
Parents	E ₁	E ₂	E ₃	E ₄	P	E ₁	E ₂	E ₃	E ₄	P	
296A	59.98	73.47	23.33	48.35	51.28	5.33	8.00	6.00	6.00	6.33	
2219A	73.37	173.37*	42.33	108.35*	99.36*	7.67*	11.50*	9.00	10.50	9.67	
2077A	113.37*	140.00	50.02*	95.01*	99.60*	5.67	7.50	10.50	10.50	8.54	
1111A	86.67	113.37	43.33	78.35	80.43	6.33	11.50*	10.00	10.00	9.46	
Lines Mean	83.35	125.05	39.75	82.52	82.67	6.25	9.63	8.80	9.23	8.50	
68716	56.67	80.00	33.33	56.67	56.67	10.33	7.50	5.00	4.50	6.83	
68740	36.67	86.53	23.33	55.00	50.38	7.33	7.00	6.50	6.50	6.83	
68918	36.67	83.33	23.33	53.33	49.17	12.67**	10.00	6.50	6.50	8.92	
68786	73.33**	100.00	23.33	61.67	64.58	12.00**	7.00	5.00	5.00	7.25	
68814	43.33	73.33	40.00	56.67	53.33	7.33	8.00	7.00	7.00	7.33	
FS211	63.35**	100.00	33.33	66.45	65.78	14.33**	11.00	10.00*	10.00**	11.33**	
FS205	40.00	133.35	23.33	78.34	68.76	8.33	10.00	10.50**	10.00**	9.71	
FS9401	36.66	73.33	33.33	53.33	49.16	11.67**	8.00	10.50**	10.50**	10.17*	
SS003	23.32	100.00	23.33	61.67	52.08	8.00	8.00	5.50	5.50	6.75	
SS012	26.67	100.00	23.33	61.67	52.92	7.67	9.00	5.50	5.50	6.92	
SS020	23.33	173.32**	23.33	98.33**	79.58	6.67	12.00**	6.00	6.00	7.67	
SRV605	36.67	70.00	76.67**	88.34**	67.92	4.67	13.00**	8.00	7.50	8.29	
FS9604	26.67	186.67**	23.33	105.00**	85.42**	8.00	14.50**	9.00	9.00*	10.13*	
FS9605	26.67	140.00	23.33	81.67	67.92	7.00	7.50	10.00*	10.00**	8.63	
FS9601	59.98**	173.33**	23.33	98.33**	88.74**	10.33	10.00	6.00	6.00	8.08	
FS9603	86.67**	140.00*	90.00**	115.00**	107.92**	7.33	10.00	6.00	6.00	7.33	
68710	113.37**	140.00*	23.33	81.67	89.59**	7.67	10.00	8.00	8.00	8.42	
68724	100.00**	113.33	40.01*	76.67	82.50*	14.00**	7.50	7.50	7.50	9.13	
68726	86.67**	186.67**	43.33**	115.00**	107.92**	12.33**	10.00	6.50	6.50	8.83	
Co27	33.33	186.67**	43.33**	115.00**	94.58**	7.67	8.00	7.00	8.50	7.79	
SS032	60.00**	73.33	23.33	48.22	51.22	6.33	10.00	10.50**	7.00	8.46	
Testers Mean	51.91	119.67	33.97	77.52	70.76	9.13	9.43	7.45	7.28	8.32	
Parental Mean	56.94	120.53	34.89	78.32	72.67	8.67	9.46	7.68	7.6	8.35	
SE(d)	2.9893	8.4097	2.954	2.433	4.856	0.6303	0.9398	1.023	0.825	0.867	
CD at 5%	5.892	16.5755	5.823	4.795	9.517	1.2423	1.8523	2.016	1.626	1.700	
CD at 1%	7.7753	21.8737	7.684	6.328	12.508	1.6393	2.4444	2.661	2.146	2.234	

Appendix 5. (contd.). Mean performance of hybrids in individual environments and pooled data for Hydrocyanic acid (ppm) and total soluble solids (per cent)

Characters	Hydrocyanic Acid					Total soluble Solids				
	E ₁	E ₂	E ₃	E ₄	P	E ₁	E ₂	E ₃	E ₄	P
Hybrids										
296A x 68716	86.64**	133.37**	80.00**	106.69**	101.68**	7.67	6.83	6.67	5.67	6.71
296A x 68740	86.66**	173.32**	106.65**	139.99**	126.66**	10.33**	10.00	6.67	6.00	8.25
296A x 68918	76.65**	100.00	73.33**	86.67**	84.16*	7.67	8.50	6.67	6.33	7.29
296A x 68786	86.66**	140.00**	43.33	91.34**	90.33**	6.00	8.33	7.33	7.33	7.25
296A x 68814	99.98**	76.67	73.33**	91.67**	85.41**	8.33	8.00	10.00**	9.33**	8.92
296A x FS211	100.00**	100.00	53.33	76.67	82.50*	12.67**	8.33	8.00	8.00	9.25
296A x FS205	53.30	93.32	53.33	93.33**	73.32	12.33**	7.33	6.00	6.00	7.92
296A x FS9401	86.67**	100.00	106.65**	103.33**	99.16**	6.33	8.33	6.00	5.67	6.58
296A x SS003	76.66**	100.00	36.67	68.34	70.42	10.33**	7.33	7.33	6.67	7.92
296A x SS012	53.29	133.33**	100.07**	116.67**	100.84**	7.33	6.00	8.00	7.33	7.17
296A x SS020	56.67	73.32	36.67	55.00	55.42	11.33**	10.33	7.00	6.67	8.83
296A x SRV605	56.67	173.33**	90.00**	131.67**	112.92**	9.33	11.00*	6.33	5.33	8.00
296A x FS9604	123.33**	140.00**	43.33	91.67**	99.58**	6.33	8.00	7.67	5.67	6.92
296A x FS9605	43.32	73.33	63.33**	68.33	62.08	7.67	10.33	8.00	7.67	8.42
296A x FS9601	53.33	100.00	86.68**	93.34**	83.34*	11.33**	10.00	10.00**	9.67**	10.25**
296A x FS9603	123.33**	140.00**	86.68**	113.34**	115.84**	9.67*	10.67	7.67	6.67	8.67
296A x 68710	46.32	73.33	33.33	53.33	51.58	8.67	10.33	9.67*	9.67**	9.58*
296A x 68724	36.67	136.67**	73.33**	105.00**	87.92**	9.67*	10.33	9.67*	9.33**	9.75*
296A x 68726	73.33**	86.67	56.67**	71.67	72.09	8.33	11.67**	7.33	6.67	8.50
296A x Co27	73.32**	173.33**	56.66**	115.00**	104.58**	8.33	9.67	9.33*	8.67*	9.00
296A x SS032	73.30**	110.00	53.33	81.67	79.58	9.00	10.67	7.33	6.67	8.42
2219A x 68716	23.33	140.00**	53.33	96.67**	78.33	9.00	6.33	8.00	7.00	7.58
2219A x 68740	113.36**	140.00**	36.67	88.34**	94.59**	5.67	9.00	7.00	7.00	7.17
2219A x 68918	73.35**	113.37	86.67**	100.02**	93.35**	8.00	6.67	7.33	6.67	7.17
2219A x 68786	43.32	113.37	23.33	68.35	62.09	6.33	6.33	6.00	5.33	6.00
2219A x 68814	100.02**	33.33	23.33	28.33	46.25	12.33**	10.33	5.67	5.67	8.50
2219A x FS211	140.00**	150.02**	40.00	95.01**	106.26**	6.33	7.67	8.67	9.67**	8.08
2219A x FS205	23.33	140.00**	23.33	81.67	67.08	10.33**	6.00	9.67*	9.00**	8.75
2219A x FS9401	36.67	133.33**	40.00	86.67**	74.17	6.67	10.33	7.00	6.67	7.67
2219A x SS003	36.67	133.33**	23.33	78.33	67.92	5.67	8.67	10.67**	9.67**	8.67
2219A x SS012	43.33	140.00**	23.33	81.67	72.08	9.33	11.00*	9.67*	8.67*	9.67*
2219A x SS020	46.67	140.00**	23.33	81.67	72.92	7.33	9.67	7.00	7.33	7.83
2219A x SRV605	56.67	113.33	23.33	68.33	65.42	6.00	7.33	7.00	6.33	6.67

222

Appendix 5 (contd..)

Characters	Hydrocyanic Acid					Total soluble Solids				
	E ₁	E ₂	E ₃	E ₄	P	E ₁	E ₂	E ₃	E ₄	P
Hybrids										
2219A x FS9604	56.67	110.00	23.33	66.67	64.17	10.33**	11.67**	7.00	6.67	8.92
2219A x FS9605	26.67	53.35	33.33	43.34	39.17	5.67	13.33**	9.67*	9.00**	9.42
2219A x FS9601	23.32	106.68	33.33	70.01	58.34	6.33	10.00	9.00	8.67*	8.50
2219A x FS9603	106.66**	110.00	90.00**	100.00**	101.67**	6.00	8.00	7.33	7.00	7.08
2219A x 68710	23.33	106.68	26.00	66.34	55.59	7.33	8.33	10.00**	9.00**	8.67
2219A x 68724	23.32	73.32	33.33	53.33	45.83	6.33	9.67	11.33**	10.67**	9.50*
2219A x 68726	36.67	100.00	33.33	66.67	59.17	10.67**	9.67	9.33*	9.33**	9.75*
2219A x Co27	73.35**	100.00	23.33	56.67	63.34	5.67	12.67**	7.67	7.33	8.33
2219A x SS032	23.35	136.66**	23.22	75.00	64.56	7.33	11.33	10.33**	9.33**	9.58*
2077A x 68716	33.33	93.35	70.00**	81.68	69.59	6.33	5.00	5.67	5.00	5.50
2077A x 68740	46.67	110.00	93.03**	101.52**	87.81**	11.00**	7.00	5.00	5.00	7.00
2077A x 68918	60.00*	106.66	23.33	65.00	63.75	5.33	7.67	5.00	4.67	5.67
2077A x 68786	26.66	106.66	23.33	65.00	55.41	5.67	5.00	5.00	4.33	5.00
2077A x 68814	33.33	53.33	53.33	53.33	48.33	9.00	9.00	6.33	6.00	7.58
2077A x FS211	46.66	130.00*	46.66	88.33**	77.91	11.00**	10.00	6.33	5.33	8.17
2077A x FS205	23.33	73.32	23.33	48.33	42.08	6.33	5.33	5.17	5.50	5.58
2077A x FS9401	33.33	73.33	23.33	48.33	44.58	7.00	7.33	6.00	6.00	6.58
2077A x SS003	33.33	106.66	33.33	69.99	60.83	9.00	8.00	6.00	5.00	7.00
2077A x SS012	46.66	73.33	73.33**	73.33	66.66	9.33	7.00	5.00	4.67	6.50
2077A x SS020	36.67	73.33	23.33	48.33	45.42	7.67	9.67	6.33	5.67	7.33
2077A x SRV605	36.67	86.66	23.33	55.08	50.44	6.00	7.67	6.00	5.33	6.25
2077A x FS9604	73.32**	113.35	53.33	83.34	80.84	10.33**	13.67**	4.67	4.33	8.25
2077A x FS9605	36.68	93.33	53.23	73.33	64.14	10.33	11.67**	5.67	5.00	8.17
2077A x FS9601	46.67	73.33	23.33	48.33	47.92	9.00	8.00	7.00	6.67	7.67
2077A x FS9603	53.33	123.33	36.66	80.00	73.33	8.00	8.00	6.67	6.00	7.17
2077A x 68710	43.33	110.00	23.33	66.67	60.83	5.00	7.67	7.00	6.67	6.58
2077A x 68724	26.65	140.00**	36.67	88.34**	72.92	4.33	10.33	5.33	6.67	6.67
2077A x 68726	56.65	73.33	23.33	48.33	50.41	10.67**	9.00	6.00	6.00	7.92
2077A x Co27	23.33	106.66	23.33	65.00	54.58	9.00	9.00	8.33	7.67	8.50
2077A x SS032	23.33	66.65	33.33	49.99	43.33	6.00	9.33	6.00	5.67	6.75
111A x 68716	60.00*	113.33	58.33**	85.83**	79.37	11.67**	5.00	6.00	5.67	7.08
111A x 68740	23.33	130.00*	83.33**	106.67**	85.83**	8.33	6.33	5.33	6.67	6.67
111A x 68918	33.33	106.62	73.33**	90.00**	75.82	8.67	7.67	6.33	6.33	7.25
111A x 68786	26.65	86.62	33.33	60.00	51.65	10.33**	7.33	4.00	4.00	6.42

Appendix 5 (contd..)

Characters	Hydrocyanic					Acid					Total soluble Solids				
	E ₁	E ₂	E ₃	E ₄	P	E ₁	E ₂	E ₃	E ₄	P	E ₁	E ₂	E ₃	E ₄	P
Hybrids															
I11A x 68814	23.33	106.66	33.33	70.00	58.33	7.00	7.00	5.00	5.00	6.00	7.00	7.00	5.00	5.00	6.00
I11A x FS211	33.30	90.00	56.66**	73.33	63.32	7.33	10.00	6.33	6.33	7.50	7.33	10.00	6.33	6.33	7.50
I11A x FS205	23.33	56.64	32.33	45.00	39.33	12.33**	8.33	6.00	6.67	8.33	12.33**	8.33	6.00	6.67	8.33
I11A x FS9401	36.67	150.02**	33.33	91.68**	77.93	11.67**	8.33	5.67	5.67	7.83	11.67**	8.33	5.67	5.67	7.83
I11A x SS003	53.33	106.66	33.33	70.00	65.83	7.67	8.00	7.00	7.00	7.42	7.67	8.00	7.00	7.00	7.42
I11A x SS012	23.30	130.00*	60.00**	95.00**	77.08	9.67*	7.67	6.33	6.33	7.50	9.67*	7.67	6.33	6.33	7.50
I11A x SS020	23.33	163.04**	36.66	99.85**	80.72	6.67	7.00	6.33	6.33	6.58	6.67	7.00	6.33	6.33	6.58
I11A x SRV605	73.33**	140.00**	56.66**	98.33**	92.08**	9.00	9.00	6.00	6.00	7.50	9.00	9.00	6.00	6.00	7.50
I11A x FS9604	90.00**	106.66	23.33	65.00	71.25	10.00**	13.33**	6.67	7.33	9.33	10.00**	13.33**	6.67	7.33	9.33
I11A x FS9605	23.33	120.00	23.33	71.67	59.58	6.67	13.67**	9.00	9.33**	9.67*	6.67	13.67**	9.00	9.33**	9.67*
I11A x FS9601	33.33	106.66	60.00**	83.33	70.83	6.33	7.67	8.33	8.33	7.67	6.33	7.67	8.33	8.33	7.67
I11A x FS9603	43.33	186.67**	113.35**	150.01**	123.34**	7.33	13.33**	6.33	6.33	8.33	7.33	13.33**	6.33	6.33	8.33
I11A x 68710	23.33	130.00	103.12	116.68**	93.28**	12.00**	10.67	6.67	6.67	9.00	12.00**	10.67	6.67	6.67	9.00
I11A x 68724	100.00**	106.66	56.66**	81.66	86.25**	7.33	10.67	6.67	6.67	7.83	7.33	10.67	6.67	6.67	7.83
I11A x 68726	86.65**	66.64	36.67	51.67	60.41	11.33**	9.00	6.67	7.00	8.50	11.33**	9.00	6.67	7.00	8.50
I11A x Co27	23.33	106.66	23.33	65.00	54.58	8.33	7.33	8.67	8.33	8.17	8.33	7.33	8.67	8.33	8.17
I11A x SS032	23.33	130.00	90.00	110.00**	88.33**	9.33	10.67	6.67	7.00	8.42	9.33	10.67	6.67	7.00	8.42
Hybrids Mean	52.57	110.03	48.60	79.64	72.71	8.37	8.92	7.12	6.82	7.81	8.37	8.92	7.12	6.82	7.81
SE(d)	2.9893	8.4097	2.954	2.433	4.856	0.6303	0.9398	1.023	0.825	0.867	0.6303	0.9398	1.023	0.825	0.867
CD at 5%	5.892	16.5755	5.823	4.795	9.517	1.2423	1.8523	2.016	1.626	1.700	1.2423	1.8523	2.016	1.626	1.700
CD at 1%	7.7753	21.8737	7.684	6.328	12.508	1.6393	2.4444	2.661	2.146	2.234	1.6393	2.4444	2.661	2.146	2.234

25

Appendix 6. Mean performance of parents in individual environments and pooled data for crude protein (per cent) and dry fodder yield (g)

Characters	Crude protein					Dry fodder yield				
	E ₁	E ₂	E ₃	E ₄	P	E ₁	E ₂	E ₃	E ₄	P
Parents										
296A	7.53	7.88	8.23	7.00	7.66	21.28	31.94	33.24	32.90	29.84
2219A	7.35	8.14	8.92*	7.26	7.92	7.56	13.26	23.77	39.15	20.94
2077A	8.40*	8.84*	9.27*	7.96*	8.62*	16.11	33.57	71.18*	46.19	41.76
111A	8.40*	8.14	7.88	7.26	7.92	20.77	24.96	50.61	48.71	36.26
Lines Mean	7.92	8.25	8.58	7.37	8.03	16.43	25.94	44.69	41.73	32.20
68716	7.88	8.31	8.75**	7.44	8.10	47.90	47.49	101.91	36.99	58.57
68740	8.23	8.06	7.90	7.19	7.85	38.21	83.20**	117.94*	92.52**	82.97*
68918	7.88	7.53	7.88	7.00	7.57	68.10**	56.34	56.30	36.24	54.25
68786	7.88	8.05	8.23	7.18	7.84	79.59**	137.73**	183.98**	122.09**	130.85**
68814	8.40*	8.31	8.23	7.44	8.10	51.10	69.91	74.83	22.81	54.66
FS211	7.53	7.61	7.70	6.74	7.40	68.12**	64.89	75.96	52.99	65.49
FS205	7.88	7.92	8.23	7.01	7.76	49.28	80.10**	89.57	59.77	69.68
FS9401	7.53	7.44	7.35	6.56	7.22	51.41	70.46	108.68	64.90	73.86
SS003	7.53	8.40*	9.28**	7.53*	8.19	61.13	35.80	49.50	33.52	44.99
SS012	8.23	8.23	8.23	7.35	8.01	42.75	27.50	44.28	28.96	35.87
SS020	7.35	7.79	8.22	6.91	7.57	49.71	40.87	91.67	55.85	59.53
SRV605	7.88	8.23	8.58*	7.35	8.01	44.08	76.95*	60.24	88.96**	67.56
FS9604	7.35	8.31	9.28**	7.44	8.10	52.01	49.85	67.78	57.93	56.89
FS9605	8.23	8.58**	8.93**	7.70*	8.36**	45.34	60.74	70.96	45.97	55.75
FS9601	7.88	7.96	8.05	7.09	7.75	44.52	44.02	109.59	55.65	63.45
FS9603	8.93**	8.31	9.27**	7.44	8.49**	45.49	53.18	104.39	107.78**	77.71
68710	8.23	7.96	7.00	7.09	7.57	48.04	89.69**	66.48	40.29	61.12
68724	9.28**	8.31	7.35	7.44	8.10	73.91**	58.34	61.01	133.55**	81.70
68726	8.40*	7.70	7.00	6.83	7.48	68.86**	79.35**	99.14	99.82**	86.79*
Co27	8.40*	8.49**	8.58*	7.61**	8.27*	79.71**	51.02	103.97	49.31	71.00
SS032	8.93**	8.31	7.70	8.22**	8.29**	58.18	65.31	176.93**	57.35	89.44**
Testers Mean	8.09	8.08	8.17	7.27	7.9	55.59	63.94	91.12	63.96	68.67
Parental Mean	8.06	8.12	8.24	7.28	7.92	49.32	57.86	83.76	60.41	62.84
SE(d)	0.1459	0.1521	0.187	0.131	0.155	3.0957	5.8133	11.667	5.118	7.171
CD at 5%	0.2876	0.2999	0.369	0.259	0.305	6.1017	11.458	22.995	10.087	14.055
CD at 1%	0.3795	0.3957	0.487	0.341	0.401	8.0521	15.1204	30.345	13.311	18.472

Appendix 6. (contd.). Mean performance of hybrids in individual environments and pooled data for crude protein (per cent) and dry fodder yield (g)

Characters	Crude protein				Dry fodder				Yield	P
	E ₁	E ₂	E ₃	E ₄	P	E ₁	E ₂	E ₃	E ₄	
Hybrids										
296A x 68716	9.28**	10.15**	11.03**	9.28**	9.94**	58.80	59.56	77.98	39.83	59.04
296A x 68740	9.10*	9.36	9.63	8.49	9.15	54.55	106.19**	128.61	52.11	85.36
296A x 68918	8.75	9.54*	10.33**	8.66*	9.32	66.40	70.49	57.99	62.61	64.37
296A x 68786	9.63**	8.66	7.70	7.79	8.45	64.42	89.69	92.96	40.05	71.78
296A x 68814	9.10*	9.71**	10.33**	8.84**	9.50**	70.72	83.35	89.46	60.31	75.96
296A x FS211	7.88	9.28	10.68**	8.40	9.06	49.35	66.93	101.75	60.62	69.66
296A x FS205	7.18	8.58	9.98	7.70	8.36	51.35	61.95	108.13	65.32	71.69
296A x FS9401	9.10*	9.71**	10.33**	8.84**	9.50**	50.03	66.29	125.00	56.70	74.51
296A x SS003	7.00	8.75	10.50**	7.88	8.53	41.87	58.01	117.51	49.55	66.74
296A x SS012	8.75	9.63**	10.50**	8.75**	9.41*	44.13	44.26	68.20	42.77	49.84
296A x SS020	7.18	8.84	10.50**	7.96	8.62	43.96	79.65	121.78	61.07	76.62
296A x SRV605	7.00	9.28	11.55**	8.40	9.06	62.54	60.34	120.81	46.92	72.65
296A x FS9604	7.88	9.19	10.50**	8.31	8.97	36.75	97.33**	178.61**	53.43	91.53
296A x FS9605	7.88	7.96	8.05	7.09	7.75	42.56	83.65	96.16	46.12	67.12
296A x FS9601	9.63**	9.63**	9.63	8.75**	9.41*	60.67	80.60	139.49	72.29	88.26
296A x FS9603	7.18	8.75	10.33**	7.88	8.54	53.06	59.67	119.51	94.65*	81.72
296A x 68710	7.00	7.44	7.88	6.56	7.22	73.46**	75.22	145.38*	56.88	87.74
296A x 68724	8.75	9.36	9.98	8.49	9.15	115.67**	83.11	164.14**	56.60	104.88*
296A x 68726	9.10*	8.40	7.70	7.53	8.18	113.52**	116.71**	191.45**	89.67	127.84**
296A x Co27	8.75	9.71**	10.68**	8.84**	9.50**	71.00*	82.16	104.05	74.55	82.94
296A x SS032	9.28**	9.01	8.75	8.14	8.80	58.76	105.45**	146.12*	59.68	92.50
2219A x 68716	8.75	9.19	9.63	8.31	8.97	50.29	119.89**	122.64	115.30**	102.03*
2219A x 68740	9.63**	9.98**	10.33**	9.10**	9.76**	44.84	103.24**	87.46	79.48	78.76
2219A x 68918	9.28**	10.33**	11.38**	9.45**	10.11**	58.04	42.27	108.06	68.35	69.18
2219A x 68786	8.75	9.71**	10.68**	8.84**	9.50**	51.70	86.67	114.24	106.67**	89.82
2219A x 68814	9.80**	10.06**	10.33**	9.19**	9.85**	88.23**	67.28	86.13	86.66	82.08
2219A x FS211	9.98**	9.80**	9.63	8.93	9.59**	50.48	63.11	96.10	75.04	71.18
2219A x FS205	9.63**	10.33**	11.03**	9.45**	10.11**	41.30	52.40	86.94	62.78	60.86
2219A x FS9401	9.63**	10.06**	10.50**	9.19**	9.85**	52.16	77.51	129.66	71.53	82.71
2219A x SS003	7.18	8.84	10.50**	7.96	8.62	36.40	58.47	119.90	55.00	67.44
2219A x SS012	9.63**	9.80**	9.98	8.93	9.59**	50.61	46.50	74.02	58.31	57.36
2219A x SS020	9.28**	9.98**	10.68**	9.10**	9.76**	52.41	57.78	142.13	59.07	77.85
2219A x SRV605	9.28**	9.98**	9.63	9.10**	9.50**	36.19	51.99	110.21	41.04	59.86

Appendix 6 (contd..)

Characters	Crude protein					Dry fodder					Yield
	E ₁	E ₂	E ₃	E ₄	P	E ₁	E ₂	E ₃	E ₄	P	
Hybrids											
2219A x FS9604	10.15**	10.59**	11.03**	9.71**	10.37**	34.38	37.11	59.31	50.83	45.41	
2219A x FS9605	8.75	9.63**	10.50**	8.75**	9.41**	61.54	71.28	107.99	63.87	76.17	
2219A x FS9601	9.28**	8.57	7.87	7.70	8.36	63.45	72.65	108.43	77.65	80.54	
2219A x FS9603	9.28**	9.45	9.63	8.58	9.24	51.34	68.25	102.21	47.00	67.20	
2219A x 68710	9.63**	10.33**	11.03**	9.45**	10.11**	57.08	60.57	105.64	82.47	76.44	
2219A x 68724	9.28**	9.63**	9.98	8.75**	9.41*	53.28	78.31	90.09	82.97	76.16	
2219A x 68726	9.63**	9.98**	9.28	9.10**	9.50**	52.28	55.26	133.69	78.19	79.86	
2219A x Co27	9.10*	9.54*	9.98	8.66*	9.32	69.91*	54.78	82.95	54.51	65.54	
2219A x SS032	9.63**	9.98**	10.33**	9.10**	9.76**	72.83**	78.23	116.48	58.04	81.40	
2077A x 68716	7.88	9.10	10.33**	8.23	8.89	107.14**	113.47**	135.34	117.78**	118.43**	
2077A x 68740	9.63**	10.06**	10.50**	9.19**	9.85**	104.37**	97.40**	134.52	137.07**	118.34**	
2077A x 68918	8.75	9.36	9.98	8.49	9.15	73.88**	76.89	109.67	52.99	78.36	
2077A x 68786	9.28**	8.66	8.05	7.79	8.45	91.78**	120.93**	136.94	143.80**	123.36**	
2077A x 68814	10.15**	10.24**	10.33**	9.36**	10.02**	72.54**	121.06**	145.78*	174.52**	128.48**	
2077A x FS211	10.15**	9.10	8.05	8.23	8.88	59.70	80.09	131.63	61.81	83.31	
2077A x FS205	8.75	9.71**	10.68**	8.84**	9.50**	65.15	78.21	130.52	104.17**	94.51	
2077A x FS9401	7.18	7.96	8.75	7.09	7.75	78.98**	86.58	130.33	82.03	94.48	
2077A x SS003	9.28**	9.63**	9.98	8.75**	9.41*	89.82**	64.33	91.13	82.82	82.02	
2077A x SS012	9.28**	9.98**	10.68**	9.10**	9.76**	38.90	60.35	102.14	98.74**	75.03	
2077A x SS020	7.88	7.96	8.05	7.09	7.75	66.35	79.36	95.78	68.87	77.59	
2077A x SRV605	6.83	7.35	7.88	6.48	7.14	56.92	71.36	88.32	89.37	76.49	
2077A x FS9604	7.18	8.93	10.68**	8.05	8.71	56.07	52.11	123.43	95.29*	81.72	
2077A x FS9605	9.63**	9.80**	9.98	8.93**	9.59**	55.12	105.08**	88.72	113.95**	90.72	
2077A x FS9601	8.75	9.19	9.63	8.31	8.97	58.05	71.60	131.60	94.39*	88.91	
2077A x FS9603	8.75	8.40	8.05	7.53	8.18	58.00	99.93**	126.73	99.78**	96.11	
2077A x 68710	9.10*	8.93	8.75	8.05	8.71	166.58**	69.61	153.40**	105.74**	123.83**	
2077A x 68724	9.63**	9.19	8.75	8.31	8.97	104.83**	120.75**	128.36	117.94**	117.97**	
2077A x 68726	7.88	8.38	8.88	7.50	8.16	158.17**	126.59**	127.51	188.15**	150.11**	
2077A x Co27	9.28**	8.90	8.52	8.02	8.68	65.17	101.98**	172.39**	89.00	107.14**	
2077A x SS032	7.35	8.49	9.63	7.61	8.27	41.65	47.43	71.94	51.00	53.01	
1111A x 68716	8.75	8.40	8.05	7.53	8.18	70.10	59.93	154.10**	52.06	84.05	
1111A x 68740	9.10*	9.80**	10.50**	8.93**	9.58**	62.66	112.03**	128.79	84.43	96.98	
1111A x 68918	8.23	8.93	9.63	8.05	8.71	53.05	61.81	83.54	103.72**	75.53	
1111A x 68786	8.75	9.36	9.98	8.49	9.15	85.34**	104.81**	121.66	90.17	100.49	

Appendix 6 (contd..)

Characters		Crude protein					Dry fodder					Yield
		E ₁	E ₂	E ₃	E ₄	P	E ₁	E ₂	E ₃	E ₄	P	
Hybrids												
	111A x 68814	8.75	8.81	8.88	7.94	8.60	84.29**	99.29**	125.13	180.89**	122.40**	
	111A x FS211	8.75	8.81	8.88	7.94	8.60	53.27	68.83	107.78	133.91**	91.45	
	111A x FS205	9.28**	8.66	8.05	7.79	8.45	57.04	83.04	139.16	68.23	86.87	
	111A x FS9401	7.00	7.53	8.05	6.65	7.31	61.15	78.35	144.57*	66.34	87.60	
	111A x SS003	7.88	9.19	10.50**	8.31	8.97	54.17	56.00	107.88	61.76	69.95	
	111A x SS012	8.75	9.19	9.63	8.31	8.97	53.23	57.58	87.49	95.99*	73.57	
	111A x SS020	9.28**	10.33**	11.38**	9.45**	10.11**	45.39	46.37	124.17	92.50	77.11	
	111A x SRV605	7.18	8.58	9.98	7.70	8.36	63.72	69.34	163.40**	47.17	85.91	
	111A x FS9604	9.63**	10.59**	11.55**	9.71**	10.37**	41.73	64.47	140.72	120.87**	91.95	
	111A x FS9605	8.75	9.63**	10.50**	8.75**	9.41*	49.75	78.97	165.07**	140.66	108.61**	
	111A x FS9601	7.18	7.44	7.70	6.56	7.22	41.19	88.48	149.17*	80.39	89.81	
	111A x FS9603	7.88	8.31	8.75	7.44	8.10	55.32	119.85**	221.36**	86.36	120.73**	
	111A x 68710	9.10*	8.93	8.75	8.05	8.71	65.03	99.47**	133.44	118.13**	104.02**	
	111A x 68724	9.28**	9.45	9.63	8.58	9.24	61.99	96.29**	143.53	98.22**	100.01	
	111A x 68726	9.10*	9.54*	9.98	8.66*	9.32	60.86	89.01	157.70**	166.52**	118.52**	
	111A x Co27	9.28**	9.45	9.63	8.58	9.24	60.60	75.08	130.81	91.05	89.39	
	111A x SS032	9.28**	9.45	9.63	8.58	9.24	56.20	99.64**	203.98	112.57**	118.10**	
	Hybrids Mean	8.75	9.24	9.71	8.37	9.02	63.40	78.35	121.06	83.59	86.60	
SE(d)												
	SE(d)	0.1459	0.1521	0.187	0.131	0.155	3.0957	5.8133	11.667	5.118	7.171	
CD at 5%												
	CD at 5%	0.2876	0.2999	0.369	0.259	0.305	6.1017	11.458	22.995	10.087	14.055	
CD at 1%												
	CD at 1%	0.3795	0.3957	0.487	0.341	0.401	8.0521	15.1204	30.345	13.311	18.472	

Appendix 7. Mean performance of parents in individual environments and pooled data for green fodder yield per plant (g) green fodder yield per plot (kg)

Characters		Green fodder				plant	Yield per plot				
Parents		E ₁	E ₂	E ₃	E ₄	P	E ₁	E ₂	E ₃	E ₄	P
296A		155.26*	227.00*	151.50	152.00	171.44	13.51*	8.17*	4.26	2.73	7.17
22219A		96.67	83.00	101.50	243.84	131.25	5.03	3.07	1.03	1.45	2.65
2077A		148.73*	171.00*	285.00*	272.50*	219.31**	9.38	3.08	8.00	4.90	6.34
11111A		156.73*	164.00*	230.00*	300.00*	212.68**	10.98	9.84*	11.98*	11.39*	11.05*
Lines Mean		139.35	161.25	192.00	242.09	183.67	9.73	6.04	6.32	5.12	6.80
68716		154.67	283.00	416.00**	196.67	262.59	10.06	9.05	10.00	1.37	7.62
68740		176.53	367.00**	388.00**	371.67**	325.80**	11.48	12.84	10.49	3.34	9.54
68918		262.50**	336.00**	288.00	193.00	269.88	10.24	6.38	3.18	0.96	5.19
68786		285.40**	600.00**	536.25**	490.00**	477.91**	17.41**	22.80**	16.10**	6.36**	15.67**
68814		181.87	383.00**	260.00	111.83	234.16	10.19	18.00**	10.16	1.11	9.86
FS211		288.10**	319.00**	289.00	236.67	283.19	13.55*	9.57	6.38	1.65	7.79
FS205		174.20	343.00**	298.00	235.67	262.72	7.84	11.66	7.76	2.11	7.35
FS9401		199.46	349.00**	325.00	291.34	291.20	9.98	10.82	7.49	2.61	7.73
SS003		208.86	257.00	242.00	210.00	229.47	10.87	9.76	7.28	2.51	7.60
SS012		200.06	171.00	238.00	160.00	192.27	13.61*	4.79	4.78	0.63	5.95
SS020		226.80**	204.00	308.50	253.34	248.16	16.34**	11.22	14.52**	6.07**	12.04**
SRV605		148.46	285.00	276.00	306.66**	254.03	9.06	15.38**	12.71	3.36	10.13
FS9604		181.73	221.00	334.50	235.84	243.27	10.55	9.06	11.06	1.64	8.08
FS9605		172.00	300.00	298.00	206.67	244.17	8.09	12.30	9.85	1.44	7.92
FS9601		197.00	236.00	362.00**	269.00	266.00	9.07	8.49	10.15	1.87	7.40
FS9603		147.80	222.00	399.50**	415.00**	296.08*	9.17	7.54	10.40	5.80**	8.23
68710		252.83**	349.00**	325.00	181.00	276.96	12.65	12.21	8.79	2.52	9.04
68724		237.00	275.50	208.50	575.00**	324.00**	14.23**	12.67	7.94	12.64**	11.87**
68726		289.66**	360.00**	352.00	415.00**	354.17**	19.12**	18.36**	15.15**	8.29**	15.23**
Co27		233.07**	219.00	336.00	244.17	258.06	13.99*	9.19	11.10	2.68	9.24
SS032		235.00**	368.00**	695.00**	290.00	397.00**	11.52	15.82**	24.34**	3.76	13.86**
Testers Mean		212.04	307.02	341.68	280.41	285.28	11.86	11.81	10.46	3.46	9.39
Parental Mean		200.42	283.70	317.73	274.27	269.03	11.51	10.88	9.80	3.73	9.98
SE(d)		4.8197	4.6025	6.515	5.741	5.473	0.8268	0.5982	1.309	0.547	0.874
CD at 5%		9.4996	9.0716	12.841	11.316	10.727	1.6297	1.1791	2.581	1.078	1.713
CD at 1%		12.536	11.9713	16.945	14.933	14.099	2.1506	1.556	3.405	1.423	2.251

Appendix 7. (contd.). Mean performance of hybrids in individual environments and pooled data for green fodder yield per plant (g) green fodder yield per plot (kg)

Characters	Green fodder				plant	Green fodder				Yield per plot
	E ₁	E ₂	E ₃	E ₄		E ₁	E ₂	E ₃	E ₄	
Hybrids					P					P
296A x 68716	311.40**	370.00	371.33	198.11	312.71	12.46	11.10	9.67	0.98	8.55
296A x 68740	281.73	477.33**	465.33	197.56	355.49	14.94	16.22*	13.98	1.18	11.58
296A x 68918	398.47**	391.00	280.67	283.89	338.50	17.14**	14.47	9.28	1.41	10.57
296A x 68786	342.25**	561.67**	406.00	200.67	377.65	6.85	7.86	4.48	0.79	5.00
296A x 68814	331.80**	367.33	314.00	227.55	310.17	15.27*	11.75	8.49	1.81	9.33
296A x FS211	313.00**	383.00	453.33	282.22	357.89	16.91**	14.17	14.52	1.97	11.89
296A x FS205	197.13	332.32	418.00	288.33	308.95	9.47	11.29	12.56	3.74	9.26
296A x FS9401	214.67	382.67	415.33	266.11	319.70	12.88	18.36**	18.29	2.38	12.98
296A x SS003	220.53	323.33	404.67	225.89	293.61	13.02	12.93	14.58	2.02	10.64
296A x SS012	230.20	272.00	314.00	210.89	256.77	14.28	9.24	9.12	1.26	8.48
296A x SS020	247.30	389.00	474.67	249.44	340.10	8.66	9.33	9.98	1.74	7.43
296A x SRV605	225.80	328.00	436.67	206.33	299.20	2.72	3.06	4.38	0.82	2.74
296A x FS9604	271.42	513.67**	781.56**	232.77	449.86**	3.08	5.82	6.52	1.15	4.14
296A x FS9605	251.10	417.33	424.00	190.56	320.75	12.31	16.69**	15.70	1.32	11.51
296A x FS9601	247.30	368.00	458.13	281.56	338.75	13.36	19.13**	22.01**	3.65	14.54**
296A x FS9603	251.43	301.33	466.67	397.68**	354.28	7.05	7.23	9.35	3.97	6.90
296A x 68710	460.93**	428.00	609.33**	263.33	440.39**	17.52**	11.55	13.42	1.31	10.95
296A x 68724	401.60**	470.67**	583.46**	261.11	429.21**	14.06	15.53	16.35	3.38	12.33
296A x 68726	524.47**	630.43**	694.00**	398.22**	561.78**	5.43	6.30	4.64	3.18	4.88
296A x Co27	281.80	356.67	422.00	275.89	334.09	16.35**	16.05	14.21	3.03	12.41
296A x SS032	349.27**	594.00**	532.00**	274.44	437.43**	11.18	14.85	10.12	3.01	9.79
2219A x 68716	213.33	623.33**	563.33**	517.78**	479.44**	12.81	31.16**	25.93**	12.93**	20.71**
2219A x 68740	199.47	498.00**	380.65	335.00	353.28	11.58	19.91**	15.34	7.70**	13.63
2219A x 68918	272.00	282.59	446.67	380.54	345.45	18.50**	12.43	17.44	9.12**	14.37*
2219A x 68786	270.00	446.67**	471.80	465.53**	413.50**	15.67**	18.76**	17.94*	8.37**	15.18**
2219A x 68814	373.00**	371.33	350.67	410.55**	376.39	24.25**	18.93**	15.80	8.20**	16.80**
2219A x FS211	226.67	329.33	362.67	338.67	314.34	14.74	15.15	14.89	5.07	12.46
2219A x FS205	184.00	303.33	328.00	309.64	281.24	9.76	13.34	11.36	5.56	10.01
2219A x FS9401	210.00	378.00	390.13	304.45	320.65	13.44	20.41**	19.13**	6.99	15.00**
2219A x SS003	175.33	292.00	402.00	266.11	283.86	10.70	15.47	18.51**	8.24**	13.23
2219A x SS012	239.67	281.47	326.67	298.89	286.68	13.43	12.66	12.76	6.86	11.43
2219A x SS020	207.67	297.33	492.67	263.22	315.22	15.17*	16.35*	24.65**	8.41**	16.15**
2219A x SRV605	188.33	279.33	370.67	190.00	257.08	12.44	14.24	17.06	3.41	11.79

Appendix 7 (contd.)

Characters	Green fodder					Yield per plant					Green fodder					Yield per plot				
	E ₁	E ₂	E ₃	E ₄	P	E ₁	E ₂	E ₃	E ₄	P	E ₁	E ₂	E ₃	E ₄	P	E ₁	E ₂	E ₃	E ₄	P
Hybrids																				
2219A x FS9604	174.40	251.00	303.07	278.89	251.84	9.94	11.54	12.14	6.40	10.01	9.94	11.54	12.14	6.40	10.01	9.94	11.54	12.14	6.40	10.01
2219A x FS9605	214.67	349.00	346.80	272.81	295.82	13.74	16.05	13.89	4.08	11.94	13.74	16.05	13.89	4.08	11.94	13.74	16.05	13.89	4.08	11.94
2219A x FS9601	244.67	330.00	432.00	310.55	329.31	14.44	16.50*	19.02**	5.58	13.89	14.44	16.50*	19.02**	5.58	13.89	14.44	16.50*	19.02**	5.58	13.89
2219A x FS9603	228.00	356.33	289.33	212.22	271.47	13.68	16.74**	12.17	5.08	11.92	13.68	16.74**	12.17	5.08	11.92	13.68	16.74**	12.17	5.08	11.92
2219A x 68710	246.33	318.00	379.33	373.89	329.39	11.34	9.53	9.50	5.22	8.90	11.34	9.53	9.50	5.22	8.90	11.34	9.53	9.50	5.22	8.90
2219A x 68724	227.80	410.67	321.33	382.22	335.51	12.76	20.94**	14.48	11.46**	14.91**	12.76	20.94**	14.48	11.46**	14.91**	12.76	20.94**	14.48	11.46**	14.91**
2219A x 68726	268.00	308.67	452.67	371.67	350.25	18.23**	18.82**	25.37**	12.63**	18.76**	18.23**	18.82**	25.37**	12.63**	18.76**	18.23**	18.82**	25.37**	12.63**	18.76**
2219A x Co27	277.47	287.00	320.00	248.89	283.34	18.32**	16.93**	17.30	6.71	14.81**	18.32**	16.93**	17.30	6.71	14.81**	18.32**	16.93**	17.30	6.71	14.81**
2219A x SS032	316.67**	404.67	411.32	265.55	349.55	17.42**	18.61**	16.47	6.36	14.72**	17.42**	18.61**	16.47	6.36	14.72**	17.42**	18.61**	16.47	6.36	14.72**
2077A x 68716	411.93**	758.66**	539.33**	626.67	584.15**	5.09	8.59	4.86	4.38	5.73	5.09	8.59	4.86	4.38	5.73	5.09	8.59	4.86	4.38	5.73
2077A x 68740	432.26**	513.00**	570.00**	599.17**	528.61**	17.73**	14.36	12.56	7.18*	12.96	17.73**	14.36	12.56	7.18*	12.96	17.73**	14.36	12.56	7.18*	12.96
2077A x 68918	472.46**	519.33**	445.00	282.00	429.69**	13.71	9.35	6.25	2.25	7.89	13.71	9.35	6.25	2.25	7.89	13.71	9.35	6.25	2.25	7.89
2077A x 68786	472.26**	792.00**	688.67**	746.34**	674.89**	15.12	17.42**	12.41	7.45**	13.10	15.12	17.42**	12.41	7.45**	13.10	15.12	17.42**	12.41	7.45**	13.10
2077A x 68814	369.07**	606.33**	672.00**	728.32**	593.93**	11.82	16.97**	17.49*	11.64**	14.48*	11.82	16.97**	17.49*	11.64**	14.48*	11.82	16.97**	17.49*	11.64**	14.48*
2077A x FS211	346.47**	465.33**	566.67**	291.67	417.54**	15.94**	18.14**	15.88	4.95	13.73	15.94**	18.14**	15.88	4.95	13.73	15.94**	18.14**	15.88	4.95	13.73
2077A x FS205	305.80	416.00	500.67**	455.00**	419.37**	11.01	12.48	12.53	4.70	10.18	11.01	12.48	12.53	4.70	10.18	11.01	12.48	12.53	4.70	10.18
2077A x FS9401	315.20**	485.33**	432.67	375.83	402.26	12.61	16.50*	12.56	8.64**	12.58	12.61	16.50*	12.56	8.64**	12.58	12.61	16.50*	12.56	8.64**	12.58
2077A x SS003	346.33**	393.67	462.00	407.50**	402.38	12.82	12.20	12.03	4.07	10.28	12.82	12.20	12.03	4.07	10.28	12.82	12.20	12.03	4.07	10.28
2077A x SS012	228.67	401.00	539.47**	518.34**	421.87**	8.47	12.83	15.12	5.69	10.53	8.47	12.83	15.12	5.69	10.53	8.47	12.83	15.12	5.69	10.53
2077A x SS020	308.73*	466.67**	392.00	335.84	375.81	13.59	15.40	11.78	7.38**	12.04	13.59	15.40	11.78	7.38**	12.04	13.59	15.40	11.78	7.38**	12.04
2077A x SRV605	268.26	397.00	437.00	406.67**	377.23	13.42	15.08	14.88	6.90	12.57	13.42	15.08	14.88	6.90	12.57	13.42	15.08	14.88	6.90	12.57
2077A x FS9604	265.26	282.67	718.00**	425.00**	422.73**	9.29	7.06	15.09	7.22*	9.67	9.29	7.06	15.09	7.22*	9.67	9.29	7.06	15.09	7.22*	9.67
2077A x FS9605	244.80	520.00**	400.32	470.84**	408.99*	11.76	21.84**	14.03	9.88**	14.38*	11.76	21.84**	14.03	9.88**	14.38*	11.76	21.84**	14.03	9.88**	14.38*
2077A x FS9601	269.90	353.67	482.00	381.67	371.81	12.96	13.79	16.40	7.24*	12.60	12.96	13.79	16.40	7.24*	12.60	12.96	13.79	16.40	7.24*	12.60
2077A x FS9603	303.33	496.00**	469.00	420.00**	422.08**	10.62	12.40	9.87	6.29	9.79	10.62	12.40	9.87	6.29	9.79	10.62	12.40	9.87	6.29	9.79
2077A x 68710	568.20**	424.00	683.00**	505.40**	545.15**	14.78	8.48	10.95	5.04	9.81	14.78	8.48	10.95	5.04	9.81	14.78	8.48	10.95	5.04	9.81
2077A x 68724	387.93**	607.33**	461.33	491.67**	487.07**	14.36	20.04**	10.78	9.82**	13.75	14.36	20.04**	10.78	9.82**	13.75	14.36	20.04**	10.78	9.82**	13.75
2077A x 68726	565.27**	642.00**	539.00**	793.34**	634.90**	13.57	12.84	8.64	8.72**	10.94	13.57	12.84	8.64	8.72**	10.94	13.57	12.84	8.64	8.72**	10.94
2077A x Co27	317.93**	530.67**	642.67**	573.35**	516.15**	7.32	9.55	9.01	6.87	8.19	7.32	9.55	9.01	6.87	8.19	7.32	9.55	9.01	6.87	8.19
2077A x SS032	209.33	262.00	310.67	225.50	251.88	1.26	1.31	1.87	1.12	1.39	1.26	1.31	1.87	1.12	1.39	1.26	1.31	1.87	1.12	1.39
111A x 68716	352.13**	462.00**	703.32**	306.67	456.03**	14.80	13.39	17.60*	2.44	12.06	14.80	13.39	17.60*	2.44	12.06	14.80	13.39	17.60*	2.44	12.06
111A x 68740	271.93	504.00**	396.67	321.67	373.57	15.51**	18.64**	12.31	3.85	12.58	15.51**	18.64**	12.31	3.85	12.58	15.51**	18.64**	12.31	3.85	12.58
111A x 68918	301.80	348.67	392.67	421.66**	366.20	18.11**	13.25	12.97	5.47	12.45	18.11**	13.25	12.97	5.47	12.45	18.11**	13.25	12.97	5.47	12.45
111A x 68786	445.60**	615.32**	477.33	489.06**	506.83**	20.95**	20.92**	13.86	6.84	15.64**	20.95**	20.92**	13.86	6.84	15.64**	20.95**	20.92**	13.86	6.84	15.64**

Appendix 7 (contd.)

Characters	Green fodder				yield per plant		Green fodder				Yield per plot			
	E ₁	E ₂	E ₃	E ₄	P		E ₁	E ₂	E ₃	E ₄	P			
Hybrids														
I11A x 68814	396.13**	601.32**	574.67**	797.78**	592.48**		23.78**	25.25**	21.85**	15.95**	21.71**			
I11A x FS211	277.93	384.67	434.67	590.53**	421.95**		14.46	16.92**	16.97	7.67**	14.00			
I11A x FS205	264.46	447.32**	484.00	310.55	376.58		13.49	20.13**	19.86**	3.72	14.30*			
I11A x FS9401	304.73	422.67	487.36	338.32	388.27		16.46**	18.17**	18.54**	5.74	14.73**			
I11A x SS003	266.93	326.67	446.67	270.02	327.57		17.09**	16.00	19.67**	2.96	13.93			
I11A x SS012	289.73	346.67	381.47	476.92**	373.70		16.81**	15.94	15.28	5.24	13.32			
I11A x SS020	215.33	280.67	491.33	490.00**	369.33		10.34	11.79	18.19	13.22**	13.39			
I11A x SRV605	266.13	415.33	671.65**	197.78	387.72		17.84**	24.92**	34.94**	3.35	20.26**			
I11A x FS9604	258.46	318.33	622.67**	540.00**	434.87**		13.19	14.00	22.20**	8.63**	14.51*			
I11A x FS9605	300.53	434.00	643.33**	567.78**	486.41**		16.83**	19.53**	26.39**	9.64**	18.10**			
I11A x FS9601	214.13	454.00**	576.67**	370.56	403.84		12.00	20.88**	23.08**	6.29	15.56**			
I11A x FS9603	273.00	594.66**	782.00**	357.11	501.69**		5.47	10.70	10.18	3.20	7.39			
I11A x 68710	341.32**	561.33**	545.33**	570.57**	504.64**		6.15	9.54	7.10	4.56	6.84			
I11A x 68724	362.33**	588.67**	661.87**	458.67**	517.89**		21.38**	27.07**	26.49**	15.58**	22.63**			
I11A x 68726	314.80**	486.00**	654.67**	673.34**	532.20**		19.52**	25.27**	30.78**	20.19**	23.94**			
I11A x Co27	275.66	381.33	425.33	410.56**	373.22		15.72**	17.54**	17.88*	7.79**	14.73**			
I11A x SS032	308.00*	538.00**	814.00**	500.00**	540.00**		18.48**	26.36**	35.02**	10.49**	22.59**			
Hybrids Mean	297.88	427.38	481.97	377.73	396.24		13.37	15.12	14.98	5.93	12.35			
SE(d)	4.8197	4.6025	6.515	5.741	5.473		0.8268	0.5982	1.309	0.547	0.874			
CD at 5%	9.4996	9.0716	12.841	11.316	10.727		1.6297	1.1791	2.581	1.078	1.713			
CD at 1%	12.536	11.9713	16.945	14.933	14.099		2.1506	1.556	3.405	1.423	2.251			

Appendix 8. General combining ability effects of parents in individual environments and pooled data for days to 50 per cent flowering

Parents	E ₁	E ₂	E ₃	E ₄	P
Lines					
296A	2.147**	-1.500**	-0.437**	0.143	0.088
2219A	-5.329**	-4.024**	-1.976**	-1.794**	-3.281**
2077A	0.988**	2.452**	0.913**	1.413**	1.441**
111A	2.194**	3.071**	1.500**	0.238	1.751**
SE(g_i)	0.142	0.135	0.132	0.125	0.067
Testers					
68716	0.627	6.690**	-0.651*	-0.714*	1.488**
68740	-0.290	4.190**	0.599*	-0.714*	0.946**
68918	2.794**	-1.060**	-2.234**	1.286**	0.196
68786	8.794**	6.440**	3.599**	1.786**	5.155**
68814	4.460**	2.440**	1.183**	5.536**	3.405**
FS211	-0.623	-2.060**	-4.401**	-2.214**	-2.324**
FS205	-2.540**	0.940**	2.599**	0.286	0.321*
FS9401	-2.623**	-2.810**	-1.151**	-0.964**	-1.887**
SS003	-1.290**	-3.560**	-3.151**	-0.798**	-2.199**
SS012	-0.540	-4.310**	-1.151**	-0.714*	-1.679**
SS020	-1.956**	2.940**	1.766**	-1.464**	0.321*
SRV605	-4.206**	3.190**	6.099**	3.786**	2.217**
FS9604	-0.456	4.940**	5.849**	2.286**	3.155**
FS9605	-1.706**	-2.060**	1.349**	-0.881**	-0.824**
FS9601	-3.623**	-3.310**	-1.317**	-0.714*	-2.241**
FS9603	-0.873**	-3.060**	-0.651*	-1.464**	-1.512**
68710	3.627**	-0.060	-2.234**	2.286**	0.905**
68724	4.877**	1.940**	-1.651**	-1.214**	0.988**
68726	-1.123**	-4.810**	-3.401**	-1.964**	-2.824**
Co27	-1.956**	-1.560**	-1.151**	-1.714**	-1.595**
SS032	-1.373**	-5.060**	0.099	-1.714**	-2.012**
SE(g_j)	0.324	0.310	0.302	0.287	0.153

* significant at 5 per cent level

** significant at 1 per cent level

Appendix 9. General combining ability effects of parents in individual environments and pooled data for plant height

Parents	E ₁	E ₂	E ₃	E ₄	P
Lines					
296A	-10.132**	-8.809**	-19.033**	-31.424**	-17.349**
2219A	-11.737**	-18.066**	1.186	0.723	-6.974**
2077A	18.234**	25.836**	5.529**	24.700**	18.575**
111A	3.635**	1.040	12.318**	6.000**	5.748**
SE(g)	0.752	0.750	0.753	0.761	0.377
Testers					
68716	-4.360*	28.199**	2.784	0.009	6.658**
68740	17.925**	31.371**	3.738*	4.262*	14.324**
68918	-17.235**	-19.795**	-25.509**	-26.851**	-22.347**
68786	16.628**	21.016**	2.808	-6.101**	8.588**
68814	22.380**	16.731**	4.357*	6.539**	12.502**
FS211	-3.627*	-14.144**	-18.810**	-23.516**	-15.024**
FS205	3.830*	14.736**	13.086**	4.177*	8.957**
FS9401	2.855	5.666**	14.926**	-2.793	5.163**
SS003	-20.668**	-18.354**	-6.337**	-13.398**	-14.689**
SS012	-13.760**	-25.726**	-19.019**	-9.701**	-17.052**
SS020	12.770**	9.869**	24.671**	37.287**	21.149**
SRV605	-10.300**	-5.369**	-5.134**	-5.218**	-6.505**
FS9604	-39.412**	-16.729**	-1.322	-18.293**	-18.939**
FS9605	9.010**	1.474	7.486**	12.412**	7.595**
FS9601	2.711	6.126**	16.688**	8.116**	8.410**
FS9603	-10.802**	-15.881**	-6.334**	-3.031	-9.012**
68710	3.758*	-7.036**	-6.997**	4.417*	-1.465
68724	20.228**	5.999**	11.603**	10.012**	11.960**
68726	15.325**	8.799**	-3.749*	22.878**	10.813**
Co27	-2.070	-7.445**	-0.159	-2.001	-2.918**
SS032	-5.187**	-19.506**	-8.776**	0.791	-8.169**
SE(g)	1.723	1.719	1.725	1.743	0.864

* Significant at 5 per cent level

** Significant at 1 per cent level

Appendix 10. General combining ability effects of parents in individual environments and pooled data for number of tillers

Parents	E ₁	E ₂	E ₃	E ₄	P
Lines					
296A	-0.094	0.249**	0.211*	-0.232**	0.034
2219A	0.064	-0.058	-0.209*	0.060	-0.036
2077A	0.057	-0.141	-0.156	0.026	-0.054
111A	-0.027	-0.051	0.155	0.146	0.056
SE(g_i)	0.055	0.076	0.1006	0.090	0.041
Testers					
68716	-0.076	0.212	0.118	-0.210	0.011
68740	0.157	0.087	-0.232	0.151	0.041
68918	-0.126	-0.463**	-0.686**	-0.548**	-0.456**
68786	-0.297*	0.195	-0.215	-0.594**	-0.228*
68814	0.074	0.237	-0.199	0.782**	0.224*
FS211	-0.126	-0.347*	0.051	-0.236	-0.164
FS205	0.291*	-0.163	-0.365	-0.336	-0.144
FS9401	-0.051	0.003	0.068	0.359	0.095
SS003	-0.226	-0.330	-0.332	-0.417*	-0.326**
SS012	-0.209	-0.547**	-0.582*	-0.674**	-0.503**
SS020	-0.159	-0.613**	-0.449	0.199	-0.256**
SRV605	0.157	-0.352*	-0.574*	-0.271	-0.260**
FS9604	-0.376**	-0.597**	-0.388	-0.016	-0.344**
FS9605	0.024	0.070	0.018	-0.016	0.024
FS9601	-0.043	-0.080	0.068	0.080	0.006
FS9603	0.132	0.370*	0.651**	0.080	0.309**
68710	0.024	0.270	0.866**	0.546**	0.426**
68724	-0.101	0.403*	0.251	0.220	0.194*
68726	0.434**	1.603**	1.951**	0.917**	1.226**
Co27	0.316*	-0.180	-0.307	-0.001	-0.043
SS032	0.182	0.220	0.285	-0.016	0.168
SE(g_i)	0.126	0.174	0.231	0.207	0.094

* significant at 5 per cent level

** significant at 1 per cent level

Appendix 11. General combining ability effects of parents in individual environments and pooled data for number of leaves

Parents	E ₁	E ₂	E ₃	E ₄	P
Lines					
296A	-0.383**	-0.300*	-0.251**	-1.047**	-0.495**
2219A	-0.365**	-0.648**	-0.329**	-0.409**	-0.438**
2077A	0.236*	0.780**	0.191*	0.809**	0.504**
111A	0.512**	0.169	0.389**	0.647**	0.429**
SE(g_i)	0.093	0.120	0.087	0.110	0.052
Testers					
68716	0.081	0.218	-0.106	0.186	0.095
68740	-0.044	0.697*	-0.206	0.579*	0.257*
68918	0.631**	0.539*	-0.260	0.398	0.327**
68786	1.014**	0.439	0.278	-0.054	0.419**
68814	0.847**	0.197	-0.022	0.945**	0.492**
FS211	0.464*	-0.486	-0.939**	0.434	-0.132
FS205	-0.636**	0.672*	0.686**	0.243	0.241*
FS9401	-0.503*	0.130	0.278	-0.410	-0.126
SS003	0.081	-0.071	-0.089	-0.146	-0.056
SS012	0.181	-0.170	-0.239	0.313	0.021
SS020	-0.519*	0.380	0.794**	0.202	0.214
SRV605	-1.019**	-0.036	0.453*	-0.327	-0.232*
FS9604	-0.144	0.297	0.934**	-0.492	0.149
FS9605	-0.386	0.030	-0.156	-0.327	-0.210
FS9601	-0.569**	-0.370	0.044	-0.405	-0.325**
FS9603	-0.744**	-0.636*	-0.547**	-0.422	-0.588**
68710	0.281	-0.803**	-0.516**	0.048	-0.247*
68724	0.847**	0.030	0.111	0.159	0.287*
68726	0.689**	-0.376	-0.814**	-0.122	-0.156
Co27	-0.561**	-0.209	0.336	-0.382	-0.204
SS032	0.014	-0.470	-0.022	-0.423	-0.225
SE(g_j)	0.212	0.275	0.198	0.253	0.118

* significant at 5 per cent level

** significant at 1 per cent level

Appendix 12. General combining ability effects of parents in individual environments and pooled data for leaf length

Parents	E ₁	E ₂	E ₃	E ₄	P
Lines					
296A	0.367	0.262	0.616	0.616	-0.387
2219A	-2.395**	-0.931	-1.677*	-1.677*	-1.395**
2077A	2.268**	1.790*	0.195	0.195	1.368**
111A	-0.240	-1.120	0.866	0.866	0.415
SE(g_i)	0.675	0.789	0.732	0.737	0.367
Testers					
68716	1.612	2.122	1.449	-1.048	1.034
68740	-1.631	4.127*	0.073	-3.196	-0.157
68918	0.487	-1.843	-2.844	-2.368	-1.642
68786	4.780**	3.337	0.902	-1.569	1.862*
68814	8.217**	6.745**	5.357**	2.163	5.621**
FS211	2.021	1.303	-5.250**	0.800	-0.281
FS205	-4.493**	-2.608	1.269	-2.991	-2.206**
FS9401	-3.499*	0.345	0.820	-1.413	-0.937
SS003	-0.693	-0.778	-2.847	0.292	-1.006
SS012	-6.433**	-8.180**	-4.829**	-3.304	-5.686**
SS020	2.639	-0.268	6.369**	7.141**	3.970**
SRV605	-6.031**	-2.220	1.257	-3.261	-2.564**
FS9604	-2.387	-4.380*	0.620	-3.417*	-2.391**
FS9605	-0.786	-0.017	4.331**	4.423**	1.988*
FS9601	-4.789**	-3.207	-0.741	0.669	-2.017*
FS9603	-2.048	-2.145	-0.135	-4.304	-2.158*
68710	7.329**	3.380	1.498	5.984**	4.548**
68724	8.072**	3.732*	2.185	4.428**	4.604**
68726	3.737*	1.540	-4.530**	5.332**	1.520
Co27	-1.454	1.378	0.002	2.197	0.531
SS032	-4.653**	-2.362	-4.955**	-6.557**	-4.631**
SE(g_j)	1.546	1.807	1.678	1.688	0.841

* significant at 5 per cent level

** significant at 1 per cent level

Appendix 13. General combining ability effects of parents in individual environments and pooled data for leaf breadth

Parents	E ₁	E ₂	E ₃	E ₄	P
Parents					
Lines	-0.010	0.018	0.411**	0.040	0.115*
296A	-0.988**	-0.549**	-0.483**	-0.265**	-0.571**
2219A	0.531**	0.126	-0.125	-0.158	0.093
2077A	0.468**	0.404**	0.198	0.383**	0.363**
111A					
	0.123	0.081	0.084	0.097	0.049
SE(g_i)					
Testers	-0.279	0.258	0.067	-0.116	-0.018
68716	-0.390	0.625**	0.060	-0.057	0.060
68740	0.600*	0.584**	0.785**	0.677**	0.661**
68918	0.519	0.608**	-0.171	-0.381	0.144
68786	0.132	-0.287	0.003	0.093	-0.015
68814	0.352	0.145	-0.124	0.397	0.192
FS211	0.080	0.395*	0.760**	-0.137	0.275*
FS205	0.117	0.018	0.015	0.133	0.071
FS9401	0.320	-0.077	0.115	0.089	0.112
SS003	-0.230	-0.144	0.085	0.268	-0.005
SS012	-0.406	0.193	0.206	0.299	0.073
SS020	-0.482	-0.299	0.035	-0.186	-0.233*
SRV605	-0.160	0.328	0.540**	0.094	0.201
FS9604	-0.311	-0.129	-0.396*	-0.283	-0.280*
FS9605	-0.258	-0.430*	-0.230	-0.151	-0.267*
FS9601	-0.130	-0.257	-0.119	-0.103	-0.152
FS9603	0.575*	0.029	-0.289	-0.004	0.078
68710	-0.061	-0.368*	-0.531**	-0.004	-0.241*
68724	-0.246	-1.036**	-1.017**	-0.473*	-0.693**
68726	-0.091	-0.319	-0.040	-0.091	-0.136
Co27	0.350	0.163	0.244	-0.061	0.174
SS032					
	0.282	0.186	0.192	0.222	0.112
SE(g_j)					

* significant at 5 per cent level

** significant at 1 per cent level

Appendix 14. General combining ability effects of parents in individual environments and pooled data for leaf stem ratio

Parents	E ₁	E ₂	E ₃	E ₄	P
Lines					
296A	-0.012**	0.029**	0.002	0.019**	0.010**
2219A	0.017**	0.003	0.014**	-0.003	0.008**
2077A	-0.004	-0.018**	-0.003	-0.008**	-0.008**
111A	-0.002	-0.014**	-0.013**	-0.008**	-0.009**
SE(g_i)	0.025	0.0024	0.0025	0.0025	0.0012
Testers					
68716	-0.000	-0.006	0.007	-0.014*	-0.003
68740	-0.003	0.001	0.022**	0.026**	0.012**
68918	0.025**	0.004	-0.033**	0.054**	0.012**
68786	-0.003	-0.021**	0.030**	0.018**	0.006*
68814	0.007	-0.011*	0.022**	0.034**	0.013**
FS211	0.022**	-0.021**	-0.053**	-0.004	-0.014**
FS205	0.007	0.001	0.017**	-0.016**	0.002
FS9401	-0.018**	-0.014**	0.007	0.001	-0.006*
SS003	0.005	0.004	-0.005	-0.014*	-0.003
SS012	-0.015**	0.001	-0.035**	-0.029**	-0.019**
SS020	0.002	0.009	0.022**	0.001	0.009**
SRV605	-0.030**	0.014**	0.017**	-0.006	-0.001
FS9604	-0.000	0.031**	0.065**	-0.034**	0.016**
FS9605	0.017**	-0.006	-0.003	-0.006	0.001
FS9601	-0.015**	-0.039**	0.007	0.014*	-0.008**
FS9603	0.002	-0.021**	0.015**	-0.014*	-0.004
68710	-0.003	-0.019**	-0.030**	0.001	-0.013**
68724	0.007	-0.016**	-0.035**	-0.011*	-0.014**
68726	-0.013*	0.141**	-0.023**	0.009	0.029**
Co27	0.017**	-0.016**	-0.010	-0.006	-0.004
SS032	-0.013*	-0.016**	-0.008	-0.009	-0.011**
SE(g_i)	0.0058	0.0056	0.0058	0.0058	0.0029

* significant at 5 per cent level

** significant at 1 per cent level

Appendix 15. General combining ability effects of parents in individual environments and pooled data for stem thickness

Parents	E ₁	E ₂	E ₃	E ₄	P
Lines					
296A	0.099**	-0.074	-0.022	0.012	0.004
2219A	-0.235**	-0.107**	-0.130**	0.039	-0.108**
2077A	0.202**	0.135**	0.075	-0.092*	0.080**
111A	-0.065	0.046	0.078	0.041	0.025
SE(g_i)	0.037	0.039	0.049	0.041	0.021
Testers					
68716	-0.045	0.105	-0.073	0.057	0.011
68740	-0.052	0.197*	-0.043	-0.035	0.017
68918	0.167*	0.063	0.118	0.244**	0.148**
68786	0.285**	0.128	0.089	0.073	0.144**
68814	0.105	-0.042	-0.083	0.039	0.005
FS211	-0.015	0.182*	-0.052	0.089	0.051
FS205	-0.246**	0.043	0.084	-0.004	-0.031
FS9401	-0.177*	0.000	-0.031	-0.022	-0.057
SS003	-0.051	-0.060	0.023	-0.025	-0.028
SS012	-0.063	-0.058	0.058	0.057	-0.002
SS020	-0.179*	0.017	0.113	0.082	0.008
SRV605	-0.118	-0.072	0.178	-0.072	-0.021
FS9604	-0.032	-0.083	0.201	0.034	0.030
FS9605	-0.159	-0.085	-0.196	-0.146	-0.146**
FS9601	0.013	-0.042	-0.067	-0.056	-0.038
FS9603	0.050	-0.022	-0.114	-0.068	-0.039
68710	0.083	-0.065	-0.064	-0.009	-0.014
68724	0.074	-0.047	-0.061	-0.046	-0.020
68726	0.015	-0.164	-0.346**	-0.176	-0.168**
Co27	0.111	0.003	0.069	-0.062	0.030
SS032	0.236**	0.002	0.196	0.045	0.120*
SE(g_j)	0.085	0.089	0.113	0.094	0.048

* significant at 5 per cent level

** significant at 1 per cent level

Appendix 16. General combining ability effects of parents in individual environments and pooled data for hydrocyanic acid

Parents	E ₁	E ₂	E ₃	E ₄	P
Lines					
296A	22.005**	5.679**	18.385**	13.438**	14.877**
2219A	1.242**	3.621**	-13.402**	-5.687**	-3.557**
2077A	-12.574**	-15.434**	-9.735**	-12.902**	-12.661**
111A	-10.673 **	6.134**	4.752**	5.152**	1.341**
SE(g_i)	0.460	1.281	0.454	0.377	0.371
Testers					
68716	-1.746	9.978**	16.814**	13.074**	9.530**
68740	14.934**	28.295**	31.319**	29.486**	26.009**
68918	8.262**	-3.372	15.564**	5.779**	6.558**
68786	-6.748**	1.628	-17.771**	-8.472**	-7.841**
68814	11.594**	-42.538**	-2.771**	-18.811**	-13.132**
FS211	27.419**	7.470*	0.561	3.691**	9.786**
FS205	-21.748**	-19.215**	-15.521**	-12.561**	-17.261**
FS9401	-4.237**	4.135	2.226*	2.859**	1.246
SS003	-2.573*	1.627	-16.936**	-7.979**	-6.465**
SS012	-10.926**	9.130**	15.580**	12.024**	6.452**
SS020	-11.736**	2.388	-18.604**	-8.431**	-9.096**
SRV605	3.264**	18.296**	-0.271	8.709**	7.499**
FS9604	33.259**	7.468*	-12.771**	-2.974**	6.246**
FS9605	-20.071**	-25.032**	-5.296**	-15.476**	-16.469**
FS9601	-13.408**	-13.367**	2.234*	-5.891**	-7.608**
FS9603	29.092**	29.965**	33.071**	31.193**	30.831**
68710	-18.493**	-5.032	-2.156*	-3.889**	-7.393**
68724	-5.911**	4.128	1.396	2.439**	0.513
68726	10.754**	-28.375**	-11.101**	-20.059**	-12.195**
Co27	-4.238**	11.628**	-16.939**	-4.226**	-3.444**
SS032	-16.743**	0.793	1.370	-0.479	-3.765**
SE(g_i)	1.055	2.936	1.040	0.863	0.850

* significant at 5 per cent level

** significant at 1 per cent level

Appendix 17. General combining ability effects of parents in individual environments and pooled data for total soluble solids

Parents	E ₁	E ₂	E ₃	E ₄	P
Lines					
296A	0.619**	0.222	0.621**	0.367*	0.457**
2219A	-0.810**	0.317*	1.224**	1.081**	0.453**
2077A	-0.444**	-0.571**	-1.196**	-1.244**	-0.864**
111A	0.635**	0.032	-0.649**	-0.204	-0.047
SE(g)	0.099	0.153	0.177	0.143	0.073
Testers					
68716	0.302	-3.129**	-0.542	-0.990**	-1.090**
68740	0.468*	-0.837*	-1.125**	-0.657*	-0.538**
68918	-0.948**	-1.296**	-0.792	-0.823*	-0.965**
68786	-1.282**	-2.171**	-1.542**	-1.573**	-1.642**
68814	0.802**	-0.337	-0.375	-0.323	-0.059
FS211	0.968**	0.079	0.208	0.510	0.441**
FS205	1.968**	-2.171**	-0.417	-0.032	-0.163
FS9401	-0.448*	-0.337	-0.958*	-0.823*	-0.642**
SS003	-0.198	-0.921**	0.625	0.260	-0.059
SS012	0.552*	-1.004**	0.125	-0.073	-0.100
SS020	-0.115	0.246	-0.458	-0.323	-0.163
SRV605	-0.782**	-0.171	-0.792	-1.073**	-0.704**
FS9604	0.885**	2.746**	-0.625	-0.823*	0.546**
FS9605	-0.782**	3.329**	0.958*	0.927**	1.108**
FS9601	-0.115	-0.004	1.458**	1.510**	0.712**
FS9603	-0.615**	1.079**	-0.125	-0.323	0.004
68710	-0.115	0.329	1.208**	1.177**	0.650**
68724	-1.448**	1.329**	1.125**	1.510**	0.629**
68726	1.885**	0.913**	0.208	0.427	0.858**
Co27	-0.532*	0.746*	1.375**	1.177**	0.691**
SS032	-0.448*	1.579**	0.458	0.343	0.483**
SE(g)	0.227	0.351	0.406	0.327	0.167

* significant at 5 per cent level

** significant at 1 per cent level

Appendix 18. General combining ability effects of parents in individual environments and pooled data for crude protein

Parents	E ₁	E ₂	E ₃	E ₄	P
Parents					
Lines	-0.394**	-0.15**	0.119**	-0.15**	-0.144**
296A	0.565**	0.555**	0.47**	0.554**	0.536**
2219A	-0.052	-0.228**	-0.378**	-0.227**	-0.221**
2077A	-0.119**	-0.177**	-0.211**	-0.177**	-0.171**
111A					
	0.023	0.024	0.029	0.020	0.012
SE(g _i)					
Testers					
68716	-0.082	-0.033	0.043	-0.03	-0.025
68740	0.618**	0.557**	0.523**	0.56**	0.565**
68918	0.006	0.297**	0.613**	0.295**	0.303**
68786	0.356**	-0.145**	-0.615**	-0.14**	-0.136**
68814	0.703**	0.462**	0.25**	0.465**	0.47**
FS211	0.443**	0.005	-0.407**	0.007	0.012
FS205	-0.037	0.077	0.218**	0.077	0.084**
FS9401	-0.519**	-0.428**	-0.31**	-0.425**	-0.42**
SS003	-0.912**	-0.14**	0.653**	-0.143**	-0.135**
SS012	0.356**	0.407**	0.48**	0.405**	0.412**
SS020	-0.342**	0.035	0.435**	0.032	0.04
SRV605	-1.174**	-0.445**	0.043	-0.448**	-0.506**
FS9604	-0.037	0.582**	1.223**	0.577**	0.586**
FS9605	0.006	0.012	0.04	0.012	0.018
FS9601	-0.037	-0.535**	-1.01**	-0.538**	-0.53**
FS9603	-0.474**	-0.515**	-0.527**	-0.51**	-0.507**
68710	-0.039	-0.335**	-0.615**	-0.34**	-0.332**
68724	0.488**	0.165**	-0.132*	0.165**	0.171**
68726	0.181**	-0.168**	-0.757**	-0.17**	-0.229**
Co27	0.356**	0.157**	-0.015	0.157**	0.164**
SS032	0.138**	-0.01	-0.132*	-0.01	-0.004
	0.051	0.054	0.066	0.047	0.028
SE(g _j)					

* significant at 5 per cent level

** significant at 1 per cent level

Appendix 19. General combining ability effects of parents in individual environments and pooled data for dry fodder yield

Parents	E ₁	E ₂	E ₃	E ₄	P
Lines					
296A	-2.205**	-0.779	-2.246	-23.938**	-7.292**
2219A	-9.579**	-11.592**	-17.047**	-12.840**	-12.764**
2077A	16.156**	9.435**	0.663	20.228**	11.620**
111A	-4.372**	2.936**	18.629**	16.550**	8.436**
SE(g_i)	0.492	0.831	1.983	0.661	0.576
Testers					
68716	8.257**	9.785**	1.456	-1.825	4.418**
68740	3.277**	26.287**	-1.213	5.204**	8.389**
68918	-0.486	-15.563**	-31.247**	-11.148**	-14.611**
68786	9.981**	22.096**	-4.609	12.104**	9.893**
68814	15.617**	14.320**	-9.435*	42.528**	15.757**
FS211	-9.629**	-8.689**	-11.744**	-0.222	-7.571**
FS205	-9.618**	-9.530**	-4.872	-7.941**	-7.991**
FS9401	-2.750*	-1.244	11.330*	-13.916**	-1.645
SS003	-7.763**	-19.225**	-11.955**	-20.785**	-14.932**
SS012	-16.610**	-26.254**	-38.096**	-9.116**	-22.519**
SS020	-11.301**	-12.634**	-0.097	-12.691**	-9.181**
SRV605	-8.484**	-15.170**	-0.375	-26.944**	-12.743**
FS9604	-21.095**	-15.672**	4.459	-2.962	-8.818**
FS9605	-11.086**	6.317**	-6.576	8.084**	-0.815
FS9601	-7.488**	-0.096	11.111*	-1.886	0.410
FS9603	-8.898**	8.498**	21.395**	-1.121	4.969**
68710	27.209**	-2.209	13.405**	7.739**	11.536**
68724	20.612**	16.187**	10.472*	5.867**	13.285**
68726	32.877**	18.466**	31.529**	47.565**	32.609**
Co27	3.344**	0.072	1.492	-5.786**	-0.219
SS032	-5.967**	4.260*	13.569**	-12.746**	-0.221
SE(g_j)	1.128	1.903	4.543	1.513	1.319

* significant at 5 per cent level

** significant at 1 per cent level

Appendix 20. General combining ability effects of parents in individual environments and pooled data for green fodder yield per plant

Parents	E ₁	E ₂	E ₃	E ₄	P
Lines					
296A	3.486**	-15.505**	-18.875**	-117.965**	-37.215**
2219A	-61.408**	-73.904**	-94.273**	-52.036**	-70.405**
2077A	55.350**	64.253**	39.521**	95.252**	63.594**
111A	2.572**	25.156**	73.627**	74.749**	44.026**
SE(g)	0.747	0.728	1.004	0.887	0.424
Testers					
68716	24.719**	125.719 **	62.350**	36.602**	62.347**
68740	-1.131	70.304**	-28.815**	-12.356**	7.001**
68918	55.371**	-42.382**	-90.725**	-33.684**	-27.855**
68786	85.049**	176.136 **	28.973**	99.695**	97.463**
68814	70.021**	58.799**	-4.142	165.344 **	72.506**
FS211	-6.461**	-37.196**	-27.642**	0.067	-17.808**
FS205	-59.631**	-53.036**	-49.310**	-34.826**	-49.201**
FS9401	-36.329**	-10.611**	-50.605**	-54.528**	-38.018**
SS003	-45.199**	-85.528**	-53.142**	-83.326**	-66.799**
SS012	-50.411**	-102.494 **	-91.575**	0.554	-60.981**
SS020	-52.721**	-69.361**	-19.310**	-41.081**	-45.618**
SRV605	-60.349**	-72.864**	-2.980	-125.511 **	-65.426**
FS9604	-55.093**	-86.361**	124.348 **	-6.540**	-5.912**
FS9605	-44.704**	2.304	-28.365 **	-0.208	-17.743**
FS9601	-53.479**	-51.361**	5.223*	-39.621**	-34.810**
FS9603	-33.539**	9.302**	19.773**	-28.953**	-8.354**
68710	106.716 **	5.054**	72.270**	52.592**	59.158**
68724	47.436**	91.556**	25.021**	22.712**	46.681**
68726	120.656 **	88.996**	103.108 **	183.436 **	124.049 **
Co27	-9.264**	-38.861**	-29.477**	-41.034**	-29.659**
SS032	-1.661	21.889**	35.020**	-59.333**	-1.021
SE(g)	1.711	1.669	2.308	2.032	0.973

* significant at 5 per cent level

** significant at 1 per cent level

245

Appendix 21. General combining ability effects of parents in individual environments and pooled data for green fodder yield per plot

Parents	E ₁	E ₂	E ₃	E ₄	P
Lines					
296A	-1.704**	-3.078**	-3.479**	-3.838**	-3.025**
2219A	1.03**	1.759**	1.733**	1.415**	1.484**
2077A	-1.594**	-1.95**	-3.322**	0.607**	-1.565**
111A	2.269**	3.269**	5.068**	1.816**	3.105**
SE(g_i)	0.134	0.096	0.214	0.090	0.071
Testers					
68716	-2.08**	0.94**	-0.473	-0.753**	-0.591**
68740	1.57**	2.163**	-1.441**	-0.961**	0.333*
68918	3.498**	-2.749**	-3.504**	-1.375**	-1.033**
68786	1.279**	1.117**	-2.813**	-0.075	-0.123
68814	5.41**	3.106**	0.92	3.464**	3.225**
FS211	2.144**	0.973**	0.577	-1.024**	0.668**
FS205	-2.436**	-0.812**	-0.91	-1.506**	-1.416**
FS9401	0.483	3.239***	2.143**	0	1.466**
SS003	0.039	-0.972**	1.209*	-1.615**	-0.335*
SS012	-0.123	-2.454**	-1.918**	-1.175**	-1.417**
SS020	-1.428**	-1.905**	1.163*	1.75**	-0.105
SRV605	-1.766**	-0.798**	2.829**	-2.317**	-0.513**
FS9604	-4.491**	-5.516**	-0.999*	-0.087	-2.773**
FS9605	0.293	3.404**	2.516**	0.294	1.627***
FS9601	-0.178	2.453**	5.142**	-0.247	1.792**
FS9603	-4.163**	-3.354**	-4.596**	-1.301**	-3.354**
68710	-0.921**	-5.347**	-4.744**	-1.906**	-3.23**
68724	2.274**	5.773**	2.037**	4.124**	3.552**
68726	0.819**	0.684**	2.368**	5.24**	2.278**
Co27	1.059**	-0.106	-0.387	0.161	0.182
SS032	-1.282**	0.161	0.882	-0.692**	-0.233
SE(g_j)	0.307	0.228	0.49	0.206	0.164

* significant at 5 per cent level

** significant at 1 per cent level

Appendix 22. Specific combining ability effects of hybrids in individual environments and pooled data for days to 50 per cent flowering

Hybrids	E ₁	E ₂	E ₃	E ₄	P
296A x 68716	-0.230	2.500**	-1.063	-0.143	0.266
296A x 68740	0.353	-5.000**	-2.313**	-1.143*	-2.026**
296A x 68918	-0.397	-3.750**	0.520	-2.143**	-1.442**
296A x 68786	3.270**	4.750**	-4.313**	0.357	1.016**
296A x 68814	-1.397*	-3.250**	3.437**	-0.393	-0.401
296A x FS211	3.687**	8.250**	0.687	0.357	3.245**
296A x FS205	1.603*	-1.750**	3.687**	1.857**	1.349**
296A x FS9401	1.687**	4.000**	-0.563	0.107	1.308**
296A x SS003	1.020	2.750**	-0.563	-0.060	0.787*
296A x SS012	0.270	1.500*	-3.563**	-0.143	-0.484
296A x SS020	1.687**	-3.750**	-2.480**	0.607	-0.984**
296A x SRV605	1.603*	-4.000**	1.187*	0.357	-0.213
296A x FS9604	-1.147	4.250**	1.437*	-0.143	1.099**
296A x FS9605	-0.563	1.250*	0.937	0.024	0.412
296A x FS9601	1.687**	2.500**	-0.397	-0.143	0.912**
296A x FS9603	-2.397**	2.250**	-0.063	0.607	0.099
296A x 68710	-3.897**	-2.750**	2.187**	-0.143	-1.151**
296A x 68724	-6.147**	-5.750**	-3.063**	0.357	-3.651**
296A x 68726	0.853	-1.000	-1.313*	0.107	-0.338
296A x Co27	-0.647	-2.250**	1.437*	-0.143	-0.401
296A x SS032	-0.897	-0.750	4.187**	-0.143	0.599
2219A x 68716	-1.421*	-4.976**	1.476*	0.794	-1.032**
2219A x 68740	-0.171	-2.476**	2.226**	1.794**	0.343
2219A x 68918	-1.587*	-2.226**	0.060	-0.206	-0.990**
2219A x 68786	-10.921**	-5.700**	1.226*	2.294**	-3.282**
2219A x 68814	-3.254**	-5.726**	-3.357**	-3.456**	-3.948**
2219A x FS211	0.829	-1.226*	1.226*	0.294	0.281
2219A x FS205	1.413*	-0.226	-2.774**	-2.206**	-0.948**
2219A x FS9401	1.496*	0.524	0.976	-0.956	0.510
2219A x SS003	-0.171	2.274**	2.976**	-1.123	0.989**
2219A x SS012	1.413*	1.024	-0.024	-0.206	0.552
2219A x SS020	0.496	0.774	-1.274*	-0.456	-0.115
2219A x SRV605	2.413**	-1.476*	-0.274	2.294**	0.739*
2219A x FS9604	0.329	3.774**	-1.024	1.794**	1.218**
2219A x FS9605	0.913	3.774**	-1.524*	2.294**	1.364**
2219A x FS9601	2.496**	1.024	-1.857**	-1.206*	0.114
2219A x FS9603	0.746	1.774**	-0.524	-0.456	0.385
2219A x 68710	-3.421**	-0.226	2.060**	-0.206	-0.448
2219A x 68724	2.996**	-1.226*	-0.524	-0.706	0.135
2219A x 68726	0.996	5.524**	0.226	0.044	1.697**
2219A x Co27	1.163	2.274**	0.976	-0.206	1.052**
2219A x SS032	3.246**	2.774**	-0.274	-0.206	1.385**
2077A x 68716	-0.071	0.548	-2.413**	-1.413*	-0.837**
2077A x 68740	-0.488	3.048**	-0.663	-1.413*	0.121

Appendix 22 (contd..)

Hybrids	E ₁	E ₂	E ₃	E ₄	P
2077A x 68918	2.429**	-3.702**	-2.829**	-3.413**	-1.879**
2077A x 68786	5.095**	0.798	1.337*	1.087	2.079**
2077A x 68814	2.762**	4.798**	1.754**	2.337**	2.913**
2077A x FS211	-0.821	-2.702**	-0.663	-0.913	-1.275**
2077A x FS205	-1.905**	1.298*	0.337	2.587**	0.579
2077A x FS9401	-2.488**	-1.952**	0.087	1.837**	-0.629*
2077A x SS003	0.179	-1.202	0.087	4.337**	0.850*
2077A x SS012	-1.571*	-0.452	6.087**	1.587**	1.413**
2077A x SS020	-3.488**	-1.702**	1.171	0.337	-0.921**
2077A x SRV605	-1.571*	2.048**	-0.163	-0.913	-0.150
2077A x FS9604	0.345	2.298**	0.087	-1.413*	0.329
2077A x FS9605	1.595*	-1.702**	-0.413	-1.246*	-0.441
2077A x FS9601	-1.488*	-1.452*	2.587**	0.587	0.059
2077A x FS9603	0.762	-1.702**	2.587**	-1.663**	-0.004
2077A x 68710	2.262**	8.298**	-2.829**	0.587	2.079**
2077A x 68724	3.012**	4.298**	3.587**	-0.913	2.496**
2077A x 68726	-1.321*	-3.952**	0.337	-1.163*	-1.525**
2077A x Co27	0.179	-5.202**	-4.913**	-0.413	-2.587**
2077A x SS032	-3.405**	-1.702**	-5.163**	-0.413	-2.671**
111A x 68716	1.722**	1.929**	2.000**	0.762	1.603**
111A x 68740	0.306	4.429**	0.750	0.762	1.562**
111A x 68918	-0.444	9.679**	2.250**	5.762**	4.312**
111A x 68786	2.556**	0.179	1.750**	-3.738**	0.187
111A x 68814	1.889**	4.179**	-1.833**	1.512**	1.437**
111A x FS211	-3.694**	-4.321**	-1.250*	0.262	-2.251**
111A x FS205	-1.111	0.679	-1.250*	-2.238**	-0.980**
111A x FS9401	-0.694	-2.571**	-0.500	-0.988	-1.188**
111A x SS003	-1.028	-3.821**	-2.500**	-3.155**	-2.626**
111A x SS012	-0.111	-2.071**	-2.500**	-1.238*	-1.480**
111A x SS020	1.306*	4.679**	2.583**	-0.488	2.020**
111A x SRV605	-2.444**	3.429**	-0.750	-1.738**	-0.376
111A x FS9604	0.472	-10.321**	-0.500	-0.238	-2.647**
111A x FS9605	-1.944**	-3.321**	1.000	-1.071	-1.334**
111A x FS9601	-2.694**	-2.071**	-0.333	0.762	-1.084**
111A x FS9603	0.889	-2.321**	-2.000**	1.512**	-0.480
111A x 68710	5.056**	-5.321**	-1.417*	-0.238	-0.480
111A x 68724	0.139	2.679**	0.000	1.262*	1.020**
111A x 68726	-0.528	-0.571	0.750	1.012	0.166
111A x Co27	-0.694	5.179**	2.500**	0.762	1.937**
111A x SS032	1.056	-0.321	1.250*	0.762	0.687*
SE(s _{ij})	0.649	0.620	0.605	0.574	0.306

* Significant at 5 per cent level

** Significant at 1 per cent level

248

Appendix 23. Specific combining ability effects of hybrids in individual environments and pooled data for plant height

Hybrids	E ₁	E ₂	E ₃	E ₄	P
296A x 68716	-3.831	-40.726**	-14.805**	-32.079**	-22.860**
296A x 68740	-3.136	-21.609**	-8.539*	-5.661	-9.736**
296A x 68918	4.944	-3.196	0.558	-0.659	0.412
296A x 68786	-6.709	4.356	-1.989	4.701	0.090
296A x 68814	10.269**	17.941**	-0.109	-24.588**	0.878
296A x FS211	16.947**	11.686**	10.266**	6.896*	11.449**
296A x FS205	1.919	3.406	1.913	-4.136	0.776
296A x FS9401	-3.636	7.676**	5.633	13.064**	5.684**
296A x SS003	6.638	20.596**	13.556**	11.109**	12.975**
296A x SS012	-0.031	-12.831**	-3.622	-6.699	-5.796**
296A x SS020	8.049*	11.574**	11.978**	-8.736*	5.716**
296A x SRV605	-21.751**	-3.619	-17.947**	22.489**	-5.207**
296A x FS9604	-9.078**	22.271**	14.991**	12.564**	10.187**
296A x FS9605	-3.921	-7.801*	-4.427	4.749	-2.850
296A x FS9601	-11.492**	-6.784*	4.161	18.198**	1.021
296A x FS9603	5.352	-1.006	0.083	10.851**	3.820*
296A x 68710	19.932**	6.269	11.946**	-4.146	8.500**
296A x 68724	2.742	-3.956	-7.264*	16.259**	1.945
296A x 68726	-5.306	-6.486	-4.703	-22.754**	-9.812**
296A x Co27	3.789	-0.143	-3.403	-14.229**	-3.496*
296A x SS032	-11.691**	2.379	-8.275*	2.809	-3.694*
2219A x 68716	4.804	14.231**	9.079**	22.005**	12.530**
2219A x 68740	-18.061**	9.429**	4.632	3.082	-0.229
2219A x 68918	3.799	-1.605	-7.171*	4.415	-0.140
2219A x 68786	-9.704**	-4.586	-7.848*	29.555**	1.854
2219A x 68814	-4.886	-16.721**	-7.957*	-3.658	-8.306**
2219A x FS211	-13.578**	-0.206	-0.050	8.640*	-1.299
2219A x FS205	-5.036	-5.086	4.204	-1.503	-1.855
2219A x FS9401	2.169	-10.836**	-10.466**	-3.973	-5.776**
2219A x SS003	11.369**	21.224**	27.587**	35.852**	24.008**
2219A x SS012	12.564**	15.736**	-1.951	0.485	6.709**
2219A x SS020	4.394	-9.929**	7.779*	-16.994**	-3.674*
2219A x SRV605	8.864*	-0.281	17.194**	-3.878	5.475**
2219A x FS9604	16.477**	-5.921	4.382	-6.923*	2.004
2219A x FS9605	6.554	2.656	-5.446	-21.288**	-4.381*
2219A x FS9601	7.383*	-2.016	-15.358**	-10.332**	-5.081**
2219A x FS9603	-5.793	-1.809	-16.526**	-10.735**	-8.716**
2219A x 68710	-10.733**	-0.394	5.457	-6.293	-2.991
2219A x 68724	-2.733	5.801	-4.603	5.112	0.894
2219A x 68726	-3.261	-0.149	7.848*	-0.974	0.866
2219A x Co27	1.394	-9.679**	3.598	-1.875	-1.640
2219A x SS032	-5.989	0.136	-14.384**	-20.770**	-10.252**

2019

Appendix 23 (contd..)

Hybrids	E ₁	E ₂	E ₃	E ₄	P
2077A x 68716	-1.186	11.329**	21.003**	13.467**	11.153**
2077A x 68740	-7.531*	0.957	5.048	-3.445	-1.243
2077A x 68918	-8.371*	4.103	3.946	-19.173**	-4.874**
2077A x 68786	9.216**	18.712**	6.578	-33.423**	0.271
2077A x 68814	-0.056	6.547	15.196**	5.938	6.906**
2077A x FS211	3.281	-1.518	-1.533	-14.008**	-3.444*
2077A x FS205	-5.576	-4.028	5.301	11.640**	1.834
2077A x FS9401	-0.001	2.262	8.791*	-19.730**	-2.170
2077A x SS003	-7.418*	-18.418**	-8.807*	-9.955**	-11.149**
2077A x SS012	-7.346*	1.654	10.476**	3.007	1.948
2077A x SS020	-19.666**	14.939**	-8.884*	18.530**	1.230
2077A x SRV605	6.194	15.017**	-3.879	-7.635*	2.424
2077A x FS9604	13.536**	-13.103**	-8.392*	-15.890**	-5.962**
2077A x FS9605	0.284	-5.526	-7.929*	0.065	-3.277
2077A x FS9601	-3.104	-19.298**	-13.772**	-13.306**	-12.370**
2077A x FS9603	5.247	-9.291**	11.821**	11.677**	4.863**
2077A x 68710	-0.164	-4.866	-8.417*	17.400**	0.988
2077A x 68724	-0.634	0.299	-0.347	-14.535**	-3.804*
2077A x 68726	6.299	4.649	-11.022**	30.099**	7.506**
2077A x Co27	-4.446	2.443	-15.212**	28.597**	2.846
2077A x SS032	21.441**	-6.866*	0.033	10.685**	6.323**
111A x 68716	0.213	15.165**	-15.277**	-3.393	-0.823
111A x 68740	28.728**	11.223**	-1.141	6.025	11.209**
111A x 68918	-0.372	0.698	2.667	15.417**	4.603**
111A x 68786	7.198*	-18.482**	3.259	-0.833	-2.215
111A x 68814	-5.327	-7.767*	-7.13*	22.308**	0.521
111A x FS211	-6.650	-9.962**	-8.682*	-1.528	-6.706**
111A x FS205	8.693*	5.708	-11.418**	-6.000	-0.755
111A x FS9401	1.468	0.898	-3.958	10.640**	2.262
111A x SS003	-10.589**	-23.402**	-32.336**	-37.005**	-25.833**
111A x SS012	-5.187	-4.560	-4.903	3.207	-2.861
111A x SS020	7.223*	-16.585**	-10.873**	7.150*	-3.271
111A x SRV605	6.693	-11.117**	4.632	-10.975**	-2.692
111A x FS9604	-20.935**	-3.247	-10.981**	10.250**	-6.228**
111A x FS9605	-2.917	10.670**	17.802**	16.475**	10.507**
111A x FS9601	7.212*	28.098**	24.969**	5.441	16.430**
111A x FS9603	-4.805	12.105**	4.622	-11.793**	0.032
111A x 68710	-9.035**	-1.010	-8.986**	-6.960*	-6.498**
111A x 68724	0.625	-2.145	12.214**	-6.835*	0.965
111A x 68726	2.268	1.985	7.876*	-6.371	1.439
111A x Co27	-0.737	7.378**	15.016**	-12.493**	2.291
111A x SS032	-3.761	4.350	22.627**	7.276*	7.623**
SE(s _{II})	3.446	3.437	3.450	3.486	1.727

* Significant at 5 per cent level

** Significant at 1 per cent level

Appendix 24. Specific combining ability effects of hybrids in individual environments and pooled data for number of tillers

Hybrids	E ₁	E ₂	E ₃	E ₄	P
296A x 68716	-0.006	-0.924**	-0.611	-0.270	-0.453*
296A x 68740	0.161	0.067	0.073	-0.734	-0.108
296A x 68918	-0.089	0.217	-0.940*	0.625	-0.047
296A x 68786	-0.368	-0.074	-0.277	-0.196	-0.229
296A x 68814	0.244	-0.816*	-0.761	-1.038*	-0.593**
296A x FS211	0.244	-0.366	-0.411	-0.131	-0.166
296A x FS205	-0.039	-0.416	-0.261	0.523	-0.048
296A x FS9401	0.236	-0.316	-0.561	-0.059	-0.175
296A x SS003	0.077	-0.049	-0.294	0.494	0.057
296A x SS012	-0.073	-0.033	-0.377	-0.249	-0.183
296A x SS020	0.211	-0.166	-0.244	0.128	-0.018
296A x SRV605	-0.106	-0.160	0.181	1.014*	0.232
296A x FS9604	-0.039	0.351	0.872	-0.130	0.263
296A x FS9605	-0.039	0.017	-0.511	-0.407	-0.235
296A x FS9601	0.027	0.167	0.373	-0.340	0.057
296A x FS9603	-0.281	-0.149	0.323	-0.160	-0.067
296A x 68710	0.094	-0.049	0.309	0.521	0.218
296A x 68724	-0.048	-0.383	0.123	0.967*	0.165
296A x 68726	-0.009	2.684**	2.623**	-0.063	1.308**
296A x Co27	-0.198	-0.066	-0.252	-0.588	-0.276
296A x SS032	0.002	0.467	0.623	0.093	0.296
2219A x 68716	0.036	0.716*	1.009*	0.665	0.607**
2219A x 68740	-0.064	0.108	0.426	0.411	0.220
2219A x 68918	0.086	-0.142	1.013*	0.220	0.294
2219A x 68786	0.291	-0.134	-0.124	0.266	0.075
2219A x 68814	0.553*	0.158	0.192	0.227	0.283
2219A x FS211	-0.114	0.008	0.276	-0.316	-0.036
2219A x FS205	-0.197	0.025	-0.041	0.342	0.032
2219A x FS9401	-0.122	0.258	0.192	0.316	0.161
2219A x SS003	-0.147	-0.142	0.059	0.316	0.021
2219A x SS012	0.236	0.208	0.442	0.573	0.365
2219A x SS020	-0.014	0.208	0.642	-0.523	0.078
2219A x SRV605	-0.397	-0.276	0.034	-0.391	-0.257
2219A x FS9604	0.070	-0.142	-0.552	-0.418	-0.261
2219A x FS9605	0.003	-0.075	0.242	-0.088	0.020
2219A x FS9601	0.070	0.275	0.192	-0.295	0.060
2219A x FS9603	-0.172	0.425	-1.058*	-0.405	-0.302
2219A x 68710	-0.330	-0.475	-0.805	-0.207	-0.455*
2219A x 68724	-0.105	-0.142	-0.858	-0.212	-0.329
2219A x 68726	-0.340	-1.075**	-1.024*	-0.398	-0.710**
2219A x Co27	0.511*	0.241	-0.099	0.120	0.193
2219A x SS032	0.145	-0.025	-0.158	-0.202	-0.060
2077A x 68716	0.043	0.233	-0.510	0.029	-0.051
2077A x 68740	0.409	0.058	-0.094	1.332**	0.426*

Appendix 24 (contd..)

Hybrids	E ₁	E ₂	E ₃	E ₄	P
2077A x 68918	-0.307	0.008	0.077	-0.433	-0.164
2077A x 68786	-0.270	-0.051	0.556	-0.587	-0.088
2077A x 68814	-0.507*	0.108	0.206	0.667	0.119
2077A x FS211	-0.107	0.291	0.623	-0.012	0.199
2077A x FS205	0.409	0.241	0.173	-0.344	0.120
2077A x FS9401	0.118	0.208	0.340	-0.043	0.155
2077A x SS003	0.193	0.074	0.206	-0.093	0.095
2077A x SS012	-0.024	-0.042	0.323	-0.197	0.015
2077A x SS020	-0.007	0.291	-0.077	0.784	0.248
2077A x SRV605	0.143	-0.103	-0.452	-0.260	-0.168
2077A x FS9604	-0.124	-0.326	-0.138	-0.501	-0.272
2077A x FS9605	-0.191	0.208	-0.444	-0.331	-0.189
2077A x FS9601	0.209	-0.242	-0.260	0.682	0.097
2077A x FS9603	0.134	-0.492	-0.377	-0.278	-0.253
2077A x 68710	0.343	-0.126	0.332	-0.133	0.104
2077A x 68724	0.001	0.674	0.423	-0.231	0.217
2077A x 68726	0.399	-0.392	-0.944*	-0.098	-0.259
2077A x Co27	-0.449	0.191	0.781	0.654	0.294
2077A x SS032	-0.416	-0.809*	-0.744	-0.608	-0.644**
111A x 68716	-0.073	-0.024	0.112	-0.424	-0.102
111A x 68740	-0.506*	-0.233	-0.405	1.008*	-0.538**
111A x 68918	0.310	-0.083	-0.150	-0.412	-0.084
111A x 68786	0.348	0.259	-0.155	0.517	0.242
111A x 68814	-0.290	0.551	0.362	0.144	0.192
111A x FS211	-0.023	0.067	-0.488	0.458	0.004
111A x FS205	-0.173	0.151	0.129	-0.521	-0.104
111A x FS9401	-0.231	-0.149	0.029	-0.213	-0.141
111A x SS003	-0.123	0.117	0.029	-0.717	-0.173
111A x SS012	-0.140	-0.133	-0.388	-0.127	-0.197
111A x SS020	-0.190	-0.333	-0.321	-0.389	-0.308
111A x SRV605	0.360	0.540	0.237	-0.363	0.193
111A x FS9604	0.094	0.117	-0.182	1.049*	0.269
111A x FS9605	0.227	-0.149	0.712	0.826*	0.404*
111A x FS9601	-0.306	-0.199	-0.305	-0.047	-0.214
111A x FS9603	0.319	0.217	1.112*	0.843*	0.623**
111A x 68710	-0.106	0.651	0.165	-0.180	0.132
111A x 68724	0.152	-0.149	0.312	-0.524	-0.052
111A x 68726	-0.050	-1.216**	-0.655	0.559	-0.340
111A x Co27	0.135	-0.366	-0.430	-0.186	-0.212
111A x SS032	0.269	0.367	0.279	0.716	0.408*
SE(s _{ij})	0.252	0.347	0.461	0.413	0.188

* Significant at 5 per cent level

** Significant at 1 per cent level

232

Appendix 25. Specific combining ability effects of hybrids in individual environments and pooled data for number of leaves

Hybrids	E ₁	E ₂	E ₃	E ₄	P
296A x 68716	0.016	-0.804	0.168	-0.700	-0.330
296A x 68740	0.341	-0.816	-0.065	-0.650	-0.298
296A x 68918	0.666	0.009	-0.145	1.03*	0.390
296A x 68786	-0.584	0.409	-0.615	-0.464	-0.314
296A x 68814	0.383	0.417	-0.315	0.817	0.325
296A x FS211	0.300	0.767	0.335	-0.619	0.196
296A x FS205	0.200	0.709	0.376	-0.315	0.242
296A x FS9401	0.333	0.217	0.718	0.672	0.485*
296A x SS003	0.283	0.152	0.018	-0.092	0.090
296A x SS012	0.250	-0.083	-0.432	-0.940	-0.301
296A x SS020	-0.250	-0.500	0.001	-0.273	-0.255
296A x SRV605	-0.284	-0.216	-0.190	1.029*	0.085
296A x FS9604	0.141	1.317*	0.952*	0.534	0.736**
296A x FS9605	-0.317	-0.416	-0.382	-0.077	-0.298
296A x FS9601	-0.267	-0.483	0.285	1.000*	0.134
296A x FS9603	0.041	-0.350	0.143	0.128	-0.009
296A x 68710	0.083	0.484	0.178	0.047	0.198
296A x 68724	-0.684	-0.483	-0.582	-0.560	-0.577*
296A x 68726	-0.325	-0.567	-0.857*	-0.505	-0.564*
296A x Co27	-0.075	-0.111	-0.207	-0.413	-0.201
296A x SS032	-0.250	0.350	0.618	0.352	0.267
2219A x 68716	-0.001	0.944	-0.021	0.661	0.396
2219A x 68740	-0.410	0.998	0.479	-0.842	0.056
2219A x 68918	-0.751	-0.777	-0.734	0.335	-0.482*
2219A x 68786	-0.601	-0.010	0.262	1.568**	0.305
2219A x 68814	-0.368	-0.368	-0.638	-1.101*	-0.619**
2219A x FS211	-0.251	0.248	-0.188	-0.587	-0.195
2219A x FS205	0.249	0.023	0.120	-0.063	0.082
2219A x FS9401	0.649	-0.102	0.395	-0.076	0.217
2219A x SS003	-0.535	0.167	1.162**	0.436	0.308
2219A x SS012	0.432	-0.802	-0.488	-0.022	-0.220
2219A x SS020	-0.001	0.182	-0.121	-0.245	-0.046
2219A x SRV605	0.565	0.198	-0.380	-0.383	0.000
2219A x FS9604	-0.376	0.065	-0.194	0.119	-0.097
2219A x FS9605	-0.068	-0.202	-0.371	-0.386	-0.257
2219A x FS9601	0.715	-1.002	-0.705	0.032	-0.240
2219A x FS9603	0.357	0.532	-0.180	-0.064	0.161
2219A x 68710	0.665	0.165	0.455	-0.311	0.244
2219A x 68724	0.232	0.398	0.295	0.684	0.403
2219A x 68726	-0.276	-0.262	0.687	0.079	0.057
2219A x Co27	-0.026	0.238	0.270	0.119	0.150
2219A x SS032	-0.201	-0.635	-0.105	0.047	-0.223
2077A x 68716	-0.269	-0.134	-0.074	-0.276	-0.188
2077A x 68740	-0.544	-0.097	-0.708	0.394	-0.239

Appendix 25 (contd..)

Hybrids	E ₁	E ₂	E ₃	E ₄	P
2077A x 68918	0.314	0.195	0.930*	-1.059*	0.095
2077A x 68786	0.931*	0.695	0.676	-0.839	0.365
2077A x 68814	-0.036	0.803	0.909*	0.438	0.529*
2077A x FS211	0.147	-0.647	0.092	0.306	-0.025
2077A x FS205	-0.419	-0.738	-0.033	-0.504	-0.423
2077A x FS9401	-0.753	-0.397	-0.524	-0.350	-0.506*
2077A x SS003	0.464	-0.262	-0.691	0.719	0.058
2077A x SS012	-0.703	-0.030	0.592	-1.073*	-0.303
2077A x SS020	-0.003	0.087	-0.041	0.705	0.187
2077A x SRV605	0.097	0.237	0.334	0.236	0.226
2077A x FS9604	-0.244	-0.497	-0.447	-0.269	-0.364
2077A x FS9605	0.464	0.503	0.309	0.234	0.378
2077A x FS9601	-0.353	0.103	-0.758	-1.005*	-0.503*
2077A x FS9603	0.056	0.103	0.134	0.832	0.281
2077A x 68710	-0.469	-0.063	0.562	1.021*	0.263
2077A x 68724	0.364	-0.163	-0.024	-0.419	-0.061
2077A x 68726	0.056	0.443	-0.266	0.846	0.269
2077A x Co27	0.239	-0.614	-0.216	0.455	-0.034
2077A x SS032	0.664	0.470	-0.758	-0.390	-0.003
111A x 68716	0.254	-0.006	-0.072	0.315	0.123
111A x 68740	0.613	-0.085	0.294	1.099*	0.480*
111A x 68918	-0.229	0.573	-0.051	-0.307	-0.004
111A x 68786	0.254	-1.094*	-0.322	-0.265	-0.357
111A x 68814	0.021	-0.852	0.044	-0.154	-0.235
111A x FS211	-0.196	-0.369	-0.239	0.900	0.024
111A x FS205	-0.029	0.006	-0.464	0.881	0.099
111A x FS9401	-0.229	0.281	-0.589	-0.245	-0.196
111A x SS003	-0.212	-0.057	-0.489	-1.063*	-0.455
111A x SS012	0.021	0.915	0.328	2.035**	0.825**
111A x SS020	0.254	0.231	0.161	-0.187	0.115
111A x SRV605	-0.379	-0.219	0.236	-0.882	-0.311
111A x FS9604	0.479	-0.885	-0.311	-0.384	-0.275
111A x FS9605	-0.079	0.115	0.444	0.229	0.177
111A x FS9601	-0.096	1.381*	1.178**	-0.027	0.609**
111A x FS9603	-0.454	-0.285	-0.097	-0.896	-0.433
111A x 68710	-0.279	-0.585	-1.196**	-0.757	-0.704**
111A x 68724	0.088	0.248	0.311	0.295	0.236
111A x 68726	0.546	0.387	0.436	-0.420	0.237
111A x Co27	-0.137	0.487	0.153	-0.160	0.086
111A x SS032	-0.212	-0.185	0.244	-0.009	-0.041
SE(s _{ij})	0.424	0.550	0.397	0.505	0.237

* Significant at 5 per cent level

** Significant at 1 per cent level

Appendix 26. Specific combining ability effects of hybrids in individual environments and pooled data for leaf length

Hybrids	E ₁	E ₂	E ₃	E ₄	P
296A x 68716	-1.665	-5.432	-3.357	-11.514**	-5.492**
296A x 68740	2.318	-1.114	-1.538	-2.859	-0.798
296A x 68918	1.746	-2.613	-0.925	4.980	0.797
296A x 68786	2.517	-3.773	-3.344	-3.819	-2.105
296A x 68814	-0.970	-1.515	-2.592	-2.551	-1.907
296A x FS211	2.853	-5.507	2.121	3.255	0.681
296A x FS205	0.040	-1.075	3.309	-3.264	-0.248
296A x FS9401	-1.460	0.025	1.365	1.958	0.472
296A x SS003	0.746	0.582	1.272	-2.124	0.119
296A x SS012	-1.920	0.817	5.953	1.083	1.483
296A x SS020	-0.059	10.258**	-1.624	-2.146	1.607
296A x SRV605	-1.969	6.170	-2.812	9.999**	2.847
296A x FS9604	-2.916	5.370	2.052	-0.171	1.084
296A x FS9605	0.000	1.040	-1.473	-3.668	-1.025
296A x FS9601	2.490	0.810	2.333	6.276	2.977
296A x FS9603	0.528	-0.932	3.160	6.273	2.257
296A x 68710	1.305	1.083	-1.867	7.591*	2.028
296A x 68724	-0.958	-2.715	-2.673	2.017	-1.082
296A x 68726	0.123	-3.537	-4.046	-11.366**	-4.706**
296A x Co27	-0.012	-1.588	5.683	-1.028	0.764
296A x SS032	-2.734	3.645	-0.994	1.079	0.249
2219A x 68716	0.337	3.714	1.722	5.220	2.748
2219A x 68740	-1.607	2.435	-2.149	-1.341	-0.665
2219A x 68918	0.735	0.820	1.061	2.921	1.384
2219A x 68786	-5.364	-0.760	3.569	10.005**	1.862
2219A x 68814	-1.995	-0.122	-2.086	-8.08*	-3.071
2219A x FS211	-4.618	-0.787	-2.293	-2.837	-2.634
2219A x FS205	0.942	0.231	-1.658	4.940	1.114
2219A x FS9401	1.762	-1.489	2.458	-1.391	0.335
2219A x SS003	1.888	3.975	5.864	2.370	3.524*
2219A x SS012	3.808	-0.577	-4.374	0.814	-0.082
2219A x SS020	-0.663	-1.575	-5.245	-0.855	-2.085
2219A x SRV605	3.733	0.743	1.094	-1.326	1.061
2219A x FS9604	2.929	-3.597	3.884	5.966	2.296
2219A x FS9605	-2.872	3.060	-0.254	-6.380	-1.612
2219A x FS9601	1.465	1.850	-3.075	-1.406	-0.292
2219A x FS9603	3.850	-2.605	-5.051	0.724	-0.771
2219A x 68710	-1.013	-5.797	-0.307	-5.791	-3.227
2219A x 68724	0.558	-0.715	1.806	-3.989	-0.585
2219A x 68726	-3.128	-1.444	3.767	-0.872	-0.419
2219A x Co27	1.157	0.725	1.042	-3.800	-0.219
2219A x SS032	-1.905	1.918	0.225	5.110	1.337
2077A x 68716	1.093	-2.218	-0.210	9.211**	1.969
2077A x 68740	-4.543	-0.913	0.399	-0.548	-1.401

Appendix 26 (contd..)

Hybrids	E ₁	E ₂	E ₃	E ₄	P
2077A x 68918	0.438	5.098	0.726	-10.032**	-0.942
2077A x 68786	4.919	5.945	1.650	-8.131*	1.096
2077A x 68814	0.802	-0.270	3.942	0.666	1.285
2077A x FS211	3.132	3.365	1.762	0.533	2.198
2077A x FS205	0.505	-1.557	3.763	-5.126	-0.604
2077A x FS9401	-0.922	-2.230	-1.547	-0.588	-1.322
2077A x SS003	-2.115	-0.940	-2.394	2.237	-0.803
2077A x SS012	-7.622*	1.108	0.994	0.767	-1.188
2077A x SS020	1.407	-5.583	6.330	9.076**	2.807
2077A x SRV605	-2.057	-3.432	4.415	-3.876	-1.237
2077A x FS9604	-1.961	-5.232	-6.337	-4.817	-4.587**
2077A x FS9605	1.658	0.338	2.718	5.410	2.531
2077A x FS9601	2.102	2.908	-2.000	0.961	0.993
2077A x FS9603	-1.053	0.526	2.801	-2.539	-0.066
2077A x 68710	0.117	0.615	5.484	-0.811	1.351
2077A x 68724	0.314	0.470	-1.769	-0.599	-0.396
2077A x 68726	-2.345	4.862	-6.078	7.645*	1.021
2077A x Co27	-0.367	0.610	-9.670**	6.313	-0.778
2077A x SS032	6.498*	-3.470	-4.980	-5.750	-1.926
111A x 68716	0.235	3.936	1.845	-2.917	0.775
111A x 68740	3.832	-0.409	3.288	4.748	2.865
111A x 68918	-2.920	-3.305	-0.862	2.131	-1.239
111A x 68786	-2.072	-1.411	-1.875	1.945	-0.853
111A x 68814	2.164	1.907	0.737	9.966**	3.693*
111A x FS211	-1.366	2.929	-1.590	-0.951	-0.245
111A x FS205	-1.486	2.400	-5.415	3.450	-0.263
111A x FS9401	0.620	3.694	-2.275	0.021	0.515
111A x SS003	-0.520	-3.616	-4.742	-2.484	-2.840
111A x SS012	5.734	-1.348	-2.574	-2.664	-0.213
111A x SS020	-0.685	-3.100	0.539	-6.075	-2.330
111A x SRV605	0.292	-3.481	-2.696	-4.797	-2.671
111A x FS9604	1.948	3.459	0.401	-0.978	1.208
111A x FS9605	1.214	-4.438	-0.990	4.639	0.106
111A x FS9601	-6.056	-5.568	2.742	-5.830	-3.678*
111A x FS9603	-3.325	3.010	-0.910	-4.457	-1.420
111A x 68710	-0.408	4.099	-3.310	-0.989	-0.152
111A x 68724	0.086	2.960	2.636	2.571	2.063
111A x 68726	5.350	0.119	6.357	4.594	4.105*
111A x Co27	-0.778	0.254	2.945	-1.484	0.234
111A x SS032	-1.860	-2.093	5.749	-0.438	0.340
SE(s _{ij})	3.092	3.615	3.355	3.375	1.682

* Significant at 5 per cent level

** Significant at 1 per cent level

Appendix 27. Specific combining ability effects of hybrids in individual environments and pooled data for leaf breadth

Hybrids	E ₁	E ₂	E ₃	E ₄	P
296A x 68716	-0.561	-0.005	-0.398	-0.396	-0.340
296A x 68740	-0.480	-0.132	-0.251	-0.405	-0.317
296A x 68918	0.424	0.069	0.365	1.2**	0.515*
296A x 68786	-0.445	0.075	-0.286	-0.592	-0.312
296A x 68814	0.339	0.360	0.013	0.051	0.191
296A x FS211	0.219	-0.398	0.220	0.074	0.028
296A x FS205	1.084	0.398	-0.078	-0.079	0.331
296A x FS9401	-0.206	-0.332	0.201	-0.069	-0.102
296A x SS003	-0.310	0.130	0.402	-0.311	-0.022
296A x SS012	0.120	-0.143	0.311	0.076	0.091
296A x SS020	0.217	0.607	-0.260	0.252	0.204
296A x SRV605	0.099	-0.868*	-0.399	0.793*	-0.094
296A x FS9604	0.190	0.932*	-0.168	0.554	0.377
296A x FS9605	-0.152	-0.124	-0.488	-0.84*	-0.401
296A x FS9601	-0.265	0.010	0.199	0.152	0.024
296A x FS9603	-0.213	-0.230	0.102	-0.013	-0.089
296A x 68710	0.222	-0.069	0.185	0.251	0.147
296A x 68724	0.099	-0.279	-0.179	-0.002	-0.090
296A x 68726	-0.110	0.226	-0.340	-0.700	-0.231
296A x Co27	-0.038	-0.261	0.270	0.172	0.036
296A x SS032	-0.233	0.037	0.579	-0.169	0.053
2219A x 68716	0.028	0.042	0.090	0.302	0.116
2219A x 68740	0.185	0.182	0.510	0.180	0.264
2219A x 68918	-0.372	-0.517	-0.387	-0.424	-0.425
2219A x 68786	-0.743	-0.475	0.255	1.1*	0.034
2219A x 68814	-0.263	-0.293	-0.489	-0.427	-0.368
2219A x FS211	-0.277	-0.198	-0.296	-0.024	-0.199
2219A x FS205	-0.425	-0.261	-0.090	0.047	-0.182
2219A x FS9401	0.498	0.115	-0.052	0.170	0.183
2219A x SS003	-0.025	0.124	-0.014	0.221	0.076
2219A x SS012	0.392	0.130	-0.255	-0.215	0.013
2219A x SS020	-0.165	0.160	0.171	0.111	0.069
2219A x SRV605	0.858	0.612	0.385	-0.028	0.457*
2219A x FS9604	0.215	0.405	0.810*	-0.418	0.253
2219A x FS9605	-0.061	0.033	0.167	0.129	0.067
2219A x FS9601	0.147	0.090	-0.473	-0.006	-0.061
2219A x FS9603	0.058	0.057	-0.151	-0.078	-0.028
2219A x 68710	-0.073	-0.212	-0.207	-0.077	-0.142
2219A x 68724	0.070	0.141	-0.018	-0.207	-0.003
2219A x 68726	0.328	-0.004	0.341	0.026	0.173
2219A x Co27	-0.133	-0.597	-0.009	-0.433	-0.293
2219A x SS032	-0.242	0.464	-0.287	0.050	-0.004
2077A x 68716	0.102	-0.046	0.419	1.112*	0.397
2077A x 68740	-0.094	0.514	0.332	-0.117	0.159

Appendix 27 (contd..)

Hybrids	E ₁	E ₂	E ₃	E ₄	P
2077A x 68918	0.443	0.475	0.351	-0.351	0.229
2077A x 68786	0.324	0.330	-0.023	-0.843*	-0.053
2077A x 68814	0.098	0.132	0.823*	0.183	0.309
2077A x FS211	-0.102	0.260	0.310	-0.141	0.082
2077A x FS205	-0.484	-0.783*	0.725	-0.403	-0.236
2077A x FS9401	-0.354	-0.126	-0.196	0.023	-0.163
2077A x SS003	-0.291	-0.091	-0.302	0.057	-0.157
2077A x SS012	-0.387	-0.098	0.054	-0.058	-0.122
2077A x SS020	0.443	-0.348	-0.067	-0.063	-0.009
2077A x SRV605	-0.215	0.484	-0.300	-0.425	-0.114
2077A x FS9604	0.296	-0.703	-0.245	-0.151	-0.201
2077A x FS9605	0.070	-0.199	0.115	0.309	0.074
2077A x FS9601	0.028	-0.418	-0.498	0.051	-0.209
2077A x FS9603	0.099	-0.358	-0.325	0.479	-0.025
2077A x 68710	-0.126	0.330	0.045	-0.470	-0.055
2077A x 68724	-0.296	-0.044	-0.010	0.010	-0.085
2077A x 68726	-0.244	0.055	-0.154	0.562	0.055
2077A x Co27	0.214	0.631	-0.464	0.617	0.250
2077A x SS032	0.473	0.002	-0.591	-0.383	-0.125
111A x 68716	0.431	0.009	-0.111	-1.019*	-0.172
111A x 68740	0.389	-0.564	-0.591	0.342	-0.106
111A x 68918	-0.495	-0.027	-0.329	-0.425	-0.319
111A x 68786	0.864	0.069	0.054	0.336	0.331
111A x 68814	-0.173	-0.199	-0.347	0.192	-0.132
111A x FS211	0.160	0.336	-0.234	0.091	0.088
111A x FS205	-0.175	0.646	-0.558	0.436	0.087
111A x FS9401	0.062	0.343	0.047	-0.124	0.082
111A x SS003	0.625	-0.162	-0.085	0.033	0.103
111A x SS012	-0.125	0.111	-0.110	0.197	0.018
111A x SS020	-0.495	-0.419	0.156	-0.300	-0.264
111A x SRV605	-0.742	-0.227	0.314	-0.339	-0.249
111A x FS9604	-0.701	-0.634	-0.398	0.015	-0.430
111A x FS9605	0.143	0.290	0.205	0.401	0.260
111A x FS9601	0.090	0.318	0.772*	-0.197	0.246
111A x FS9603	0.055	0.531	0.375	-0.389	0.143
111A x 68710	-0.023	-0.048	-0.022	0.296	0.051
111A x 68724	0.127	0.182	0.207	0.199	0.179
111A x 68726	0.025	-0.277	0.153	0.111	0.003
111A x Co27	-0.043	0.227	0.203	-0.357	0.007
111A x SS032	0.002	-0.502	0.299	0.502	0.075
SE(s _{ij})	0.564	0.371	0.383	0.444	0.224

* Significant at 5 per cent level

** Significant at 1 per cent level

Appendix 28. Specific combining ability effects of hybrids in individual environments and pooled data for leaf stem ratio

Hybrids	E ₁	E ₂	E ₃	E ₄	P
296A x 68716	-0.026*	0.033**	0.023	-0.059**	-0.007
296A x 68740	0.027*	-0.025**	0.008	0.031**	0.010
296A x 68918	-0.011	-0.007*	-0.007	-0.016**	-0.010
296A x 68786	0.007	-0.042**	0.010	0.006	-0.005
296A x 68814	0.037**	0.008*	-0.002	0.104**	0.036**
296A x FS211	-0.008	0.038**	0.003	0.001	0.008
296A x FS205	-0.013	-0.015**	-0.007	-0.006	-0.010
296A x FS9401	0.002	0.010	0.023	-0.014**	0.005
296A x SS003	0.009	-0.007*	-0.005	-0.009**	-0.003
296A x SS012	-0.011	0.005	-0.025*	-0.014**	-0.011*
296A x SS020	0.002	-0.012**	-0.032**	-0.024**	-0.017**
296A x SRV605	0.014	0.103**	-0.037**	0.064**	0.036**
296A x FS9604	-0.026*	-0.035**	0.085**	-0.019**	0.001
296A x FS9605	-0.023	-0.037**	0.013	0.004	-0.011*
296A x FS9601	0.009	0.015**	-0.037**	-0.006	-0.005
296A x FS9603	0.032**	0.018**	0.005	-0.029**	0.006
296A x 68710	-0.013	-0.035**	-0.010	0.056**	0.000
296A x 68724	-0.033**	0.003	-0.015	-0.001	-0.012*
296A x 68726	0.017	-0.032**	-0.017	-0.001	-0.009
296A x Co27	-0.003	0.033**	0.020	-0.036**	0.003
296A x SS032	0.017	-0.017**	0.008	-0.034**	-0.007
2219A x 68716	-0.005	-0.024**	0.031**	0.043**	0.011*
2219A x 68740	-0.022	-0.011**	-0.014	0.003	-0.011*
2219A x 68918	-0.020	0.026**	0.021	-0.045**	-0.004
2219A x 68786	-0.002	0.031**	-0.001	-0.019**	0.002
2219A x 68814	-0.032**	0.001	-0.024*	-0.025**	-0.020**
2219A x FS211	-0.007	-0.009**	0.001	0.003	-0.003
2219A x FS205	0.018	0.019**	0.021	-0.005	0.013*
2219A x FS9401	0.023	0.014**	0.021	0.038**	0.024**
2219A x SS003	0.000	-0.004	0.054**	0.003	0.013*
2219A x SS012	-0.03*	-0.021**	0.034**	-0.002	-0.005
2219A x SS020	0.003	0.001	0.006	-0.022**	-0.003
2219A x SRV605	0.025*	-0.034**	-0.019	-0.025**	-0.013*
2219A x FS9604	0.025*	-0.011**	-0.056**	0.003	-0.010
2219A x FS9605	0.028*	0.006	0.031**	0.025**	0.023**
2219A x FS9601	-0.010	-0.021**	-0.009	-0.005	-0.011*
2219A x FS9603	-0.007	-0.009**	-0.036**	0.003	-0.012*
2219A x 68710	-0.002	0.039**	-0.001	-0.042**	-0.002
2219A x 68724	-0.002	-0.004	-0.006	0.010**	-0.001
2219A x 68726	0.008	0.011**	-0.019	0.000	0.000
2219A x Co27	0.008	-0.004	-0.041**	0.045**	0.002
2219A x SS032	-0.002	0.006	0.006	0.018**	0.007
2077A x 68716	0.036**	0.018**	-0.042**	-0.052**	-0.010
2077A x 68740	-0.011	0.020	-0.007	-0.032**	-0.008

Appendix 28 (contd..)

Hybrids	E ₁	E ₂	E ₃	E ₄	P
2077A x 68918	0.001	-0.003	0.028**	0.090**	0.029**
2077A x 68786	-0.001	-0.007*	-0.005	-0.004	-0.004
2077A x 68814	0.009	0.023**	0.043**	-0.060**	0.004
2077A x FS211	0.044**	-0.007*	0.008	-0.012**	0.008
2077A x FS205	-0.011	0.030**	-0.032**	0.020**	0.002
2077A x FS9401	-0.006	-0.005	-0.062**	-0.007*	-0.020**
2077A x SS003	0.011	-0.003	-0.03**	-0.022**	-0.011*
2077A x SS012	0.031**	0.030**	0.000	0.003	0.016**
2077A x SS020	-0.016	-0.038**	0.023*	0.083**	0.013*
2077A x SRV605	-0.044**	-0.053**	0.028**	-0.020**	-0.022**
2077A x FS9604	-0.024*	0.000	-0.020	0.008*	-0.009
2077A x FS9605	0.019	0.008*	-0.032**	0.010**	0.001
2077A x FS9601	0.011	0.030**	-0.002	0.020**	0.015**
2077A x FS9603	-0.006	-0.007*	0.000	-0.002	-0.004
2077A x 68710	0.009	0.000	0.055**	0.003	0.017**
2077A x 68724	0.029*	-0.002	0.010	-0.015**	0.006
2077A x 68726	-0.041**	-0.007*	0.028**	-0.005	-0.006
2077A x Co27	-0.001	-0.032**	0.005	0.000	-0.007
2077A x SS032	-0.041**	0.008*	0.003	-0.007*	-0.009
111A x 68716	-0.006	-0.026**	-0.012	0.068**	0.006
111A x 68740	0.007	0.016**	0.013	-0.002	0.009
111A x 68918	0.029*	-0.016**	-0.042**	-0.029**	-0.015**
111A x 68786	-0.003	0.019**	-0.004	0.017**	0.007
111A x 68814	-0.013	-0.031**	-0.017	-0.019**	-0.020**
111A x FS211	-0.028*	-0.021**	-0.012	0.008*	-0.013*
111A x FS205	0.007	-0.034**	0.018	-0.009**	-0.005
111A x FS9401	-0.018	-0.019**	0.018	-0.017**	-0.009
111A x SS003	-0.021	0.014**	-0.019	0.028**	0.000
111A x SS012	0.009	-0.014**	-0.009	0.013**	0.000
111A x SS020	0.012	0.049**	0.003	-0.037**	0.007
111A x SRV605	0.004	-0.016**	0.028**	-0.019**	-0.001
111A x FS9604	0.024*	0.046**	-0.009	0.008*	0.017**
111A x FS9605	-0.023	0.024**	-0.012	-0.039**	-0.013*
111A x FS9601	-0.011	-0.024**	0.048**	-0.009**	0.001
111A x FS9603	-0.018	-0.001	0.031**	0.028**	0.010
111A x 68710	0.007	-0.004	-0.044**	-0.017**	-0.015**
111A x 68724	0.007	0.004	0.011	0.006	0.007
111A x 68726	0.017	0.029**	0.008	0.006	0.015**
111A x Co27	-0.003	0.004	0.016	-0.009**	0.002
111A x SS032	0.027*	0.004	-0.017	0.023**	0.009
SE(s _{ij})	0.0115	0.00035	0.0115	0.0036	0.0057

* Significant at 5 per cent level

** Significant at 1 per cent level

Appendix 29. Specific combining ability effects of hybrids in individual environments and pooled data for stem thickness

Hybrids	E ₁	E ₂	E ₃	E ₄	P
296A x 68716	-0.143	-0.001	-0.295	-0.036	-0.118
296A x 68740	-0.063	0.237	-0.115	-0.087	-0.007
296A x 68918	0.035	-0.158	0.188	0.280	0.086
296A x 68786	-0.089	0.037	0.016	-0.195	-0.058
296A x 68814	0.244	-0.001	-0.078	0.213	0.094
296A x FS211	0.137	-0.034	0.165	0.023	0.073
296A x FS205	-0.135	0.121	0.071	0.179	0.059
296A x FS9401	-0.058	-0.116	0.176	0.094	0.024
296A x SS003	0.033	-0.186	0.122	-0.014	-0.011
296A x SS012	-0.085	-0.058	-0.015	-0.072	-0.058
296A x SS020	0.161	0.444*	0.135	0.049	0.198*
296A x SRV605	0.000	-0.187	0.208	0.287	0.077
296A x FS9604	0.121	0.437*	0.371	0.151	0.270**
296A x FS9605	0.034	-0.061	0.051	-0.236	-0.053
296A x FS9601	-0.194	-0.074	0.079	0.160	-0.007
296A x FS9603	-0.164	0.027	-0.160	-0.051	-0.087
296A x 68710	0.162	-0.134	-0.184	-0.023	-0.045
296A x 68724	0.088	-0.192	-0.240	-0.166	-0.127
296A x 68726	0.061	-0.102	-0.239	-0.153	-0.108
296A x Co27	-0.062	-0.116	-0.170	-0.233	-0.145
296A x SS032	-0.080	0.116	-0.087	-0.171	-0.056
2219A x 68716	0.228	0.025	0.217	-0.029	0.110
2219A x 68740	-0.069	-0.140	0.187	-0.104	-0.031
2219A x 68918	0.035	0.031	-0.157	-0.043	-0.033
2219A x 68786	-0.232	-0.117	-0.139	0.109	-0.095
2219A x 68814	-0.022	-0.042	-0.156	-0.134	-0.088
2219A x FS211	0.004	-0.195	-0.077	0.010	-0.065
2219A x FS205	0.138	0.047	-0.180	-0.095	-0.022
2219A x FS9401	-0.034	0.043	-0.059	0.007	-0.011
2219A x SS003	-0.033	0.180	-0.056	0.023	0.028
2219A x SS012	-0.008	0.052	0.316	-0.082	0.069
2219A x SS020	-0.002	-0.223	-0.063	0.120	-0.042
2219A x SRV605	0.060	0.063	-0.167	0.087	0.011
2219A x FS9604	-0.232	-0.053	0.106	0.005	-0.044
2219A x FS9605	0.048	0.005	0.030	0.057	0.035
2219A x FS9601	0.093	-0.055	-0.073	-0.003	-0.010
2219A x FS9603	-0.221	-0.211	0.121	-0.030	-0.085
2219A x 68710	-0.064	0.058	0.261	-0.106	0.037
2219A x 68724	0.108	0.134	-0.102	0.135	0.069
2219A x 68726	0.118	0.058	0.120	-0.033	0.065
2219A x Co27	0.015	-0.033	-0.172	0.084	-0.027
2219A x SS032	0.070	0.372*	0.045	0.023	0.127
2077A x 68716	-0.029	-0.017	-0.001	0.222	0.044
2077A x 68740	0.131	0.045	0.035	0.150	0.090

Appendix 29 (contd..)

Hybrids	E ₁	E ₂	E ₃	E ₄	P
2077A x 68918	0.065	0.189	-0.012	-0.126	0.029
2077A x 68786	0.138	0.021	0.209	0.063	0.108
2077A x 68814	-0.072	0.013	0.282	-0.053	0.042
2077A x FS211	-0.092	-0.200	0.098	0.010	-0.046
2077A x FS205	-0.118	-0.132	0.231	-0.127	-0.037
2077A x FS9401	-0.007	0.068	-0.004	-0.002	0.014
2077A x SS003	-0.387*	-0.005	-0.048	-0.166	-0.152
2077A x SS012	-0.135	-0.044	0.008	-0.168	-0.085
2077A x SS020	-0.235	-0.049	-0.138	-0.086	-0.127
2077A x SRV605	-0.007	0.197	-0.019	-0.166	0.002
2077A x FS9604	-0.212	-0.219	-0.242	-0.115	-0.197*
2077A x FS9605	-0.172	0.173	-0.079	0.161	0.021
2077A x FS9601	0.233	0.100	-0.198	-0.049	0.021
2077A x FS9603	0.553**	-0.059	-0.077	0.214	0.157
2077A x 68710	-0.171	0.130	-0.037	-0.012	-0.023
2077A x 68724	-0.085	-0.021	0.089	-0.158	-0.044
2077A x 68726	-0.099	0.039	0.021	0.081	0.010
2077A x Co27	0.415*	0.185	0.049	0.291	0.235*
2077A x SS032	0.290	-0.414*	-0.167	0.037	-0.063
111A x 68716	-0.056	-0.007	0.079	-0.158	-0.035
111A x 68740	0.001	-0.142	-0.108	0.041	-0.052
111A x 68918	-0.135	-0.062	-0.019	-0.112	-0.082
111A x 68786	0.184	0.060	-0.087	0.023	0.045
111A x 68814	-0.149	0.029	-0.048	-0.026	-0.048
111A x FS211	-0.049	0.429*	-0.185	-0.043	0.038
111A x FS205	0.115	-0.036	-0.122	0.043	0.000
111A x FS9401	0.099	0.004	-0.114	-0.098	-0.027
111A x SS003	0.387*	0.011	-0.018	0.157	0.134
111A x SS012	0.228	0.049	-0.309	0.322	0.073
111A x SS020	0.075	-0.172	0.066	-0.083	-0.029
111A x SRV605	-0.053	-0.073	-0.022	-0.208	-0.089
111A x FS9604	0.324	-0.166	-0.235	-0.041	-0.029
111A x FS9605	0.091	-0.117	-0.002	0.018	-0.003
111A x FS9601	-0.131	0.029	0.192	-0.108	-0.004
111A x FS9603	-0.167	0.243	0.116	-0.133	0.015
111A x 68710	0.073	-0.054	-0.040	0.142	0.030
111A x 68724	-0.112	0.078	0.253	0.189	0.102
111A x 68726	-0.079	0.005	0.098	0.105	0.032
111A x Co27	-0.368*	-0.036	0.293	-0.142	-0.063
111A x SS032	-0.280	-0.074	0.210	0.111	-0.008
SE(s _{ij})	0.170	0.177	0.226	0.188	0.096

* Significant at 5 per cent level

** Significant at 1 per cent level

Appendix 30. Specific combining ability effects of hybrids in individual environments and pooled data for hydrocyanic acid

Hybrids	E ₁	E ₂	E ₃	E ₄	P
296A x 68716	13.810**	7.678	-3.800	0.535	4.556**
296A x 68740	-2.850	29.311**	8.345**	17.422**	13.057**
296A x 68918	-6.188**	-12.342*	-9.220**	-12.190**	-9.985**
296A x 68786	18.832**	22.658**	-5.885**	6.727**	10.583**
296A x 68814	13.810**	3.491	9.115**	17.400**	10.954**
296A x FS211	-1.995	-23.184**	-14.217**	-20.103**	-14.875**
296A x FS205	0.472	-3.179	1.865	12.810**	2.992
296A x FS9401	16.327**	-19.849**	37.438**	7.390**	10.326**
296A x SS003	4.657*	-17.341**	-13.380**	-16.763**	-10.706**
296A x SS012	-10.360**	8.486	17.501**	11.565**	6.798**
296A x SS020	-6.170**	-44.782**	-11.712**	-29.650**	-23.079**
296A x SRV605	-21.170**	39.320**	23.285**	29.880**	17.829**
296A x FS9604	15.495**	16.818**	-10.885**	1.562	5.748**
296A x FS9605	-11.185**	-17.352**	1.640	-9.275**	-9.043**
296A x FS9601	-7.838**	-2.347	17.460**	6.150**	3.356*
296A x FS9603	19.661**	-5.679	-13.377**	-10.934**	-2.582
296A x 68710	-9.763**	-37.352**	-31.500**	-35.863**	-28.619**
296A x 68724	-31.995**	16.828**	4.948*	9.480**	-0.185
296A x 68726	-12.000**	-0.669	0.785	-1.353	-3.309
296A x Co27	2.982	45.988**	6.613**	26.145**	20.432**
296A x SS032	15.467**	-6.507	-15.025**	-10.933**	-4.249*
2219A x 68716	-28.737**	16.366**	1.317	9.640**	-0.353
2219A x 68740	44.613**	-1.951	-29.848**	-15.103**	-0.572
2219A x 68918	11.276**	3.086	35.907**	20.285**	17.638**
2219A x 68786	-3.744	-1.914	5.902**	2.866	0.777
2219A x 68814	34.613**	-37.788**	-9.098**	-26.815**	-9.772**
2219A x FS211	58.768**	28.894**	4.239*	17.362**	27.316**
2219A x FS205	-8.734**	45.559**	3.652	20.275**	15.188**
2219A x FS9401	-12.906**	15.539**	2.574	9.855**	3.766*
2219A x SS003	-14.569**	18.047**	5.067*	12.352**	5.224**
2219A x SS012	0.443	17.214**	-27.449**	-4.310*	-3.526*
2219A x SS020	4.593*	23.956**	6.734**	16.145**	12.857**
2219A x SRV605	-0.407	-18.622**	-11.598**	-14.335**	-11.241**
2219A x FS9604	-30.402**	-11.124	0.902	-4.313*	-11.234**
2219A x FS9605	-7.072**	-35.274**	3.427	-15.140**	-13.515**
2219A x FS9601	-17.084**	6.391	-4.103*	1.945	-3.213
2219A x FS9603	23.758**	-33.621**	21.729**	-5.149**	1.679
2219A x 68710	-11.989**	-1.944	-7.043**	-3.728*	-6.176**
2219A x 68724	-24.582**	-44.464**	-3.266	-23.065**	-23.844**
2219A x 68726	-27.897**	14.719*	9.232**	12.772**	2.207
2219A x Co27	23.776**	-25.284**	5.069*	-13.060**	-2.375
2219A x SS032	-13.719**	22.211**	-13.346**	1.522	-0.833
2077A x 68716	-4.921*	-11.228	14.32**	1.865	0.009
2077A x 68740	-8.261**	-12.896*	22.845**	5.292**	1.745

264

Appendix 30 (contd..)

Hybrids	E ₁	E ₂	E ₃	E ₄	P
2077A x 68918	11.742**	15.432**	-31.100**	-7.52**	-2.862
2077A x 68786	-6.588**	10.432	2.235	6.730**	3.202
2077A x 68814	-18.261**	1.267	17.235**	5.400**	1.410
2077A x FS211	-20.756**	27.929**	7.232**	17.897**	8.076**
2077A x FS205	5.082*	-2.066	-0.015	-5.850**	-0.713
2077A x FS9401	-2.430	-25.406**	-17.763**	-21.270**	-16.717**
2077A x SS003	-4.093	10.429	11.400**	11.227**	7.241**
2077A x SS012	17.589**	-30.401**	18.880**	-5.435**	0.158
2077A x SS020	8.409**	-23.658**	3.067	-9.980**	-5.541**
2077A x SRV605	-6.591**	-26.233**	-15.265**	-20.370**	-17.115**
2077A x FS9604	0.064	11.282	27.235**	19.572**	14.538**
2077A x FS9605	16.754**	23.762**	19.660**	22.065**	20.560**
2077A x FS9601	20.082**	-7.903	-17.770**	-12.520**	-4.528**
2077A x FS9603	-15.759**	-1.236	-35.278**	-17.935**	-17.552**
2077A x 68710	21.827**	20.432**	-13.380**	3.817*	8.174**
2077A x 68724	-7.436**	41.272**	-3.593	19.160**	12.351**
2077A x 68726	5.899**	7.104	-4.435*	1.647	2.554
2077A x Co27	-12.428**	0.432	1.402	2.485	-2.028
2077A x SS032	0.077	-28.743**	-6.906**	-16.273**	-12.961**
111A x 68716	19.848**	-12.816*	-11.837**	-12.039**	-4.211*
111A x 68740	-33.502**	-14.464*	-1.342	-7.612**	-14.230**
111A x 68918	-16.830**	-6.176	4.413*	-0.574	-4.792**
111A x 68786	-8.500**	-31.176**	-2.252	-16.323**	-14.563**
111A x 68814	-30.162**	33.029**	-17.252**	4.016*	-2.592
111A x FS211	-36.017**	-33.639**	2.746	-15.157**	-20.517**
111A x FS205	3.180	-40.314**	-5.502**	-27.234**	-17.467**
111A x FS9401	-0.991	29.716**	-22.249**	4.026*	2.625
111A x SS003	14.005**	-11.136	-3.087	-6.817**	-1.758
111A x SS012	-7.672**	4.701	-8.900**	-1.819	-3.431*
111A x SS020	-6.832**	44.484**	1.911	23.486**	15.762**
111A x SRV605	28.168**	5.535	3.578	4.826**	10.527**
111A x FS9604	14.843**	-16.976**	-17.252**	-16.822**	-9.052**
111A x FS9605	1.503	28.864**	-24.727**	2.351	1.998
111A x FS9601	4.840*	3.859	4.413*	4.426*	4.384**
111A x FS9603	-27.661**	40.536**	26.926**	34.018**	18.455**
111A x 68710	-0.075	18.864**	51.923**	35.773**	26.621**
111A x 68724	64.013**	-13.636*	1.911	-5.574**	11.678**
111A x 68726	33.998**	-21.154**	-5.582**	-13.067**	-1.451
111A x Co27	-14.330**	-21.136**	-13.084**	-15.569**	-16.030**
111A x SS032	-1.825	13.039*	35.277**	25.683**	18.044**
SE(s _{ij})	2.12	5.872	2.08	1.727	1.7

* Significant at 5 per cent level

** Significant at 1 per cent level

Appendix 31. Specific combining ability effects of hybrids in individual environments and pooled data for total soluble solids

Hybrids	E ₁	E ₂	E ₃	E ₄	P
296A x 68716	-1.619**	0.819	-0.538	-0.534	-0.468
296A x 68740	0.881	1.694*	0.046	-0.534	0.522
296A x 68918	-0.369	0.653	-0.288	-0.034	-0.009
296A x 68786	-1.702**	1.361	1.129	1.716**	0.626*
296A x 68814	-1.452**	-0.806	2.629**	2.466**	0.709*
296A x FS211	2.714**	-0.889	0.046	0.300	0.543
296A x FS205	1.381**	0.361	-1.329	-1.159	-0.187
296A x FS9401	-2.202**	-0.472	-0.788	-0.700	-1.041**
296A x SS003	1.548**	-0.889	-1.038	-0.784	-0.291
296A x SS012	-2.202**	-2.139**	0.129	0.216	-0.999**
296A x SS020	2.464**	0.944	-0.288	-0.200	0.730*
296A x SRV605	1.131*	2.028**	-0.621	-0.784	0.438
296A x FS9604	-3.536**	-3.889**	0.546	-0.700	-1.895**
296A x FS9605	-0.536	-2.139**	-0.704	-0.450	-0.957**
296A x FS9601	2.464**	0.861	0.796	0.966	1.272**
296A x FS9603	1.298**	0.444	0.046	-0.200	0.397
296A x 68710	-0.202	0.861	0.712	1.3*	0.668*
296A x 68724	2.131**	-0.139	0.796	0.633	0.855**
296A x 68726	-2.536**	1.611*	-0.621	-0.950	-0.624*
296A x Co27	-0.119	-0.222	0.212	0.300	0.043
296A x SS032	0.464	-0.056	-0.871	-0.867	-0.332
2219A x 68716	1.143*	0.224	0.192	0.085	0.411
2219A x 68740	-2.357**	0.599	-0.224	-0.248	-0.558
2219A x 68918	1.393**	-1.276	-0.224	-0.415	-0.130
2219A x 68786	0.060	-0.734	-0.808	-0.998	-0.620*
2219A x 68814	3.976**	1.433*	-2.308**	-1.915**	0.297
2219A x FS211	-2.19**	-1.651*	0.109	1.252	-0.620*
2219A x FS205	0.810	-1.067	1.734*	1.127	0.651*
2219A x FS9401	-0.440	1.433*	-0.391	-0.415	0.047
2219A x SS003	-1.690**	0.349	1.692*	1.502*	0.463
2219A x SS012	1.226**	2.766**	1.192	0.835	1.505**
2219A x SS020	-0.107	0.183	-0.891	-0.248	-0.266
2219A x SRV605	-0.774	-1.734*	-0.558	-0.498	-0.891**
2219A x FS9604	1.893**	-0.317	-0.724	-0.415	0.109
2219A x FS9605	-1.107*	0.766	0.359	0.169	0.047
2219A x FS9601	-1.107*	0.766	-0.808	-0.748	-0.474
2219A x FS9603	-0.940*	-2.317**	-0.891	-0.581	-1.183**
2219A x 68710	-0.107	-1.234	0.442	-0.081	-0.245
2219A x 68724	0.226	-0.901	1.859*	1.252	0.609
2219A x 68726	1.226**	-0.484	0.776	1.002	0.630*
2219A x Co27	-1.357**	2.683**	-2.058*	-1.748**	-0.620*
2219A x SS032	0.226	0.516	1.526	1.085	0.838**
2077A x 68716	-1.889**	-0.220	0.280	0.411	-0.355
2077A x 68740	2.611**	-0.512	0.196	0.077	0.593

Appendix 31 (contd..)

Hybrids	E ₁	E ₂	E ₃	E ₄	P
2077A x 68918	-1.639**	0.613	-0.137	-0.089	-0.313
2077A x 68786	-0.972*	-1.179	0.613	0.327	-0.303
2077A x 68814	0.278	0.988	0.780	0.744	0.697*
2077A x FS211	2.111**	1.571*	0.196	-0.756	0.781*
2077A x FS205	-3.556**	-0.845	-0.345	-0.048	-1.198**
2077A x FS9401	-0.472	-0.679	1.030	1.244	0.281
2077A x SS003	1.278**	0.571	-0.554	-0.839	0.114
2077A x SS012	0.861	-0.345	-1.054	-0.839	-0.344
2077A x SS020	-0.139	1.071	0.863	0.411	0.552
2077A x SRV605	-1.139*	-0.512	0.863	0.827	0.010
2077A x FS9604	1.528**	2.571**	-0.637	-0.423	0.760*
2077A x FS9605	3.194**	-0.012	-1.220	-1.506*	0.114
2077A x FS9601	1.194**	-0.345	-0.387	-0.423	0.010
2077A x FS9603	0.694	-1.429*	0.863	0.744	0.218
2077A x 68710	-2.806**	-1.012	-0.137	-0.089	-1.010**
2077A x 68724	-2.139**	0.655	-1.720*	-0.423	-0.907**
2077A x 68726	0.861	-0.262	-0.137	-0.006	0.114
2077A x Co27	1.611**	-0.095	1.030	0.911	0.861**
2077A x SS032	-1.472**	-0.595	-0.387	-0.256	-0.678*
111A x 68716	2.365**	-0.823	0.065	0.038	0.411
111A x 68740	-1.135*	-1.782*	-0.018	0.704	-0.558
111A x 68918	0.615	0.010	0.649	0.538	0.453
111A x 68786	2.615**	0.552	-0.935	-1.046	0.297
111A x 68814	-2.802**	-1.615*	-1.101	-1.296*	-1.703**
111A x FS211	-2.635**	0.968	-0.351	-0.796	-0.703*
111A x FS205	1.365**	1.552*	-0.060	0.079	0.734*
111A x FS9401	3.115**	-0.282	0.149	-0.129	0.713*
111A x SS003	-1.135*	-0.032	-0.101	0.121	-0.287
111A x SS012	0.115	-0.282	-0.268	-0.212	-0.162
111A x SS020	-2.218**	-2.198**	0.315	0.038	-1.016**
111A x SRV605	0.782	0.218	0.315	0.454	0.442
111A x FS9604	0.115	1.635*	0.815	1.538*	1.026**
111A x FS9605	-1.552**	1.385*	1.565	1.788**	0.797*
111A x FS9601	-2.552**	-1.282	0.399	0.204	-0.808**
111A x FS9603	-1.052*	3.302**	-0.018	0.038	0.567
111A x 68710	3.115**	1.385*	-1.018	-1.129	0.588
111A x 68724	-0.218	0.385	-0.935	-1.462*	-0.558
111A x 68726	0.448	-0.865	-0.018	-0.046	-0.120
111A x Co27	-0.135	-2.365**	0.815	0.538	-0.287
111A x SS032	0.782	0.135	-0.268	0.038	0.172
SE(s _{ij})	0.453	0.701	0.813	0.654	0.313

* Significant at 5 per cent level

** Significant at 1 per cent level

Appendix 32. Specific combining ability effects of hybrids in individual environments and pooled data for crude protein

Hybrids	E ₁	E ₂	E ₃	E ₄	P
296A x 68716	1.009**	1.090**	1.151**	1.092**	1.086**
296A x 68740	0.129	-0.290**	-0.729**	-0.288**	-0.294**
296A x 68918	0.392**	0.150	-0.119	0.147	0.143**
296A x 68786	0.922**	-0.287**	-1.521**	-0.288**	-0.294**
296A x 68814	0.044	0.155	0.244	0.157	0.150**
296A x FS211	-0.916**	0.183	1.251**	0.175	0.173**
296A x FS205	-1.136**	-0.590**	-0.074	-0.595**	-0.599**
296A x FS9401	1.267**	1.045**	0.804**	1.047**	1.041**
296A x SS003	-0.441**	-0.202	0.011	-0.195*	-0.207**
296A x SS012	0.042	0.130	0.184	0.127	0.121*
296A x SS020	-0.831**	-0.287**	0.229	-0.290**	-0.295**
296A x SRV605	-0.178	0.633**	1.671**	0.630**	0.689**
296A x FS9604	-0.436**	-0.485**	-0.559**	-0.485**	-0.491**
296A x FS9605	-0.478**	-1.145**	-1.826**	-1.140**	-1.147**
296A x FS9601	1.314**	1.073**	0.804**	1.070**	1.065**
296A x FS9603	-0.698**	0.173	1.021**	0.172	0.167**
296A x 68710	-1.313**	-1.317**	-1.341**	-1.318**	-1.322**
296A x 68724	-0.091	0.103	0.276*	0.107	0.099
296A x 68726	0.567**	-0.525**	-1.379**	-0.518**	-0.464**
296A x Co27	0.042	0.460**	0.859**	0.465**	0.456**
296A x SS032	0.789**	-0.072	-0.954**	-0.068	-0.076
2219A x 68716	-0.480**	-0.575**	-0.600**	-0.581**	-0.559**
2219A x 68740	-0.300**	-0.375**	-0.380**	-0.381**	-0.359**
2219A x 68918	-0.038	0.235*	0.580**	0.234*	0.253**
2219A x 68786	-0.918**	0.057	1.108**	0.059	0.076
2219A x 68814	-0.215*	-0.200	-0.107	-0.196*	-0.180**
2219A x FS211	0.225*	-0.003	-0.150	0.001	0.018
2219A x FS205	0.355**	0.455**	0.625**	0.451**	0.471**
2219A x FS9401	0.837**	0.690**	0.623**	0.694**	0.711**
2219A x SS003	-1.22**	-0.818**	-0.340*	-0.819**	-0.799**
2219A x SS012	-0.038	-0.405**	-0.687**	-0.396**	-0.382**
2219A x SS020	0.310**	0.147	0.058	0.146	0.165**
2219A x SRV605	1.142**	0.627**	-0.600**	0.626**	0.449**
2219A x FS9604	0.875**	0.210	-0.380**	0.211*	0.229**
2219A x FS9605	-0.568**	-0.180	0.273*	-0.184*	-0.165**
2219A x FS9601	0.005	-0.693**	-1.307**	-0.684**	-0.67**
2219A x FS9603	0.442**	0.167	-0.030	0.169	0.187**
2219A x 68710	0.357**	0.867**	1.458**	0.869**	0.888**
2219A x 68724	-0.52**	-0.333**	-0.075	-0.336**	-0.316**
2219A x 68726	0.137	0.350**	-0.150	0.349**	0.171**
2219A x Co27	-0.568**	-0.415**	-0.192	-0.419**	-0.399**
2219A x SS032	0.180	0.192	0.275*	0.189*	0.209**
2077A x 68716	-0.733**	0.118	0.948**	0.120	0.113*
2077A x 68740	0.317**	0.488**	0.638**	0.490**	0.483**

Appendix 32 (contd..)

Hybrids	E ₁	E ₂	E ₃	E ₄	P
2077A x 68918	0.049	0.048	0.028	0.055	0.045
2077A x 68786	0.229*	-0.210	-0.675**	-0.210*	-0.216**
2077A x 68814	0.752**	0.763**	0.740**	0.755**	0.752**
2077A x FS211	1.012**	0.080	-0.882**	0.082	0.073
2077A x FS205	0.092	0.618**	1.123**	0.622**	0.614**
2077A x FS9401	-0.996**	-0.627**	-0.280*	-0.625**	-0.632**
2077A x SS003	1.497**	0.755**	-0.012	0.752**	0.748**
2077A x SS012	0.229*	0.558**	0.860**	0.555**	0.550**
2077A x SS020	-0.473**	-1.090**	-1.725**	-1.083**	-1.093**
2077A x SRV605	-0.691**	-1.220**	-1.502**	-1.213**	-1.156**
2077A x FS9604	-1.478**	-0.667**	0.118	-0.668**	-0.674**
2077A x FS9605	0.929**	0.773**	0.600**	0.777**	0.770**
2077A x FS9601	0.092	0.710**	1.300**	0.707**	0.702**
2077A x FS9603	0.529**	-0.100	-0.762**	-0.100	-0.108*
2077A x 68710	0.444**	0.250*	0.025	0.250**	0.242**
2077A x 68724	0.447**	0.010	-0.457**	0.005	0.001
2077A x 68726	-0.996**	-0.467**	0.298*	-0.470**	-0.409**
2077A x Co27	0.229*	-0.272*	-0.805**	-0.278**	-0.281**
2077A x SS032	-1.483**	-0.515**	0.423**	-0.520**	-0.524**
111A x 68716	0.204*	-0.633**	-1.499**	-0.630**	-0.640**
111A x 68740	-0.146	0.177	0.471**	0.180	0.170**
111A x 68918	-0.403**	-0.433**	-0.489**	-0.435**	-0.440**
111A x 68786	-0.233*	0.440**	1.089**	0.440**	0.434**
111A x 68814	-0.581**	-0.718**	-0.876**	-0.715**	-0.723**
111A x FS211	-0.321**	-0.260*	-0.219	-0.258**	-0.265**
111A x FS205	0.689**	-0.483**	-1.674**	-0.478**	-0.486**
111A x FS9401	-1.108**	-1.108**	-1.146**	-1.115**	-1.120**
111A x SS003	0.164	0.265*	0.341**	0.262**	0.258**
111A x SS012	-0.233*	-0.283**	-0.356**	-0.285**	-0.290**
111A x SS020	0.994**	1.230**	1.439**	1.227**	1.222**
111A x SRV605	-0.273**	-0.040	0.431**	-0.043	0.019
111A x FS9604	1.039**	0.942**	0.821**	0.942**	0.936**
111A x FS9605	0.117	0.552**	0.954**	0.547**	0.542**
111A x FS9601	-1.411**	-1.090**	-0.796**	-1.093**	-1.098**
111A x FS9603	-0.273**	-0.240*	-0.229	-0.240**	-0.246**
111A x 68710	0.512**	0.200	-0.141	0.200*	0.192**
111A x 68724	0.164	0.220*	0.256	0.225*	0.216**
111A x 68726	0.292**	0.642**	1.231**	0.640**	0.701**
111A x Co27	0.297**	0.227*	0.139	0.232*	0.224**
111A x SS032	0.514**	0.395**	0.256	0.400**	0.391**
SE(s _{ij})	0.104	0.109	0.132	0.093	0.055

* Significant at 5 per cent level

** Significant at 1 per cent level

Appendix 33. Specific combining ability effects of hybrids in individual environments and pooled data for dry fodder yield

Hybrids	E ₁	E ₂	E ₃	E ₄	P
296A x 68716	-10.576**	-27.877**	-42.287**	-17.475**	-24.554**
296A x 68740	-9.847**	2.251	11.009	-12.227**	-2.203
296A x 68918	5.766*	8.408*	-29.580**	14.632**	-0.194
296A x 68786	-6.684**	-10.054**	-21.245*	-31.187**	-17.293**
296A x 68814	-6.023**	-8.615*	-19.922*	-41.347**	-18.977**
296A x FS211	-2.147	-2.029	-5.317	1.709	-1.946
296A x FS205	-0.151	-6.172	-5.812	14.128**	0.498
296A x FS9401	-8.346**	-10.112**	-5.147	11.490**	-3.029
296A x SS003	-11.494**	-0.413	10.652	11.208**	2.488
296A x SS012	-0.380	-7.131	-12.517	-7.247*	-6.819**
296A x SS020	-5.859**	14.639**	3.060	14.634**	6.619*
296A x SRV605	9.901**	-2.138	2.368	14.734**	6.216*
296A x FS9604	-3.275	35.357**	55.341**	-2.741	21.171**
296A x FS9605	-7.474**	-0.316	-16.081	-21.093**	-11.241**
296A x FS9601	7.039**	3.048	9.562	15.047**	8.674**
296A x FS9603	0.838	-26.473**	-20.696*	36.638**	-2.423
296A x 68710	-14.869**	-0.219	13.158	-9.988**	-2.979
296A x 68724	33.931**	-10.722**	34.858**	-8.397**	12.417**
296A x 68726	19.516**	20.593**	41.111**	-17.022**	16.049**
296A x Co27	6.536**	4.436	-16.252	21.210**	3.982
296A x SS032	3.600	23.538**	13.738	13.293**	13.542**
2219A x 68716	-11.713**	43.272**	17.168	46.898**	23.906**
2219A x 68740	-12.187**	10.117**	-15.336	4.046	-3.340
2219A x 68918	4.776*	-9.003*	35.294**	9.274**	10.085**
2219A x 68786	-12.031**	-2.265	14.836	24.342**	6.221*
2219A x 68814	18.867**	-13.873**	-8.451	-26.098**	-7.389**
2219A x FS211	6.356**	4.963	3.831	5.039	5.047
2219A x FS205	-2.828	-4.909	-12.204	0.498	-4.861
2219A x FS9401	1.160	11.914**	14.314	15.223**	10.653**
2219A x SS003	-9.584**	10.862**	27.843**	5.558	8.67**
2219A x SS012	13.467**	5.922	8.100	-2.798	6.173*
2219A x SS020	9.958**	3.582	38.211**	1.534	13.321**
2219A x SRV605	-9.072**	0.327	6.569	-2.246	-1.106
2219A x FS9604	1.729	-14.058**	-49.158**	-16.431**	-19.480**
2219A x FS9605	18.873**	-1.877	10.550	-14.444**	3.276
2219A x FS9601	17.185**	5.907	-6.694	9.309**	6.427*
2219A x FS9603	6.488**	-7.081	-23.198*	-22.106**	-11.474**
2219A x 68710	-23.882**	-4.053	-11.781	4.501	-8.804**
2219A x 68724	-21.082**	-4.717	-24.391**	6.879*	-10.828**
2219A x 68726	-34.347**	-30.038**	-1.848	-39.606**	-26.46**
2219A x Co27	12.819**	-12.128**	-22.551*	-9.927**	-7.947**
2219A x SS032	25.05**	7.137	-1.105	0.556	7.91**
2077A x 68716	19.399**	15.823**	12.161	16.306**	15.922**
2077A x 68740	21.605**	-16.746**	14.010	28.568**	11.859**

Appendix 33 (contd..)

Hybrids	E ₁	E ₂	E ₃	E ₄	P
2077A x 68918	-5.118*	4.590	19.191*	-39.157**	-5.124
2077A x 68786	2.315	10.969**	19.829*	28.397*	15.378**
2077A x 68814	-22.561**	18.878**	33.495**	28.697**	14.627**
2077A x FS211	-10.151**	0.914	21.651*	-41.266**	-7.213**
2077A x FS205	-4.719*	-0.122	13.672	8.816**	4.412
2077A x FS9401	2.243	-0.035	-2.723	-7.349*	-1.966
2077A x SS003	18.102**	-4.310	-18.638*	0.306	-1.135
2077A x SS012	-23.974**	-1.261	18.517*	4.561	-0.540
2077A x SS020	-1.836	4.135	-25.846**	-21.738**	-11.321**
2077A x SRV605	-14.080**	-1.335	-33.025**	13.016**	-8.856**
2077A x FS9604	-2.319	-20.080**	-2.755	-5.043	-7.549**
2077A x FS9605	-13.275**	10.900**	-26.430**	2.575	-6.557*
2077A x FS9601	-13.946**	-16.163**	-1.234	-7.015*	-9.590**
2077A x FS9603	-12.590**	3.566	-16.385	-2.398	-6.952**
2077A x 68710	59.887**	-16.04**	18.272*	-5.290	14.207**
2077A x 68724	4.730*	16.697**	-3.838	8.778**	6.592*
2077A x 68726	45.805**	20.265**	-25.742**	37.293**	19.405**
2077A x Co27	-17.655**	14.045**	49.172**	-8.505**	9.264**
2077A x SS032	-31.864**	-44.689**	-63.352**	-39.552**	-44.864**
111A x 68716	2.890	-31.219**	12.958	-45.729**	-15.275**
111A x 68740	0.429	4.379	-9.683	-20.388**	-6.316*
111A x 68918	-5.424*	-3.995	-24.905**	15.251**	-4.768
111A x 68786	16.399**	1.350	-13.420	-21.552**	-4.306
111A x 68814	9.717**	3.610	-5.121	38.748**	11.738**
111A x FS211	5.943**	-3.848	-20.165*	34.518**	4.112
111A x FS205	7.699**	11.203**	4.343	-23.443**	-0.049
111A x FS9401	4.944*	-1.767	-6.445	-19.364**	-5.658*
111A x SS003	2.976	-6.139	-19.857*	-17.073**	-10.023**
111A x SS012	10.887**	2.470	-14.099	5.485	1.186
111A x SS020	-2.262	-22.356**	-15.425	5.570	-8.618**
111A x SRV605	13.251**	3.146	24.089**	-25.503**	3.746
111A x FS9604	3.865	-1.219	-3.428	24.215**	5.858*
111A x FS9605	1.876	-8.708*	31.961**	32.962**	14.523**
111A x FS9601	-10.278**	7.209	-1.634	-17.341**	-5.511*
111A x FS9603	5.264*	29.988**	60.279**	-12.133**	20.849**
111A x 68710	-21.136**	20.312**	-19.650*	10.777**	-2.424
111A x 68724	-17.579**	-1.258	-6.628	-7.261*	-8.181**
111A x 68726	-30.974**	-10.820**	-13.521	19.334**	-8.995**
111A x Co27	-1.701	-6.353	-10.368	-2.778	-5.300*
111A x SS032	3.214	14.013**	50.719**	25.702**	23.412**
SE(s _{ij})	2.256	3.806	9.084	3.026	2.637

* Significant at 5 per cent level

** Significant at 1 per cent level

Appendix 34. Specific combining ability effects of hybrids in individual environments and pooled data for green fodder yield per plant

Hybrids	E ₁	E ₂	E ₃	E ₄	P
296A x 68716	-15.474**	-168.389**	-154.123	-94.208**	-108.049**
296A x 68740	-19.294**	-5.644	31.042	-45.801**	-9.924**
296A x 68918	32.611**	20.712**	-91.708	61.857**	5.868**
296A x 68786	-44.954**	-27.137**	-86.075	-154.742**	-78.227**
296A x 68814	-40.377**	-104.139**	-144.960	-193.511**	-120.747**
296A x FS211	17.306**	7.526*	17.870	26.436**	17.284**
296A x FS205	-45.394**	-27.314**	4.207	67.439**	-0.266
296A x FS9401	-51.157**	-19.389**	2.832	64.922**	-0.698
296A x SS003	-36.427**	4.521	-5.290	53.499**	4.076*
296A x SS012	-21.544**	-38.177**	-57.528	-45.381**	-40.657**
296A x SS020	-2.134	45.691**	30.877	34.804**	27.309**
296A x SRV605	-16.007**	-11.807**	-23.453	76.124**	6.214**
296A x FS9604	24.357**	187.361**	194.110	-16.403**	97.356**
296A x FS9605	-6.352	2.356	-10.758	-64.949**	-19.921**
296A x FS9601	-1.379	6.691*	-10.195	65.464**	15.145**
296A x FS9603	-17.187**	-120.643**	-16.205	170.917**	4.220*
296A x 68710	52.058**	10.276**	73.957	-44.978**	22.828**
296A x 68724	52.008**	-33.557**	95.340	-17.318**	24.118**
296A x 68726	101.658**	128.763**	127.790	-40.933**	79.320**
296A x Co27	-11.092**	-17.139**	-11.625	18.707**	-5.287**
296A x SS032	48.776**	159.441**	33.877	78.057**	80.038**
2219A x 68716	-47.063**	144.927**	113.276**	159.532**	92.668**
2219A x 68740	-35.073**	75.012**	21.761**	25.710**	21.852**
2219A x 68918	-27.378**	-27.716**	149.691**	92.575**	46.793**
2219A x 68786	-50.723**	-82.151**	55.123**	44.192**	-8.390**
2219A x 68814	67.305**	-40.153**	-32.892**	-76.441**	20.545**
2219A x FS211	-2.543	13.842**	2.608	16.956**	7.716**
2219A x FS205	7.957*	3.682	-10.394*	22.820**	6.016**
2219A x FS9401	10.655**	35.927**	53.031**	37.332**	34.236**
2219A x SS003	-15.145**	33.177**	67.438**	27.790**	28.315**
2219A x SS012	54.407**	31.279**	30.541**	-23.310**	23.229**
2219A x SS020	24.717**	14.007**	124.276**	-17.346**	36.414**
2219A x SRV605	13.005**	-0.491	-14.054**	-6.136	-1.919
2219A x FS9604	-6.181	-15.323**	-208.982**	-36.216**	-66.676**
2219A x FS9605	23.700**	-5.988	-12.539**	-48.625**	-10.863**
2219A x FS9601	62.476**	28.677**	39.073**	28.525**	39.688**
2219A x FS9603	25.865**	-5.657	-118.147**	-80.473**	-44.603**
2219A x 68710	-96.060**	-39.738**	-80.644**	-0.348	-54.198**
2219A x 68724	-55.310**	-33.571**	-91.395**	37.862**	-35.604**
2219A x 68726	-88.330**	-133.011**	-38.142**	-133.412**	-98.224**
2219A x Co27	51.060**	-26.823**	-38.227**	-74.223**	-22.053**
2219A x SS032	82.657**	30.097**	-11.404*	3.237	26.147 **
2077A x 68716	34.780**	140.513**	-44.519**	113.039**	60.953**
2077A x 68740	80.960**	-49.732**	77.316**	134.496**	60.760**

*

Appendix 34 (contd..)

Hybrids	E ₁	E ₂	E ₃	E ₄	P
2077A x 68918	56.325**	69.284**	14.226**	-161.345**	-5.378**
2077A x 68786	34.780**	123.436**	138.199**	169.616**	116.507**
2077A x 68814	-53.383**	55.103**	154.644**	85.946**	60.578**
2077A x FS211	0.500	10.098**	72.814**	-185.427**	-25.504**
2077A x FS205	13.000**	-23.392**	28.481**	12.796**	7.721**
2077A x FS9401	-0.903	3.513	-38.224**	-46.671**	-20.571**
2077A x SS003	39.097**	-4.897	-6.356	13.796**	10.410**
2077A x SS012	-73.350**	11.066**	109.546**	40.756**	22.004**
2077A x SS020	9.020**	43.603**	-110.189**	-100.109**	-39.419**
2077A x SRV605	-23.823**	-22.564**	-81.519**	55.151**	-18.189**
2077A x FS9604	-32.079**	-123.397**	72.154**	-45.489**	-32.203**
2077A x FS9605	-62.928**	25.268**	-92.814**	-5.982	-34.114**
2077A x FS9601	-29.052**	-87.397**	-44.721**	-55.739**	-54.227**
2077A x FS9603	-15.563**	-5.730	-72.271**	-28.076**	-30.410**
2077A x 68710	109.052**	-73.482**	89.231**	-24.221**	25.145**
2077A x 68724	-11.938**	23.346**	-85.190**	-8.071*	-20.463**
2077A x 68726	92.182**	60.576**	-85.606**	132.875**	50.007**
2077A x Co27	-25.238**	77.103**	150.649**	94.854**	74.342**
2077A x SS032	-141.440**	-252.317**	-245.849**	-192.196**	-207.951**
111A x 68716	27.757**	-117.050**	85.366**	-178.363**	-45.572**
111A x 68740	-26.593**	-19.635**	-130.119**	-114.405**	-72.688**
111A x 68918	-61.558**	-62.280**	-72.209**	6.913	-47.283**
111A x 68786	60.897**	-14.148**	-107.247**	-59.066**	-29.891**
111A x 68814	26.455**	89.190**	23.208**	184.005**	80.714**
111A x FS211	-15.263**	-31.465**	-93.292**	142.035**	0.504
111A x FS205	24.437**	47.025**	-22.294**	-103.055**	-13.472**
111A x FS9401	41.405**	-20.050**	-17.639**	-55.583**	-12.967**
111A x SS003	12.475**	-32.800**	-55.792**	-95.085**	-42.801**
111A x SS012	40.487**	-4.168	-82.559**	27.935**	-4.576*
111A x SS020	-31.603**	-103.300**	-44.964**	82.650**	-24.304**
111A x SRV605	26.825**	34.862**	119.026**	-125.140**	13.893**
111A x FS9604	13.902**	-48.640**	-57.282**	98.109**	1.522
111A x FS9605	45.580**	-21.635**	116.091**	119.557**	64.898**
111A x FS9601	-32.044**	52.030**	15.843**	-38.250**	-0.605
111A x FS9603	6.885*	132.030**	206.623**	-62.368**	70.793**
111A x 68710	-65.050**	102.945**	-82.544**	69.547**	6.224**
111A x 68724	15.240**	43.782**	81.245**	-12.473**	31.949**
111A x 68726	-105.510**	-56.328**	-4.042	41.470**	-31.102**
111A x Co27	-14.730**	-33.140**	-100.797**	-39.338**	-47.001**
111A x SS032	10.007**	62.78**	223.376**	110.902**	101.766**
SE(s _{ij})	3.423	3.337	4.602	4.064	1.945

* Significant at 5 per cent level

** Significant at 1 per cent level

Appendix 35. Specific combining ability effects of hybrids in individual environments and pooled data for green fodder yield per plot

Hybrids	E ₁	E ₂	E ₃	E ₄	P
296A x 68716	2.879**	-1.887**	-1.366*	-0.364	-0.184
296A x 68740	1.706**	2.016**	3.909**	0.038	1.917**
296A x 68918	1.978**	5.172**	1.273*	0.684	2.277**
296A x 68786	-6.089**	-5.301**	-4.212**	-1.232*	-4.209**
296A x 68814	-1.804**	-3.396**	-3.935**	-3.751**	-3.222**
296A x FS211	3.103**	1.149	2.438**	0.894	1.896**
296A x FS205	0.238	0.061	1.958**	3.146**	1.351**
296A x FS9401	0.737	3.080**	4.638**	0.283	2.185**
296A x SS003	1.314*	1.858**	1.866**	1.538**	1.644**
296A x SS012	2.736**	-0.347	-0.467	0.331	0.563
296A x SS020	-1.572*	-0.806	-2.688**	-2.114**	-1.795**
296A x SRV605	-7.182**	-8.190**	-9.954**	1.037	-6.072**
296A x FS9604	-4.089**	-0.711	-3.986**	-0.860	-2.412**
296A x FS9605	0.353	1.242*	1.679**	-1.071	0.551
296A x FS9601	1.874**	4.636**	5.357**	1.797**	3.416**
296A x FS9603	-0.454	-1.460*	2.438**	3.171**	0.924**
296A x 68710	6.778**	4.856**	6.659**	1.112	4.851**
296A x 68724	0.125	-2.291**	2.808**	-2.841**	-0.550
296A x 68726	-7.057**	-6.431**	-9.240**	-4.164**	-6.723**
296A x Co27	3.628**	4.109**	3.092**	0.765	2.898**
296A x SS032	0.798	2.642**	-2.267**	1.602**	0.694*
2219A x 68716	0.489	13.343**	9.682**	6.333**	7.462**
2219A x 68740	-4.391**	0.870	0.060	1.305*	-0.539
2219A x 68918	0.604	-1.701**	4.220**	3.145**	1.567**
2219A x 68786	-0.010	0.759	4.036**	1.092	1.469**
2219A x 68814	4.442**	-1.053	-1.844**	-2.613**	-0.267
2219A x FS211	-1.805**	-2.707**	-2.411**	-1.259*	-2.046**
2219A x FS205	-2.206**	-2.725**	-4.450**	-0.283	-2.416**
2219A x FS9401	-1.437*	0.290	0.270	-0.360	-0.309
2219A x SS003	-3.736**	-0.439	0.577	2.502**	-0.274
2219A x SS012	-0.848	-1.764**	-2.046**	0.685	-0.993**
2219A x SS020	2.197**	1.375*	6.766**	-0.690	2.412**
2219A x SRV605	-0.196	-1.840**	-2.486**	-1.626**	-1.537**
2219A x FS9604	0.037	0.175	-3.581**	-0.863	-1.058**
2219A x FS9605	-0.947	-4.235**	-5.346**	-3.563**	-3.523**
2219A x FS9601	0.224	-2.837**	-2.839**	-1.526**	-1.745**
2219A x FS9603	3.449**	3.217**	0.042	-0.968	1.435**
2219A x 68710	-2.14**	-2.000**	-2.476**	-0.224	-1.710**
2219A x 68724	-3.909**	-1.714**	-4.28**	-0.018	-2.480**
2219A x 68726	3.013**	1.259*	6.278**	0.037	2.646**
2219A x Co27	2.864**	0.155	0.963	-0.804	0.794**
2219A x SS032	4.308**	1.572*	-1.135	-0.298	1.112**
2077A x 68716	-4.607**	-5.519**	-6.333**	-1.412*	-4.468**
2077A x 68740	4.386**	-0.975	2.332**	1.597**	1.835**

Appendix 35 (contd.)

Hybrids	E ₁	E ₂	E ₃	E ₄	P
2077A x 68918	-1.561*	-1.076	-1.915**	-2.923**	-1.869**
2077A x 68786	2.064**	3.131**	3.561**	0.983	2.435**
2077A x 68814	-5.367**	0.696	4.901**	1.632**	0.465
2077A x FS211	2.026**	3.998**	3.640**	-0.571	2.273**
2077A x FS205	1.675**	0.116	1.778**	-0.335	0.809**
2077A x FS9401	0.357	0.089	-1.246*	2.092**	0.323
2077A x SS003	1.008	0.000	-0.848	-0.860	-0.175
2077A x SS012	-3.184**	2.108**	5.375**	0.323	1.156**
2077A x SS020	3.244**	4.130**	-1.052	-0.915	1.352**
2077A x SRV605	3.412**	2.706**	0.382	2.676**	2.294**
2077A x FS9604	2.008**	-0.593	4.427**	0.759	1.650**
2077A x FS9605	-0.310	5.261**	-0.155	3.042**	1.959**
2077A x FS9601	1.364*	-1.835**	-0.404	0.946	0.018
2077A x FS9603	3.013**	2.579**	2.797**	1.047	2.359**
2077A x 68710	3.928**	0.651	4.025**	0.404	2.252**
2077A x 68724	0.315	1.095	-2.922**	-0.846	-0.590
2077A x 68726	0.977	-1.019	-5.397**	-3.068**	-2.127**
2077A x Co27	-5.512**	-3.519**	-2.266**	0.164	-2.783**
2077A x SS032	-9.235**	-12.023**	-10.677**	-4.733**	-9.167**
111A x 68716	1.240*	-5.937**	-1.983**	-4.557**	-2.810**
111A x 68740	-1.700**	-1.910**	-6.301**	-2.939**	-3.213**
111A x 68918	-1.021	-2.395**	-3.578**	-0.906	-1.975**
111A x 68786	4.035**	1.412*	-3.386**	-0.842	0.305
111A x 68814	2.730**	3.754**	0.878	4.733**	3.023**
111A x FS211	-3.324**	-2.440**	-3.666**	0.937	-2.123**
111A x FS205	0.292	2.548**	0.714	-2.527**	0.257
111A x FS9401	0.344	-3.460**	-3.662**	-2.014**	-2.198**
111A x SS003	1.415*	-1.419*	-1.595**	-3.179**	-1.195**
111A x SS012	1.296*	0.003	-2.861**	-1.339*	-0.725*
111A x SS020	-3.869**	-4.699**	-3.026**	3.719**	-1.968**
111A x SRV605	3.965**	7.324**	12.059**	-2.087**	5.315**
111A x FS9604	2.045**	1.129	3.140**	0.963	1.819**
111A x FS9605	0.904	-2.268**	3.822**	1.593**	1.013**
111A x FS9601	-3.462**	0.036	-2.114**	-1.217*	-1.689**
111A x FS9603	-6.007**	-4.336**	-5.276**	-3.249**	-4.717**
111A x 68710	-8.565**	-3.507**	-8.208**	-1.292*	-5.393**
111A x 68724	3.469**	2.910**	4.394**	3.705**	3.619**
111A x 68726	3.067**	6.192**	8.359**	7.196**	6.204**
111A x Co27	-0.979	-0.745	-1.789**	-0.125	-0.909**
111A x SS032	4.129**	7.809**	14.079**	3.428**	7.361**
SE(s _{ij})	0.614	0.620	0.605	0.574	0.306

* Significant at 5 per cent level

** Significant at 1 per cent level

Appendix 36. Relative heterosis (di), heterobeltiosis (dii) and standard heterosis (diii) in individual environments and pooled data for days to 50 per cent flowering

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
296A x 68716	9.26**	8.26**	4.89**	0.47	-3.62**	11.52**	-8.59**	-9.34**	0.61	-1.27	-1.27	-3.11*	0.46	-0.77	3.91**
296A x 68740	7.06**	4.44**	4.44**	-14.29**	-18.30**	-4.19**	-8.59**	-9.34**	0.61	-3.16*	-3.16*	-4.97**	-4.60**	-6.36**	-0.67
296A x 68918	6.84**	1.26	7.56**	-18.76**	-21.56**	-10.47**	-7.82**	-9.34**	0.61	-1.27	-1.27	-3.11*	-5.17**	-7.21**	-0.94
296A x 68786	23.46**	20.44**	20.44**	7.88**	7.88**	14.66**	-9.92**	-12.04**	2.44	2.17	0.00	2.48	6.81**	4.97**	11.07**
296A x 68814	7.49**	1.67	8.44**	-16.06**	-21.46**	-4.19**	-2.90**	-6.60**	12.20**	4.19**	-1.14	8.07**	-2.06**	-7.21**	5.94**
296A x FS211	10.16**	6.55**	8.44**	8.51**	0.49	6.81**	-5.64**	-12.64**	-3.05*	-0.33	-3.16*	-4.97**	3.90**	0.53	2.56**
296A x FS205	7.66**	6.91**	3.11**	-9.18**	-9.85**	-4.19**	3.85**	3.85**	15.24**	5.43**	4.43**	2.48	1.79**	1.72	3.78**
296A x FS9401	7.91**	7.41**	3.11**	-4.06**	-6.90**	-1.05	-10.81**	-12.23**	0.61	-0.32	-1.27	-3.11*	-1.53*	-1.85	0.13
296A x SS003	3.08**	-2.50*	4.00**	-4.94**	-9.85**	-4.19**	-13.35**	-14.05**	-3.05*	-0.32	-1.27	-3.11*	-3.62**	-3.94**	-1.21
296A x SS012	6.61**	4.00**	4.00**	-8.05**	-12.81**	-7.33**	-9.83**	-14.29**	-4.88**	-0.64	-1.27	-3.11*	-2.56**	-4.37**	-2.43**
296A x SS020	7.59**	5.88**	4.00**	-7.11**	-9.85**	-4.19**	-5.35**	-7.69**	2.44	-0.64	-1.27	-3.11*	-1.07	-1.98	0.00
296A x SRV605	5.34**	4.61**	0.89	-14.88**	-19.38**	-4.19**	1.32	-2.54*	17.07**	8.92**	8.23**	6.21**	-0.51	-3.01**	4.32**
296A x FS9604	4.78**	2.22	2.22	13.30**	4.93**	11.52**	10.98**	5.49**	17.07**	5.43**	4.43**	2.48	8.55**	5.82**	7.96**
296A x FS9605	3.87**	1.33	1.33	-7.11**	-9.85**	-4.19**	-3.54**	-4.32**	7.93**	-0.64	-1.27	-3.11*	-1.72**	-1.72*	0.40
296A x FS9601	3.39**	0.00	1.78	-2.66*	-9.85**	-4.19**	-2.94*	-9.34**	0.61	-0.32	-1.27	-3.11*	-0.41	-3.04**	-1.08
296A x FS9603	2.04*	-0.88	0.00	-4.94**	-9.85**	-4.19**	-7.69**	-7.69**	2.44	-4.00**	-6.59**	-3.11*	-3.37**	-3.43**	-1.21
296A x 68710	-6.96**	-19.03**	4.00**	-18.81**	-24.03**	-7.33**	-11.69**	-16.26**	3.66*	-2.94*	-9.34**	2.48	-10.34**	-17.75**	0.67
296A x 68724	0.00	-6.85**	2.67*	-9.61**	-14.29**	-8.90**	-12.11**	-14.29**	-4.88**	-3.11*	-4.88**	-3.11*	-5.91**	-6.52**	-3.24**
296A x 68726	5.88**	2.63*	4.00**	-12.73**	-17.24**	-12.04**	-9.83**	-14.29**	-4.88**	-4.08**	-4.97**	-4.97**	-4.69**	-5.95**	-4.05**
296A x Co27	3.42**	0.89	0.89	-11.68**	-14.29**	-8.90**	-1.16	-6.04**	4.27**	-4.08**	-4.97**	-4.97**	-3.20**	-4.10**	-2.16**
296A x SS032	10.41**	1.79	1.33	-14.72**	-17.24**	-12.04**	-1.08	-4.19**	11.59**	-3.16*	-4.97**	-4.97**	-3.94**	-4.56**	-1.21
2219A x 68716	3.19**	-3.67**	-6.67**	-13.68**	-17.19**	-4.19**	-6.15**	-6.15**	2.44	-2.24	-3.16*	-4.97**	-4.93**	-7.99**	-3.64**
2219A x 68740	1.93	-6.22**	-6.22**	-14.29**	-18.30**	-4.19**	-2.79*	-2.79*	6.10**	-0.32	-1.27	-3.11*	-4.23**	-7.89**	-2.29**
2219A x 68918	0.93	-9.62**	-4.00**	-20.19**	-22.94**	-12.04**	-10.42**	-11.17**	-3.05*	-0.32	-1.27	-3.11*	-7.84**	-11.63**	-5.67**
2219A x 68786	-0.48	-8.44**	-8.44**	-11.33**	-11.33**	-5.76**	-2.70*	-5.76**	9.76**	3.12*	0.00	2.48	-3.18**	-6.76**	-1.35
2219A x 68814	0.70	-10.00**	-4.00**	-22.94**	-27.90**	-12.04**	-15.43**	-19.29**	-3.05*	-3.93**	-9.66**	-1.24	-10.69**	-17.02**	-5.26**
2219A x FS211	1.91	-6.99**	-5.33**	-10.64**	-17.24**	-12.04**	-6.59**	-12.85**	-4.88**	-3.29*	-5.16**	-8.70**	-4.47**	-5.66**	-7.69**
2219A x FS205	2.96**	-3.69**	-7.11**	-10.67**	-11.33**	-5.76**	-8.59**	-9.34**	0.61	-5.16**	-5.16**	-8.70**	-5.27**	-7.03**	-5.40**
2219A x FS9401	3.21**	-3.24**	-7.11**	-13.20**	-15.76**	-10.47**	-10.08**	-12.23**	0.61	-5.16**	-5.16**	-8.70**	-6.23**	-7.73**	-6.61**
2219A x SS003	-3.03**	-13.33**	-7.56**	-9.61**	-14.29**	-8.90**	-9.34**	-10.81**	0.61	-5.16**	-5.16**	-8.70**	-6.72**	-8.92**	-6.34**
2219A x SS012	3.86**	-4.44**	-4.44**	-12.73**	-17.24**	-12.04**	-5.54**	-9.50**	-1.22	-3.54**	-3.85**	-6.83**	-4.34**	-4.40**	-6.21**
2219A x SS020	1.46	-5.88**	-7.56**	-4.06**	-6.90**	-1.05	-5.11**	-6.70**	1.83	-5.47**	-5.77**	-8.70**	-3.07**	-4.05**	-4.05**

Appendix 36 (contd.)

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
2219A x SRV605	1.97	-4.61**	-8.00**	-14.88**	-19.38**	-4.19**	-2.66*	-7.11**	11.59**	9.97**	9.62**	6.21**	-2.30**	-6.65**	0.40
2219A x FS9604	2.42*	-5.78**	-5.78**	8.51**	0.49	6.81**	4.96**	0.56	9.76**	6.45**	6.45**	2.48	5.47**	4.97**	2.70**
2219A x FS9605	1.45	-6.67**	-6.67**	-7.11**	-9.85**	-4.19**	-9.34**	-10.81**	0.61	0.96	0.64	-2.48	-3.57**	-5.55**	-3.51**
2219A x FS9601	0.00	-8.73**	-7.11**	-9.04**	-15.76**	-10.47**	-7.42**	-12.85**	-4.88**	-5.16**	-5.16**	-8.70**	-5.20**	-5.79**	-7.83**
2219A x FS9603	1.92	-6.61**	-5.78**	-9.61**	-14.29**	-8.90**	-10.25**	-10.99**	-1.22	-8.70**	-11.98**	-8.70**	-6.33**	-8.31**	-6.21**
2219A x 68710	-10.88**	-26.30**	-5.33**	-18.81**	-24.03**	-7.33**	-13.61**	-18.72**	0.61	-5.64**	-12.64**	-1.24	-12.55**	-21.28**	-3.64**
2219A x 68724	8.01**	-4.84**	4.89**	-6.49**	-11.33**	-5.76**	-9.66**	-11.17**	-3.05*	-7.84**	-10.37**	-8.70**	-3.28**	-5.87**	-2.56**
2219A x 68726	1.68	-7.02**	-5.78**	-6.49**	-11.33**	-5.76**	-9.04**	-12.85**	-4.88**	-6.96**	-8.70**	-8.70**	-4.86**	-5.44**	-6.21**
2219A x Co27	1.45	-6.67**	-6.67**	-8.63**	-11.33**	-5.76**	-3.79**	-7.82**	0.61	-6.96**	-8.70**	-8.70**	-4.29**	-5.26**	-5.26**
2219A x SS032	5.57**	-2.68*	-3.11**	-13.20**	-15.76**	-10.47**	-10.81**	-13.61**	0.61	-6.96**	-8.70**	-8.70**	-6.10**	-8.60**	-5.40**
2077A x 68716	4.95**	3.10**	3.56**	8.68**	-0.9	14.66**	-2.08	-7.82**	0.61	4.70**	-1.27	-3.11*	4.32**	-0.39	4.32**
2077A x 68740	1.55	1.33	1.78	7.88**	-2.23*	14.66**	3.26**	-2.79*	6.10**	4.70**	-1.27	-3.11*	4.29**	-1.02	4.99**
2077A x 68918	6.24**	3.35**	9.78**	-8.50**	-16.06**	-4.19**	-4.79**	-9.66**	-3.05*	4.70**	-1.27	-3.11*	-0.47	-5.82**	0.54
2077A x 68786	21.06**	20.80**	21.33**	13.77**	7.88**	14.66**	8.31**	-1.05	15.24**	12.13**	3.64**	6.21**	14.36**	8.67**	14.98**
2077A x 68814	8.58**	5.42**	12.44**	5.54**	-6.01**	14.66**	3.10**	-7.11**	11.59**	17.72**	5.68**	15.53**	8.38**	-0.59	13.50**
2077A x FS211	-0.22	-0.87	0.89	3.10**	0.55	-4.19**	1.60	0.63	-3.05*	5.88**	2.68	-4.97**	2.27**	2.27**	-2.56**
2077A x FS205	-1.58	-3.54**	-3.11**	6.81**	2.00	6.81**	7.65**	0.55	11.59**	15.93**	10.32**	6.21**	6.30**	2.92**	4.72**
2077A x FS9401	-2.26*	-4.42**	-4.00**	-1.88	-4.19**	-4.19**	-1.16	-9.04**	4.27**	11.86**	6.45**	2.48	0.96	-2.00**	-0.81
2077A x SS003	-2.15*	-5.00**	1.33	0.55	0.55	-4.19**	-3.79**	-10.81**	0.61	17.29**	11.61**	7.45**	2.04**	-1.71*	1.08
2077A x SS012	-0.22	-0.44	0.00	0.55	0.55	-4.19**	17.39**	15.24**	15.24**	11.49**	5.77**	2.48	6.35**	4.81**	2.83**
2077A x SS020	-3.80**	-4.87**	-4.44**	7.77**	5.24**	5.24**	10.57**	5.78**	11.59**	7.43**	1.92	-1.24	4.77**	2.29**	2.29**
2077A x SRV605	-3.39**	-5.31**	-4.89**	4.16**	-6.17**	11.52**	8.17**	-2.54*	17.07**	15.54**	9.62**	6.21**	5.12**	-0.88	6.61**
2077A x FS9604	2.44*	2.21	2.67*	23.38**	20.33**	14.66**	19.25**	17.07**	17.07**	11.86**	6.45**	2.48	13.42**	12.55**	8.91**
2077A x FS9605	2.44*	2.21	2.67*	-0.27	-2.62*	-2.62*	3.21**	-4.32**	7.93**	5.41**	0.00	-3.11*	2.53**	-0.92	1.21
2077A x FS9601	-5.05**	-5.68**	-4.00**	3.10**	0.55	-4.19**	12.66**	12.66**	8.54**	9.83**	4.52**	0.62	4.01**	3.36**	-0.27
2077A x FS9603	1.99*	1.76	2.67*	0.55	0.55	-4.19**	5.88**	-1.1	9.76**	-0.33	-8.38**	-4.97**	2.05**	-1.45*	0.81
2077A x 68710	-3.30**	-13.84**	10.67**	6.99**	-4.72**	16.23**	-11.91**	-21.67**	-3.05*	6.21**	-6.04**	6.21**	-0.68	-11.69**	8.10**
2077A x 68724	7.59**	2.82**	13.33**	18.68**	18.68**	13.09**	8.76**	4.05**	9.76**	2.63*	-4.88**	-3.11*	9.57**	5.22**	8.91**
2077A x 68726	-1.32	-1.75	-0.44	-6.04**	-6.04**	-10.47**	2.48	0.61	0.61	1.66	-4.97**	-4.97**	-1.04	-2.99**	-3.78**
2077A x Co27	0.22	0.00	0.44	-5.09**	-7.33**	-7.33**	-3.11*	-4.88**	-4.88**	3.65**	-3.11*	-3.11*	-1.17	-3.51**	-3.51**
2077A x SS032	-3.56**	-3.98**	-3.56**	-5.09**	-7.33**	-7.33**	-8.88**	-16.75**	-3.05*	3.65**	-3.11*	-3.11*	-3.73**	-7.56**	-4.32**
1111A x 68716	10.00**	9.01**	7.56**	4.65**	1.81	17.80**	-0.28	-1.10	9.76**	0.63	0.63	-1.24	4.20**	3.87**	8.77**
1111A x 68740	5.15**	4.44**	4.44**	3.93**	0.45	17.80**	-0.28	-1.10	9.76**	0.63	0.63	-1.24	2.63**	1.65*	7.83**
1111A x 68918	4.99**	1.26	7.56**	5.39**	3.21**	17.80**	-1.68	-3.30*	7.32**	13.92**	13.92**	11.80**	5.38**	4.05**	11.07**
1111A x 68786	20.36**	19.56**	19.56**	6.31**	4.78**	14.66**	2.95**	0.52	17.07**	-5.26**	-7.27**	-4.97**	7.14**	6.25**	12.42**
1111A x 68814	9.96**	5.83**	12.89**	-0.90	-6.01**	14.66**	-8.18**	-11.68**	6.10**	7.78**	2.27	11.80**	2.29**	-2.25**	11.61**

Appendix 36 (contd.)

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
111A x FS211	-1.55	-3.06**	-1.33	-5.76**	-13.88**	-5.76**	-5.64**	-12.64**	-3.05*	-0.33	-3.16*	-4.97**	-3.32**	-7.27**	-3.64**
111A x FS205	2.05*	0.90	-0.44	-0.24	-2.39*	6.81**	-1.10	-1.10	9.76**	-2.24	-3.16*	-4.97**	-0.20	-1.17	2.70**
111A x FS9401	2.74**	1.35	0.00	-8.50**	-12.44**	-4.19**	-7.57**	-9.04**	4.27**	-2.24	-3.16*	-4.97**	-3.75**	-4.94**	-1.21
111A x SS003	-1.30	-5.00**	1.33	-9.46**	-15.31**	-7.33**	-13.35**	-14.05**	-3.05*	-6.07**	-6.96**	-8.70**	-7.24**	-7.66**	-4.05**
111A x SS012	4.25**	3.56**	3.56**	-7.93**	-13.88**	-5.76**	-4.62**	-9.34**	0.61	-2.55*	-3.16*	-4.97**	-2.40**	-5.06**	-1.35
111A x SS020	5.19**	4.95**	3.56**	11.00**	6.22**	16.23**	6.48**	3.85**	15.24**	-2.55*	-3.16*	-4.97**	5.42**	-3.51**	7.56**
111A x SRV605	-2.05*	-3.15**	-4.44**	0.46	-3.52**	14.66**	1.32	-2.54*	17.07**	5.10**	4.43**	2.48	0.89	-0.75	6.75**
111A x FS9604	5.15**	4.44**	4.44**	-4.19**	-12.44**	-4.19**	10.98**	5.49**	17.07**	5.43**	4.43**	2.48	4.17**	0.65	4.59**
111A x FS9605	0.22	-0.44	-0.44	-8.50**	-12.44**	-4.19**	-0.27	-1.08	11.59**	-2.55*	-3.16*	-4.97**	-2.75**	-3.51**	0.27
111A x FS9601	-4.21**	-5.68**	-4.00**	-4.19**	-12.44**	-4.19**	0.59	-6.04**	4.27**	1.60	0.63	-1.24	-1.88**	-5.32**	-1.62*
111A x FS9603	4.68**	3.52**	4.44**	-6.39**	-12.44**	-4.19**	-7.69**	-7.69**	2.44	-2.15	-4.79**	-1.24	-2.55**	-3.25**	0.54
111A x 68710	2.15*	-9.69**	16.00**	-17.19**	-21.46**	-4.19**	-14.29**	-18.72**	0.61	-2.94*	-9.34**	2.48	-7.75**	-14.66**	4.45**
111A x 68724	6.38**	0.81	11.11**	8.95**	1.91	11.52**	-3.66**	-6.04**	4.27**	-1.24	-3.05*	-1.24	3.12**	2.99**	7.02**
111A x 68726	2.22*	0.88	2.22	-6.39**	-12.44**	-4.19**	-2.89*	-7.69**	2.44	-2.19	-3.11*	-3.11*	-2.12**	-4.29**	-0.54
111A x Co27	1.57	0.89	0.89	5.00**	0.48	9.95**	4.05**	-1.1	9.76**	-2.19	-3.11*	-3.11*	2.25**	0.39	4.32**
111A x SS032	4.93**	4.46**	4.00**	-8.50**	-12.44**	-4.19**	-3.49**	-5.76**	9.76**	-2.19	-3.11*	-3.11*	-2.08**	-2.21**	1.62*
S.E.(d)	0.754	0.870	0.870	0.690	0.797	0.797	0.677	0.782	0.782	0.643	0.743	0.743	0.3751	0.4331	0.4331
CD at 5%	1.486	1.715	1.715	1.360	1.571	1.571	1.334	1.541	1.541	1.268	1.464	1.464	0.7365	0.8505	0.8505
CD at 1%	1.959	2.262	2.262	1.793	2.071	2.071	1.759	2.031	2.031	1.672	1.931	1.931	0.9690	11.189	11.189

* Significant at 5 per cent level

** Significant at 1 per cent level

Appendix 37. Relative heterosis (di), heterobeltiosis (dii) and standard heterosis (diii) in individual environments and pooled data for plant height

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
296A x 68716	25.37**	-9.85**	-3.65	9.88**	-24.92**	0.3	34.15**	-10.33**	-14.05**	-0.50	-31.11**	-28.55**	16.79**	-19.33**	-12.24**
296A x 68740	25.30**	-13.93**	7.79**	20.41**	-18.53**	12.98**	33.05**	-12.38**	-10.80**	29.51**	-17.27**	-14.35**	26.81**	-13.32**	-2.02
296A x 68918	37.41**	4.27	5.70*	22.37**	-10.34**	-5.65*	35.60**	-6.72**	-19.88**	15.33**	-16.08**	-26.44**	27.60**	-7.32**	-15.05**
296A x 68786	25.18**	-13.29**	5.36*	17.45**	-23.13**	21.86**	30.35**	-15.43**	-8.26**	9.78**	-26.25**	-14.35**	20.45**	-19.71**	-0.02
296A x 68814	17.92**	-22.77**	16.68**	52.37**	7.83**	27.15**	43.58**	-4.48*	-6.72**	8.19**	-25.18**	-22.06**	29.14**	-12.52**	2.29
296A x FS211	44.30**	5.41*	7.05**	45.40**	9.45**	6.03*	53.29**	6.85*	-12.49**	26.53**	-6.80*	-21.40**	42.24**	3.68**	-6.03**
296A x FS205	40.51**	3.08	3.29	41.25**	0.00	17.75**	51.73**	1.09	-1.87	29.01**	-8.09**	-13.69**	40.60**	-0.95	0.50
296A x FS9401	34.18**	-2.20	0.03	26.05**	-13.86**	15.02**	47.14**	-3.70	0.64	25.92**	-13.04**	-8.95**	33.16**	-8.37**	1.05
296A x SS003	41.18**	9.22**	-6.56**	59.24**	24.16**	8.70**	75.26**	25.00**	-5.38*	10.18**	-25.76**	-14.76**	43.16**	4.19**	-5.12**
296A x SS012	37.02**	4.26	-6.44**	29.51**	2.95	-14.51**	50.83**	7.73**	-18.84**	18.52**	-15.28**	-21.30**	33.38**	-0.83	-15.50**
296A x SS020	43.36**	2.83	10.79**	53.62**	12.04**	19.62**	39.05**	-12.22**	7.89**	18.09**	-22.64**	-0.49	37.27**	-7.07**	8.92**
296A x SRV605	18.45**	-11.83**	-15.53**	27.30**	-8.46**	2.32	23.16**	-18.38**	-19.04**	27.54**	-12.65**	-5.71*	24.19**	-12.98**	-10.03**
296A x FS9604	17.75**	-7.81**	-23.72**	58.99**	22.70**	10.58**	74.45**	22.63**	-2.47	37.55**	2.36	-16.36**	46.65**	9.90**	-8.58**
296A x FS9605	28.26**	-9.47**	2.96	22.60**	-13.77**	3.83	43.15**	-4.68*	-7.25**	30.40**	-9.93**	-5.76*	30.93**	-9.45**	-1.95
296A x FS9601	23.76**	-11.40**	-3.95	32.30**	-5.14*	7.05*	48.26**	-2.78	0.77	36.49**	-5.67*	-1.52	35.16**	-6.22**	0.35
296A x FS9603	35.91**	0.77	-2.29	37.10**	4.37	-2.18	37.44**	-8.31**	-11.45**	27.55**	-11.05**	-10.08**	34.31**	-4.19**	-6.83**
296A x 68710	48.27**	7.33**	12.22**	47.15**	10.93**	6.99*	54.07**	4.91*	-6.40**	35.79**	-1.1	-13.58**	46.32**	5.43**	-0.82
296A x 68724	40.97**	-0.02	11.86**	38.63**	0.85	8.59**	74.45**	24.92**	-6.68**	26.89**	-14.59**	-1.54	43.18**	0.79	2.55*
296A x Co27	24.83**	-13.65**	5.41*	25.44**	-12.59**	8.74**	51.84**	5.43*	-12.44**	14.83**	-21.85**	-13.65**	27.97**	-11.63**	-3.79**
296A x SS032	37.97**	1.28	1.28	38.43**	3.11	3.11	35.71**	-10.24**	-10.24**	12.62**	-21.22**	-21.22**	30.85**	-7.43**	-7.43**
2219A x 68716	39.86**	2.02	-7.98**	30.18**	-11.71**	-2.32	21.67**	-15.64**	-16.32**	27.52**	-10.30**	-12.04**	27.84**	-9.33**	-10.10**
2219A x 68740	34.69**	-6.58**	-0.15	45.99**	-5.46**	26.30**	57.70**	10.41**	5.83**	55.10**	7.38**	11.37**	48.42**	1.32	10.24**
2219A x 68918	19.51**	-20.50**	-0.44	40.77**	-9.60**	25.37**	48.76**	2.41	4.26	58.15**	13.23**	4.58*	41.04**	-4.68**	7.74**
2219A x 68786	40.99**	2.75	-7.06**	24.41**	-14.49**	-10.01**	38.02**	-0.16	-14.25**	42.37**	3.58	-9.21**	36.64**	-2.05	-10.23**
2219A x 68814	26.55**	-15.18**	3.07	12.65**	-29.66**	11.51**	33.76**	-9.46**	-1.79	43.62**	-3.52	12.04**	28.99**	-14.92**	5.95**
2219A x FS211	12.57**	-28.29**	8.33**	29.86**	-13.36**	2.17	45.36**	1.23	-1.14	42.31**	-1.59	2.51	31.32**	-12.02**	2.88*
2219A x FS205	27.40**	-10.34**	-8.94**	37.92**	-2.97	-6.00*	52.96**	12.31**	-8.02**	51.80**	11.80**	-5.71*	42.36**	2.40	-7.20**
2219A x FS9401	39.88**	-1.17	-0.98	36.97**	-8.57**	7.65**	59.89**	11.55**	8.28**	53.09**	9.06**	2.42	47.73**	2.80*	4.31**
2219A x SS003	42.16**	-0.16	2.13	14.73**	-25.69**	-0.78	43.47**	-1.93	2.49	35.61**	-6.36**	-1.95	34.00**	-8.85**	0.52
2219A x SS012	49.67**	11.04**	-5.01*	63.47**	18.55**	3.79	92.98**	45.40**	10.06**	44.24**	-2.82	11.57**	61.14**	15.74**	5.39**
2219A x SS020	51.04**	10.35**	-0.97	57.53**	16.17**	-3.52	60.11**	20.83**	-8.97**	45.96**	4.32	-3.09	53.23**	12.35**	4.26**
2219A x SRV605	45.07**	0.40	8.17**	39.70**	-4.35	2.13	42.76**	-6.34**	15.11**	31.25**	-14.02**	10.60**	39.41**	-6.65**	9.40**
	44.19**	3.24	-1.09	30.87**	-11.48**	-1.05	54.00**	6.79**	5.92**	31.18**	-10.17**	-3.03	40.16**	-2.98*	0.31

278

Appendix 37 (contd..)

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	Di	dii	diii	di	dii	diii
2219A x FS9604	42.11*	6.60*	-11.79**	37.81**	-0.94	-10.72**	72.80**	28.08**	1.86	47.20**	9.54**	-10.50**	50.48**	11.19**	-7.50**
2219A x FS9605	38.44**	-5.59**	7.37**	30.77**	-13.20**	4.51	49.49**	4.22	1.40	34.33**	-7.23**	-2.93	38.35**	-5.44**	2.40*
2219A x FS9601	32.07**	-3.47	4.65	37.24**	-7.40**	4.50	42.35**	-2.48	1.08	38.82**	4.07	0.15	39.62**	-4.26**	2.45*
2219A x FS9603	39.72**	-5.78*	-8.64**	38.33**	-1.74	-7.90**	33.65**	-6.62**	-9.82**	34.50**	-6.21**	-5.19*	34.47**	-5.28**	-7.89**
2219A x 68710	31.77**	-8.03**	-3.85	44.15**	1.55	-2.06	56.43**	11.85**	-0.21	57.63**	14.79**	0.31	47.41**	4.85**	-1.37
2219A x 68724	41.36**	-3.17	8.33**	48.01**	1.11	8.87**	83.31**	38.73**	3.64	39.43**	-6.16**	8.18**	51.42**	5.29**	7.13**
2219A x 68726	29.24**	-13.47**	5.63*	30.72**	-13.92**	7.08*	68.56**	23.22**	2.33	48.04**	0.75	11.32**	43.38**	-2.13	6.55**
2219A x Co27	40.45**	-0.71	-0.71	32.56**	-7.58**	-7.58**	47.48**	2.02	2.03	42.09**	-0.62	-0.62	41.08**	-1.42	-1.42
2219A x SS032	42.96**	4.28	-5.94*	21.46**	-17.62**	-8.86**	30.91**	-9.22**	-9.96**	33.27**	-6.26**	-8.07**	32.15**	-7.44**	-8.23**
2219A x 68716	46.16**	4.59*	11.78**	58.52**	12.00**	49.62**	60.54**	18.06**	13.17**	56.09**	14.28**	18.52**	55.42**	12.24**	22.11**
2077A x 68740	39.77**	-4.40*	19.72**	50.13**	4.93*	45.52**	44.83**	4.52*	6.40**	60.36**	21.97**	12.66**	48.47**	5.98**	19.79**
2077A x 68918	49.12**	12.55**	1.80	47.38**	12.33**	18.21**	41.53**	7.95**	-7.28**	33.98**	3.79	-9.03**	42.86**	9.10**	-0.00
2077A x 68786	52.05**	4.86*	27.41**	40.13**	-5.55**	49.73**	38.89**	-1.66	6.67**	14.42**	-19.07**	-6.02**	36.20**	-5.47**	17.72**
2077A x 68814	27.47**	-16.83**	25.66**	62.20**	19.04**	40.38**	55.84**	13.93**	11.26**	55.01**	13.33**	18.06**	48.73**	5.10**	22.90**
2077A x FS211	54.93**	12.61**	14.37**	55.51**	22.04**	18.23**	46.84**	13.88**	-6.73**	43.27**	12.53**	-5.09*	50.11**	15.08**	4.29**
2077A x FS205	55.42**	13.45**	13.68**	54.09**	13.14**	33.23**	55.74**	14.07**	10.73**	68.39**	27.36**	19.60**	58.43**	16.95**	18.67**
2077A x FS9401	56.32**	13.37**	15.97**	39.53**	-1.41	31.64**	51.21**	8.26**	13.13**	33.26**	-2.73	1.85	44.80**	4.13**	14.84**
2077A x SS003	52.80**	17.55**	0.56	48.84**	21.32**	6.22*	58.26**	26.31**	-4.39*	24.53**	-11.63**	1.47	44.45**	10.56**	0.68
2077A x SS012	53.20**	15.93**	4.04	64.14**	36.60**	13.44**	63.68**	30.86**	-1.41	54.81**	17.52**	9.18**	58.67**	24.33**	5.95**
2077A x SS020	44.47**	3.13	11.11**	74.44**	32.29**	41.25**	30.40**	-10.86**	9.56**	56.26**	7.38**	38.12**	50.25**	6.11**	24.36**
2077A x SRV605	58.58**	17.43**	12.50**	58.88**	18.65**	32.62**	36.33**	-0.82	-1.62	36.23**	-1.50	6.33**	46.79**	7.71**	11.36**
2077A x FS9604	57.83**	22.86**	1.66	51.64**	22.24**	10.16**	57.32**	23.30**	-1.94	48.55**	18.04**	-3.55	53.79**	21.57**	1.14
2077A x FS9605	49.14**	4.78*	19.17**	42.19**	3.67	24.83**	43.57**	5.08*	2.24	54.55**	12.83**	18.06**	47.48**	6.65**	15.49**
2077A x FS9601	48.03**	5.48*	14.35**	42.40**	6.01*	19.64**	39.47**	0.10	3.76	44.06**	5.25*	9.88**	43.45**	4.12**	11.42**
2077A x FS9603	56.29**	15.28**	11.78**	51.53**	20.37**	12.82**	48.08**	8.64**	4.91*	55.84**	15.04**	16.28**	52.94**	14.47**	11.33**
2077A x 68710	54.46**	11.27**	16.33**	58.77**	24.80**	20.36**	42.16**	7.03**	-4.51*	80.59**	40.05**	22.38**	58.89**	20.26**	13.13**
2077A x 68724	57.38**	11.10**	24.30**	60.53**	21.39**	30.72**	79.44**	43.92**	7.52**	34.84**	-4.42*	10.19**	56.41**	15.35**	17.37**
2077A x 68726	49.04**	2.65	25.31**	50.11**	8.34**	34.78**	49.45**	15.33**	-4.22	72.47**	23.81**	36.81**	55.67**	12.38**	22.36**
2077A x Co27	52.38**	11.30**	11.30**	60.19**	24.29**	24.29**	31.62**	-4.49*	-4.49*	68.20**	24.59**	24.59**	52.80**	13.33**	13.33**
2077A x SS032	79.98**	35.97**	22.64**	35.25**	1.35	12.13**	36.50**	-0.70	-1.50	60.85**	19.91**	17.59**	52.51**	13.43**	12.46**
1111A x 68716	30.15**	-1.56	5.21*	53.16**	3.07	37.70**	38.75**	4.19	-0.13	31.01**	-1.60	2.06	38.10**	1.04	9.93**
1111A x 68740	44.98**	4.21*	30.50**	48.47**	-1.03	37.26**	42.32**	4.78*	6.67**	50.07**	17.35**	8.38**	46.36**	5.81**	19.61**
1111A x 68918	35.65**	8.92**	-1.49	34.92**	-2.91	2.17	42.10**	10.85**	-4.80*	40.73**	12.18**	-1.67	38.46**	7.30**	-1.65
1111A x 58786	35.15**	-1.95	19.14**	11.82**	-27.79**	14.47**	38.25**	-0.22	8.24**	19.39**	-13.53**	0.41	25.99**	-11.51**	10.20**
1111A x 68814	12.46**	-23.37**	15.77**	43.94**	0.18	18.13**	43.04**	6.75**	4.25	49.73**	12.29**	16.98**	35.61**	-2.97**	13.46**
1111A x FS211	30.67**	0.59	2.16	38.82**	2.52	-0.68	43.23**	13.68**	-6.89**	34.92**	9.12**	-7.97**	36.70**	6.36**	-3.61**

Appendix 37 (contd..)

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
111A x FS205	46.47**	13.29**	13.51**	52.06**	5.87*	24.66**	46.38**	9.46**	6.25**	40.80**	9.45**	2.78	46.30**	9.49**	11.09**
111A x FS9401	39.32**	6.98**	9.43**	29.93**	-12.55**	16.76**	44.74**	5.68**	10.45**	36.81**	2.43	7.25**	37.81**	0.40	10.71**
111A x SS003	30.70**	7.21*	-8.28**	33.48**	1.97	-10.72**	42.27**	16.34**	-11.93**	-3.79	-30.07**	-19.71**	23.23**	-4.28**	-12.84**
111A x SS012	35.39**	9.03**	-2.16	48.22**	15.36**	-4.2	53.46**	25.72**	-5.28*	38.79**	8.30**	0.62	43.47**	14.17**	-2.71*
111A x SS020	44.25**	8.81**	17.23**	42.77**	2.29	9.21**	30.66**	-9.10**	11.72**	37.45**	-3.45	24.19**	38.24**	-1.15	15.85**
111A x SRV605	40.08**	10.10**	5.48*	31.21**	-7.27**	3.65	42.94**	6.14**	5.28*	20.13**	-10.95**	-3.87	33.36**	-0.82	2.55*
111A x FS9604	12.30**	-6.66*	-22.77**	49.13**	12.81**	1.67	56.62**	25.68**	-0.05	49.33**	22.25**	-0.10	41.78**	13.84**	-5.29**
111A x FS9605	30.91**	-3.01	10.31**	43.96**	-0.39	19.94**	60.80**	20.15**	16.90**	49.31**	11.82	17.00**	46.15**	7.09**	15.96**
111A x FS9601	37.51**	3.51	12.22**	66.59**	17.40**	32.50**	63.79**	19.90**	24.28**	40.46**	5.27*	9.90**	51.53**	11.45**	19.27**
111A x FS9603	31.14**	2.62	-0.49	58.47**	18.30**	10.88**	44.77**	8.45**	4.73*	26.35**	-4.28	-3.24	39.05**	5.56**	2.66*
111A x 68710	31.35**	0.10	4.65	52.04**	12.45**	8.45**	43.16**	10.18**	-1.70	46.91**	17.24**	2.44	42.80**	9.66**	3.16**
111A x 68724	41.18**	5.16*	17.66**	49.74**	7.00**	15.22**	89.30**	55.59**	16.24**	25.59**	-8.84**	5.09*	49.08**	11.46**	13.41**
111A x 68726	31.21**	-4.95*	16.04**	39.68**	-4.21	19.16**	63.72**	29.28**	7.36**	36.87**	0.70	11.26**	41.99**	3.86**	13.08**
111A x Co27	36.80**	5.88*	5.88*	54.55**	12.99**	12.99**	51.51**	12.20**	12.20**	27.45**	-3.09	-3.09	41.96**	6.76**	6.76**
111A x SS032	41.83**	14.00**	2.82	33.13**	-5.63*	4.41	51.73**	12.66**	11.75**	43.00**	9.48**	7.36**	42.83**	7.72**	6.80**
S.E.(d)	4.213	4.864	4.864	4.155	4.798	4.798	4.232	4.886	4.886	4.263	4.923	4.923	21.156	24.429	24.429
CD at 5%	8.303	9.587	9.587	8.189	9.456	9.456	8.340	9.630	9.630	8.402	9.702	9.702	41.541	47.967	47.967
CD at 1%	10.947	12.640	12.640	10.797	12.467	12.467	10.996	12.697	12.697	11.078	12.792	12.792	54.652	63.107	63.107

* Significant at 5 per cent level

** Significant at 1 per cent level

Appendix 38. Relative heterosis (di), heterobeltiosis (dii) and standard heterosis (diii) in individual environments and pooled data for number of tillers

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	Di	dii	diii
296A x 68716	13.64	-13.79	-28.57	9.47	-20.00	-24.64	14.29	-20.00	-7.69	1.76	-13.57	42.27	10.28	-17.41	-25.58*
296A x 68740	37.78	3.33	-11.43	20.93	-21.21	13.04	43.86	5.13	5.13	-40.4	-59.76**	-46.40*	12.08	-22.17*	-10.21
296A x 68918	31.43	15.00	-34.29**	83.33*	57.14	-4.35	9.52	-20.83	-51.28*	60.21	50.38	-20.00	39.58*	23.60	-28.08*
296A x 68786	-18.75	-35.00	-53.57**	22.22	-19.79	11.59	9.67	-24.45	-7.69	-32.00	-47.69	-54.67*	-1.44	-29.64**	-26.20*
296A x 68814	77.14**	55.00*	-11.43	3.7	-28.21	-18.84	48.72	38.1	-25.64	53.85	42.86	-33.33	40.81*	18.95	-22.60*
296A x FS211	36.59	7.69	-20.00	19.54	-8.77	-24.64	68.89*	40.74	-2.56	16.75	3.78	-37.73	36.11*	10.91	-20.99
296A x FS205	42.86*	11.11	-14.29	2.61	-34.12*	-18.84	41.67	13.33	-12.82	33.26	5.50	-15.6	26.82	4.52	-15.31
296A x FS9401	11.54	-21.62	-17.14	47.13	12.28	-7.25	37.14	4.35	-7.69	21.27	-11.07	-11.07	28.42*	-5.20	-10.72
296A x SS003	-5.88	-33.33*	-31.43*	33.33	-1.59	-10.14	67.9	51.11	-12.82	84.62	71.43	-20.00	39.59*	13.33	-18.49
296A x SS012	7.32	-15.38	-37.14*	47.37	21.74	-18.84	61.11	61.11	-25.64	-19.89	-24.81	-60.00**	23.32	8.11	-35.62**
296A x SS020	28.57	0.00	-22.86	19.05	-7.41	-27.54	41.94	15.79	-15.38	-6.9	-38.64*	-10.00	17.00	-13.64	-18.66
296A x SRV605	5.88	-25.00	-22.86	54.67	28.89	-15.94	49.25	16.28	-3.85	45.45	6.67	6.67	37.81**	4.09	-8.56
296A x FS9604	-20.00	-42.86**	-42.86**	63.57*	30.18	-4.35	111.04**	68.83*	29.87	25.41	6.60	-28.93	44.10**	12.96	-10.75
296A x FS9605	15.56	-13.33	-25.71	49.02*	5.56	10.14	20.00	-14.29	-7.69	-10.09	-30.88	-40.00	18.90	-12.84	-16.10
296A x FS9601	4.00	-25.71	-25.71	94.87**	58.33*	10.14	55.04*	7.53	28.21	-20.16	-44.56*	-33.47	28.66*	-7.67	-4.83
296A x FS9603	2.13	-25.00	-31.43*	48.15*	2.56	15.94	103.51**	48.72*	48.72*	-38.59*	-61.89**	-26.27	20.66	-18.02*	2.50
296A x 68710	60.00*	40.00	-20.00	56.86*	11.11	15.94	212.82**	190.48**	56.41*	132.99**	113.57**	19.60	112.66**	77.40**	19.08
296A x 68724	20.00	-4.00	-31.43*	4.96	-33.33**	7.25	67.52*	20.99	25.64	11.74	-29.32*	24.40	24.08*	-16.23	7.29
296A x 68726	33.06	-4.12	-6.86	164.05**	64.23**	192.75**	176.54**	77.78**	187.18**	-4.69	-40.41**	11.07	95.47**	25.77**	96.75**
296A x Co27	12.00	-20.00	-20.00	33.33	-4.35	-4.35	22.81	-10.26	-10.26	-27.27	-46.67*	-46.67*	9.69	-20.55	-20.55
296A x SS032	20.83	-9.37	-17.14	161.11**	141.03**	36.23	65.22**	11.76	46.15*	15.38	-7.69	-20.00	62.59**	20.74	11.64
2219A x 68716	24.44	-3.45	-20.00	87.76**	41.54	33.33	71.43**	20	38.46	79.80*	59.88	6.80	66.76**	27.75*	15.10
2219A x 68740	30.43	0.00	-14.29	6.06	-29.29*	1.45	40.35	2.56	2.56	19.94	-16.62	11.07	23.00*	-12.94	0.45
2219A x 68918	55.56	40.00	-20.00	22.67	9.52	-33.33	100.00**	75.00*	7.69	43.47	41.85	-24.53	56.57**	42.79*	-16.92
2219A x 68786	39.02	14.00	-18.57	2.33	-31.25*	-4.35	-2.51	-32.84	-17.95	8.85	-12.92	-24.53	9.16	-20.47	-16.58
2219A x 68814	111.11**	90.00**	8.57	36.94	-2.56	10.14	89.74*	76.19	-5.13	180.29**	147.95**	28.93	95.58**	69.84**	10.51
2219A x FS211	19.05	-3.85	-28.57	20.00	-5.26	-21.74	86.67*	55.56	7.69	18.81	10.89	-33.47	36.72*	14.38	-18.53
2219A x FS205	39.53	11.11	-14.29	1.69	-29.41	-13.04	29.17	3.33	-20.51	34.55	11.00	-11.2	24.61	-4.02	-14.86
2219A x FS9401	-1.89	-29.73*	-25.71	60.00*	26.32	4.35	56.19	18.84	5.13	52.11*	15.60	15.6	41.06**	6.44	0.24
2219A x SS003	-11.54	-36.11*	-34.29*	4.17	-20.63	-27.54	62.96	46.67	-15.38	83.77*	62.56	-15.47	28.80	7.33	-22.81*
2219A x SS012	38.1	11.54	-17.14	36.71	17.39	-21.74	94.44*	94.44	-10.26	60.71	58.90	-15.47	56.36**	41.12*	-15.96
2219A x SS020	20.93	-3.70	-25.71	19.54	-3.70	-24.64	72.04*	40.35	2.56	-23.89	-48.45**	-24.4	16.00	-12.47	-17.57

Appendix 38 (contd..)

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
2219A x SRV605	-3.85	-30.56*	-28.57	16.15	0.67	-34.35	15.42	-10.08	-25.64	-18.25	-37.87	-37.87	0.83	-22.07	-31.54**
2219A x FS9604	-5.88	-31.43*	-31.43*	0.36	-17.16	-39.13	-4.17	-23.33	-41.03	20.00	6.80	-28.80	2.19	-17.90	-35.14**
2219A x FS9605	26.09	-3.33	-17.14	21.90	-11.11	-7.25	36.67	-2.38	5.13	21.61	-2.76	-15.60	26.95*	-4.91	-8.46
2219A x FS9601	13.73	-17.14	-17.14	72.84*	45.83	1.45	27.13	-11.83	5.13	-6.98	-33.33	-20.00	22.45	-10.30	-7.53
2219A x FS9603	16.67	-12.5	-20.00	58.56**	12.82	27.54	8.77	-20.51	-20.51	-38.40*	-60.92**	-24.4	4.02	-28.05**	-10.03
2219A x 68710	33.33	20.00	-31.43*	10.48	-19.44	-15.94	94.87*	80.95	-2.56	89.14*	82.38*	2.13	53.93**	31.94	-11.44
2219A x 68724	24.39	2.00	-27.14	0.00	-35.14**	4.35	-4.27	-30.86	-28.21	-21.99	-49.47**	-11.07	-4.40	-34.30**	-15.86
2219A x 68726	20.00	-11.76	-14.29	2.56	-34.96**	15.94	25.93	-19.05	30.77	-8.28	-41.34**	9.33	8.58	-29.07**	10.96
2219A x Co27	60.78**	17.14	17.14	29.41	4.35	-4.35	8.77	-20.51	-20.51	22.81	-6.67	-6.67	29.63*	-4.11	-4.11
2219A x SS032	39.58*	4.69	-4.29	94.44**	79.49*	1.45	13.04	-23.53	0.00	15.19	-7.85	-20.13	34.10*	1.81	-5.86
2077A x 68716	27.27	-3.45	-20.00	40.19	15.38	8.7	0.39	-28.89	-17.95	26.18	19.76	-20.00	22.13	-3.08	-12.67
2077A x 68740	64.44**	23.33	5.71	-6.38	-33.33*	-4.35	14.29	-15.38	-15.38	51.69**	10.01	46.53*	28.57*	-6.23	8.18
2077A x 68918	25.71	10.00	-37.14*	14.29	-30.43	-30.43	34.50	19.79	-26.28	-15.19	-20.00	-52.00*	14.36	9.18	-36.47**
2077A x 68786	0.00	-20.00	-42.86**	-4.35	-31.25*	-4.35	29.52	-9.76	10.26	-45.45	-53.85*	-60.00**	-3.65	-27.52**	-23.97*
2077A x 68814	25.71	10.00	-37.14*	20.00	-7.69	4.35	91.19*	80.95	-2.56	190.40**	142.00**	45.20*	74.69**	58.37**	3.05
2077A x FS211	21.95	-3.85	-28.57	21.21	5.26	-13.04	109.84**	77.78*	23.08	28.89	28.89	-22.67	45.66**	26.92	-9.59
2077A x FS205	85.71**	44.44*	11.43	0.79	-24.71	-7.25	43.59	16.67	-10.26	-14.29	-25.00	-40.00	24.30	-0.77	-11.99
2077A x FS9401	13.46	-20.27	-15.71	37.37	19.30	-1.45	65.26*	27.54	12.82	24.83	-0.13	-0.13	34.99**	5.42	-0.72
2077A x SS003	9.8	-22.22	-20.00	2.86	-14.29	-21.74	74.55	60.00	-7.69	33.60	11.33	-33.2	27.35	10.52	-20.51
2077A x SS012	21.95	-3.85	-28.57	0.00	-4.35	-36.23	85.03*	81.33	-12.82	-7.42	-12.67	-47.60*	22.59	15.76	-31.06**
2077A x SS020	23.81	-3.70	-25.71	8.33	-3.70	-24.64	26.98	5.26	-23.08	22.45	-13.73	26.53	20.56	-5.85	-11.34
2077A x SRV605	29.41	-8.33	-5.71	10.34	6.67	-30.43	-11.76	-30.23	-42.31	-17.50	-34.00	-34.00	1.46	-18.71	-28.60**
2077A x FS9604	-16.00	-40.00**	-40.00**	-26.65	-32.94	-50.72*	23.08	0.00	-23.08	5.05	-0.20	-33.47	-3.48	-19.42	-36.34**
2077A x FS9605	15.56	-13.33	-25.71	22.81	-2.78	1.45	3.70	-25.00	-19.23	-0.09	-15.51	-26.67	10.19	-14.62	-17.81
2077A x FS9601	24.00	-11.43	-11.43	15.56	8.33	-24.64	7.28	-24.73	-10.26	30.81	-1.89	17.73	19.56	-9.53	-6.75
2077A x FS9603	38.30*	1.56	-7.14	-3.33	-25.64	-15.94	45.45	7.69	7.69	-37.40*	-58.99**	-20.67	2.58	-27.01**	-8.73
2077A x 68710	94.29**	70.00**	-2.86	15.79	-8.33	-4.35	181.01**	165.95**	43.21	78.85*	72.89*	3.73	84.59**	65.05**	10.79
2077A x 68724	35.00	8.00	-22.86	22.88	-15.32	36.23	62.03*	18.52	23.08	-26.44	-50.68**	-13.2	16.97	-17.35*	5.86
2077A x 68726	67.35**	20.59	17.14	18.79	-20.33	42.03*	29.66	-15.87	35.9	-2.60	-35.62**	20.00	23.02*	-17.69*	28.77**
2077A x Co27	6.00	-24.29	-24.29	11.71	-10.14	-10.14	55.84*	15.38	15.38	41.67	13.33	13.33	29.90*	-0.68	-0.68
2077A x SS032	6.38	-21.87	-28.57	8.64	4.76	-36.23	-11.11	-39.22*	-20.51	-15.09	-28.15	-37.73	-4.50	-24.93*	-30.58**
111A x 68716	13.64	-13.79	-28.57	23.89	7.69	1.45	33.33	2.22	17.95	17.51	-0.20	-33.33	23.56	-0.42	-10.27
111A x 68740	-2.22	-26.67	-37.14*	-18.37	-39.39**	-13.04	4.76	-15.38	-15.38	-35.8	-56.66**	-42.27	-14.32	-36.69**	-26.95*
111A x 68918	71.43**	50.00	-14.29	6.67	0.00	-30.43	25.00	25.00	-23.08	7.34	0.75	-46.40*	25.84	22.54	-28.70**
111A x 68786	40.00	12.00	-20.00	8.33	-18.75	13.04	3.28	-22.35	-5.13	33.40	2.62	-11.07	17.57	-10.32	-5.92
111A x 68814	37.14	20.00	-31.43*	39.68*	12.82	27.54	100.00**	87.50*	15.38	197.85**	176.57**	29.07	83.93**	69.89**	10.55

Appendix 38 (contd...)

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
111A x FS211	21.95	-3.85	-28.57	6.67	-1.75	-18.84	41.18	33.33	-7.69	89.25*	68.22	0.93	37.51*	21.97	-13.12
111A x FS205	38.10	7.41	-17.14	-3.76	-24.71	-7.25	44.44	30.00	0.00	-8.84	-27.83	-42.27	15.86	-6.06	-16.68
111A x FS9401	-11.54	-37.84**	-34.29*	14.29	5.26	-13.04	50.43	27.54	12.82	33.45	-2.13	-2.13	22.66	-2.76	-8.42
111A x SS003	-13.73	-38.89**	-37.14*	4.50	-7.94	-15.94	63.44	58.33	-2.56	7.69	0.00	-53.33*	14.82	1.43	-27.05*
111A x SS012	7.32	-15.38	-37.14*	-6.38	-8.33	-36.23	33.33	16.67	-28.21	20.16	12.78	-40.00	12.87	8.68	-35.27**
111A x SS020	4.76	-18.52	-37.14*	-29.41	-33.33	-47.83*	18.1	8.77	-20.51	-12.69	-42.45**	-15.6	-5.83	-25.35*	-29.69**
111A x SRV605	37.25*	-2.78	0.00	50.54*	45.83	1.45	33.33	16.28	-3.85	-9.09	-33.33	-33.33	26.95*	3.31	-9.25
111A x FS9604	-8.00	-34.29*	-34.29*	1.32	-1.38	-27.54	25.93	13.33	-12.82	135.29**	100.00**	33.33	34.80*	14.43	-9.59
111A x FS9605	37.78	3.33	-11.43	3.33	-13.89	-10.14	62.12**	27.38	37.18	86.41**	43.32	24.40	46.71**	15.37	11.06
111A x FS9601	-12.00	-37.14*	-37.14*	16.67	16.67	-18.84	10.64	-16.13	0.00	12.00	-22.22	-6.67	7.36	-17.61	-15.07
111A x FS9603	44.68*	6.25	-2.86	30.16	5.13	18.84	119.05**	76.92**	76.92**	7.38	-33.36**	28.93	46.25**	5.37	31.75**
111A x 68710	48.57	30.00	-25.71	53.33**	27.78	33.33	157.78**	141.67**	48.72*	107.79**	90.48*	6.67	90.48**	73.47**	16.44
111A x 68724	40.00	12.00	-20.00	-9.43	-35.14**	4.35	58.14*	25.93	30.77	-28.26	-54.62**	-20.13	8.37	-22.49**	-0.72
111A x 68726	34.69	-2.94	-5.71	-11.11	-38.21**	10.14	42.53*	-1.59	58.97*	29.63	-18.96	51.07*	22.79*	-16.97*	29.90**
111A x Co27	36.00*	-2.86	-2.86	-17.95	-30.43	-30.43	0.00	-19.23	-19.23	15.27	-15.47	-15.47	7.02	-16.99	-16.99
111A x SS032	44.68*	6.25	-2.86	88.51**	70.83*	18.84	36.00	0.00	30.77	80.00**	38.46	20.00	58.70**	26.67*	17.12
S.E.(d)	0.301	0.348	0.348	0.397	0.458	0.458	0.523	0.604	0.604	0.475	0.548	0.548	0.2306	0.2663	0.2663
CD at 5%	0.593	0.685	0.685	0.782	0.903	0.903	1.030	1.190	1.190	0.936	1.080	1.080	0.4528	0.5228	0.5228
CD at 1%	0.782	0.903	0.903	1.031	1.190	1.190	1.358	1.569	1.569	1.234	1.424	1.424	0.5957	0.6879	0.6879

* Significant at 5 per cent level

** Significant at 1 per cent level

Appendix 39. Relative heterosis (di), heterobeltiosis (dii) and standard heterosis (diii) in individual environments and pooled data for number of leaves

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
Hybrids															
296A x 68716	-0.88	-11.11	9.8	8.47	3.23	11.63	2.75	-2.96	-0.76	-26.18**	-35.41**	-21.94**	-4.46	-7.83*	-1.02
296A x 68740	-6.12	-8.73	12.75	11.23	3.78	17.05	-0.59	-5.62	-4.55	-21.43**	-31.25**	-16.92*	-4.38	-5.64	1.33
296A x 68918	-1.52	-5.80	27.45**	13.78	2.55	24.81	0.2	-2.75	-6.06	-5.36	-17.19*	0.08	1.91	0.92	10.52**
296A x 68786	-7.14	-7.14	14.71	18.21	7.47	28.29	-3.38	-9.91	-5.30	-35.93**	-36.41**	-21.98**	-8.23**	-12.11**	3.11
296A x 68814	4.88	2.38	26.47**	18.68	10.2	25.58	-0.2	-4.21	-5.30	-6.54	-14.06*	3.85	4.07	4.04	11.73**
296A x FS211	-2.01	-3.17	19.61*	-24.70*	-46.05**	21.71	-3.97	-8.33	-8.33	-25.32**	-32.31**	-18.20*	-15.85**	-24.81**	2.60
296A x FS205	-7.56	-17.46*	1.96	19.24	5.15	34.5	17.98**	14.51*	10.61	-25.42**	-31.25**	-16.92*	0.80	0.28	7.69
296A x FS9401	-3.57	-14.29	5.88	9.72	-2.47	22.48	8.01	-2.36	9.85	-21.35**	-28.13**	-13.14	-1.95	-2.76	6.18
296A x SS003	-2.52	-7.94	13.73	19.38	16.67	19.38	10.97	7.50	-2.27	-25.67**	-32.81**	-18.81*	-0.47	-4.79	2.24
296A x SS012	-2.90	-7.14	14.71	11.61	5.67	15.5	1.91	0.00	-9.09	-28.03**	-36.47**	-23.23**	-4.95	-8.34	-1.56
296A x SS020	-17.50**	-21.43**	-2.94	2.72	-10.12	17.05	4.03	-7.19	7.58	-25.42**	-31.25**	-16.92*	-8.89**	-11.93**	1.33
296A x SRV605	-13.74	-27.78**	-10.78	3.47	-8.02	15.5	-3.42	-14.92**	1.52	-13.14	-24.00**	-8.16	-6.18	-6.84	0.04
296A x FS9604	0.45	-12.30	8.33	32.58*	25.53	37.21*	37.10**	31.96**	19.96**	-19.51**	-30.19**	-15.63	12.01**	4.80	12.55**
296A x FS9605	-11.89	-20.63**	-1.96	10.73	5.38	13.95	-3.75	-8.61	-7.58	-24.34**	-34.38**	-20.69*	-7.38*	-10.90**	-4.32
296A x FS9601	-15.88*	-22.22**	-3.92	3.70	-2.78	8.53	8.43	4.65	2.27	-12.73	-25.00**	-9.37	-3.99	-7.33	-0.48
296A x FS9603	-10.03	-20.63**	-1.96	12.88	9.52	6.98	-4.43	-11.11	-6.06	-24.50**	-29.69**	-15.03	-7.09*	-11.91**	-5.40
296A x 68710	-8.30	-8.66	13.73	9.02	1.72	14.73	3.20	2.25	-5.30	-18.20**	-29.69**	-15.03	-3.72	-5.73	1.23
296A x 68724	-13.74*	-16.91*	10.78	12.52	9.36	13.18	10.81	2.50	-6.82	-26.29**	-34.34**	-20.66*	-5.29	-8.45**	-1.69
296A x 68726	-8.66	-9.38	13.73	5.64	1.58	7.48	-11.39	-12.50	-20.45**	-28.68**	-36.47**	-23.23**	-11.16**	-13.29**	-6.88
296A x Co27	-11.40	-19.84**	-0.98	16.08	14.73	14.73	4.76	0.00	0.00	-32.18**	-38.03**	-25.11**	-6.53	-9.75**	-3.08
296A x SS032	7.54	0.94	4.90	6.15	-16.11	17.05	2.39	-5.93	5.30	-2.46	-6.42	-16.92*	-6.51*	-8.24*	2.34
2219A x 68716	8.74	5.66	9.80	35.25*	18.28	27.91	3.89	-0.37	0.76	16.97*	11.13	0.72	16.50**	8.67*	8.47*
2219A x 68740	-7.56	-12.61	1.96	38.40*	18.9	34.11	9.47	-0.37	0.76	2.37	-2.75	-11.86	11.35**	1.68	6.32
2219A x 68918	-10.66	-21.01**	6.86	10.13	-8.28	11.63	-3.8	-10.59	-13.64*	15.48	9.71	-0.57	2.76	-8.08*	0.66
2219A x 68786	0.86	-7.14	14.71	19.15	0.00	19.38	10.37	-1.26	3.79	6.01	-11.76	8.27	9.26**	-5.14	11.29**
2219A x 68814	4.42	-1.67	15.69	15.31	-1.36	12.4	-0.83	-8.81	-9.85	-2.33	-11.88	-10.65	4.26	-5.91	0.99
2219A x FS211	-0.44	-7.32	11.76	-27.18**	-50.52**	11.63	-7.25	-15.15*	-15.15*	-0.57	-9.00	-10.61	-11.53**	-27.76**	-1.42
2219A x FS205	2.44	-0.94	2.94	17.25	-4.24	22.48	18.99**	10.59	6.82	1.52	-8.63	-6.84	10.50**	0.16	6.45
2219A x FS9401	10.78	6.60	10.78	11.07	-8.64	14.73	7.75	-6.40	5.30	-5.72	-14.42	-14.39	5.96	-5.10	3.62
2219A x SS003	-4.59	-7.14	1.96	26.90	12.88	15.50	30.63**	28.89**	9.85	5.37	-3.29	-5.59	14.47**	7.67	5.57
2219A x SS012	8.6	4.35	17.65	8.35	-5.67	3.10	4.89	2.16	-10.61	8.44	2.00	-5.59	7.59*	0.39	0.12
2219A x SS020	-6.36	-9.65	0.98	14.5	-7.14	20.93	5.9	-9.15	5.30	-1.23	-11.11	-9.37	3.81	-9.12**	4.56

Appendix 39 (contd...)

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
2219A x SRV605	8.90	-1.89	1.96	12.57	-7.41	16.28	-2.62	-17.46**	-1.52	-3.51	-8.33	-16.92*	3.73	-5.82	-0.28
2219A x FS9604	3.00	-2.83	0.98	24.64	8.51	18.60	26.98**	26.13**	6.06	2.02	-2.17	-13.10	14.64**	10.25*	3.16
2219A x FS9605	0.48	-1.89	1.96	18.85	3.94	12.40	-0.41	-9.36	-8.33	-2.5	-6.47	-16.96*	4.39	-2.36	-3.12
2219A x FS9601	6.10	5.61	10.78	2.21	-11.81	-1.55	-0.21	-7.75	-9.85	3.18	0.04	-13.10	2.72	-4.23	-4.31
2219A x FS9603	3.81	-0.94	2.94	30.94	23.21	13.18	-5.22	-15.41**	-10.61	-1.65	-7.47	-14.39	6.62	1.16	-2.63
2219A x 68710	7.30	-1.57	22.55*	10.4	-5.15	6.98	10.46	4.70	-3.03	4.64	1.43	-11.86	8.27*	-0.41	2.48
2219A x 68724	4.96	-6.62	24.51**	29.41	15.36	19.38	27.66**	23.29**	2.27	14.40	6.60	0.68	18.83**	10.62**	10.88**
2219A x 68726	0.00	-8.59	14.71	14.52	1.10	6.98	12.14*	8.55	-3.79	2.98	-4.04	-9.37	7.43*	-0.90	1.33
2219A x Co27	-1.92	-3.77	0.00	26.77	14.73	14.73	14.29*	4.55	4.55	-2.91	-11.86	-11.86	9.31*	1.88	1.88
2219A x SS032	8.54	1.89	5.88	-7.91	-27.22*	1.55	-6.45	-21.60**	-3.79	1.97	-2.17	-13.14	-1.89	-12.95**	-2.91
2077A x 68716	2.50	-8.81	14.71	27.53	22.04	31.98	12.37*	-0.74	1.52	22.27**	14.63	3.89	16.56**	13.00**	12.80**
2077A x 68740	-10.23	-13.48	8.82	30.40*	22.34	37.98*	3.8	-7.87	-6.82	36.44**	27.92**	15.94	15.14**	9.17*	14.15**
2077A x 68918	0.64	-2.90	31.37**	26.54	14.65	39.53*	27.06**	15.10*	11.17	14.67	7.50	-2.57	17.15**	8.71*	19.05**
2077A x 68786	17.18**	16.13*	46.08**	32.15*	20.78	44.19*	24.66**	8.83	14.39*	-6.15	-22.75**	-5.21	16.98**	5.21	23.44**
2077A x 68814	6.32	2.88	29.41**	34.06*	25.17	42.64*	28.21**	14.94*	13.64*	33.46**	18.92*	20.58*	25.63**	17.66**	26.29**
2077A x FS211	2.67	0.55	26.47**	-27.36**	-47.77**	17.83	5.31	-6.06	-6.06	27.63**	15.34	13.29	-2.66	-17.91**	12.03**
2077A x FS205	-8.49	-18.94**	1.96	14.87	1.82	30.23	26.84**	14.90*	10.98	12.5	0.00	1.96	11.73**	5.13	11.73**
2077A x FS9401	-10.74	-21.28**	-0.98	13.99	1.85	27.91	5.56	-10.44	0.76	7.39	-3.74	-3.70	4.75	-2.67	6.28
2077A x SS003	6.53	-0.23	25.49**	26.40	24.24	27.13	15.74*	11.11	-5.30	25.93**	14.12	11.40	18.84**	16.21**	13.95**
2077A x SS012	-7.93	-12.70	9.80	23.65	17.73	28.68	29.68**	22.94**	7.58	12.06	4.04	-3.70	14.26**	10.82**	10.52**
2077A x SS020	-7.55	-12.70	9.80	19.12	4.76	36.43*	15.40**	-3.27	12.12*	27.08**	12.96	15.18	13.80**	3.25	18.79**
2077A x SRV605	-0.61	-17.38*	3.92	18.83	6.17	33.33	13.79**	-5.71	12.50*	22.27**	14.63	3.89	14.09**	7.54*	13.86**
2077A x FS9604	2.56	-11.15	11.76	23.65	17.73	28.68	34.27**	29.73**	9.09	14.58	8.46	-3.70	18.88**	18.78**	11.32**
2077A x FS9605	5.54	-5.69	18.63*	32.58*	26.88	37.21*	17.30**	4.12	5.30	23.57**	16.97	3.85	20.21**	16.88**	15.97**
2077A x FS9601	-9.9	-17.38*	3.92	21.55	14.58	27.91	8.39	-2.33	-4.55	7.05	2.39	-11.06	7.32*	3.99	3.91
2077A x FS9603	-2.49	-14.65*	7.35	30.89	26.27	24.81	7.41	-6.45	-1.14	27.52**	18.41*	9.55	16.05**	14.52**	10.22*
2077A x 68710	-8.34	-8.81	14.71	14.29	7.22	20.93	21.73**	12.39	4.09	40.83**	34.68**	17.03*	16.08**	10.90**	14.12**
2077A x 68724	4.43	1.47	35.29**	27.97	25.09	29.46	34.31**	33.33**	4.55	17.37*	7.96	1.96	20.31**	16.40**	16.67**
2077A x 68726	2.22	2.10	28.43**	28.79	24.54	31.78	9.30	2.99	-8.71	30.19**	19.75*	13.10	17.68**	12.77**	15.31**
2077A x Co27	-0.13	-10.37	12.75	22.14	21.43	21.43	17.62**	4.92	4.92	17.94*	5.74	5.74	14.65**	11.05**	11.05**
2077A x SS032	17.49*	1.33	27.45**	9.92	-6.11	31.01	-5.84	-22.84**	-5.30	13.86	7.78	-4.31	8.31*	-0.33	11.16**
1111A x 68716	11.93	-1.15	26.47**	31.64	16.85	26.36	3.79	1.48	3.79	-0.71	-15.32*	8.76	11.02**	6.56	15.66**
1111A x 68740	6.21	1.53	29.90**	33.25*	16.15	31.01	7.43	5.62	6.82	11.46	-4.94	22.09**	14.45**	12.36**	21.95**
1111A x 68918	-3.17	-5.80	27.45**	33.13*	12.42	36.82*	5.26	4.65	2.27	-4.95	-18.94**	4.12	7.27*	6.79	16.95**
1111A x 68786	11.50	9.58	40.20**	14.44	-2.6	16.28	3.83	0.18	5.30	-20.78**	-22.55**	-0.53	0.76	-3.01	13.79**
1111A x 68814	9.38	4.98	34.31**	17.58	2.04	16.28	7.90	7.28	6.06	-2.50	-12.76*	12.05	7.60*	7.00	16.14**

Appendix 39 (contd..)

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
111A x FS211	0.99	-1.92	25.49**	-26.34**	-49.48**	13.95	-6.51	-7.58	-7.58	4.30	-7.97	18.20*	-8.80**	-18.13**	11.73**
111A x FS205	-0.65	-12.64	11.76	24.47	3.03	31.78	11.50*	10.85	8.33	0.54	-9.82	15.82	9.07**	7.93*	17.15**
111A x FS9401	-1.09	-13.41	10.78	22.89	2.47	28.68	-2.70	-9.09	2.27	-16.26**	-25.52**	-4.34	0.25	-0.06	9.13*
111A x SS003	0.62	-6.51	19.61*	31.50	19.62	22.40	8.49	1.55	-0.76	-20.92**	-30.40**	-10.61	3.42	-1.57	6.83
111A x SS012	3.46	-2.68	24.51**	37.27*	21.28	32.56	15.34**	9.30	6.82	17.36**	0.97	29.68**	18.38**	13.58**	23.27**
111A x SS020	-1.84	-8.05	17.65	22.40	0.60	31.01	9.22	0.65	16.67**	-10.38	-19.61**	3.25	4.67	1.70	17.02**
111A x SRV605	-4.41	-21.07**	0.98	15.49	-3.70	20.93	4.71	-4.76	13.64*	-18.39**	-30.40**	-10.61	-0.71	-1.92	6.45
111A x FS9604	14.92*	-1.15	26.47**	21.21	7.09	17.05	24.17**	15.50*	12.88*	-14.22*	-27.46**	-6.84	10.33**	2.72	11.50**
111A x FS9605	1.08	-10.34	14.71	30.83	16.13	25.58	9.71	7.87	9.09	-6.12	-20.61**	1.96	8.43*	3.78	12.64**
111A x FS9601	-4.00	-12.64	11.76	38.81*	21.53	35.66*	22.48**	22.48**	19.70**	-8.79	-23.55**	-1.81	11.75**	7.31*	16.47**
111A x FS9603	-6.53	-18.77**	3.52	28.83	23.21	13.18	-3.17	-6.81	-1.52	-20.22**	-31.37**	-11.86	-1.69	-7.25	0.67
111A x 68710	-3.69	-4.98	21.57*	9.60	-4.47	7.75	-9.25	-11.63	-13.64*	-11.72	-25.99**	-4.95	-3.99	-6.48	1.50
111A x 68724	3.56	1.47	35.29**	35.73*	22.85	27.13	26.41**	13.18*	10.61	-2.88	-15.73*	8.23	14.34**	9.97**	19.36**
111A x 68726	10.25	9.20	39.71**	30.8	17.22	24.03	8.94	3.88	1.52	-13.01*	-24.52**	-3.06	8.18*	5.05	14.02**
111A x Co27	-2.37	-13.03	11.27	38.31*	27.13	27.13	12.64*	11.36	11.36	-15.13*	-24.52**	-3.06	7.03*	2.82	11.60**
111A x SS032	8.28	-7.28	18.63*	4.11	-16.67	16.28	-1.72	-11.73*	8.33	-9.6	-23.55**	-1.81	-0.21	-1.55	9.81*
S.E.(d)	0.529	0.611	0.611	1.333	1.539	1.539	0.459	0.529	0.529	0.623	0.719	0.719	0.2897	0.3345	0.3345
CD at 5%	1.043	1.205	1.205	2.627	3.033	3.033	0.904	1.043	1.043	1.227	1.417	1.417	0.5688	0.6568	0.6568
CD at 1%	1.375	1.588	1.588	3.463	3.999	3.999	1.191	1.376	1.376	1.618	1.868	1.868	0.7484	0.8642	0.8642

* Significant at 5 per cent level

** Significant at 1 per cent level

Appendix 40. Relative heterosis (di), heterobeltiosis (dii) and standard heterosis (diii) in individual environments and pooled data for leaf length

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
296A x 68716	10.95	9.21	9.66	-3.48	-10.63	0.87	7.28	-2.10	16.20*	-19.96**	-23.54**	-28.65**	-1.33	-4.80	-1.65
296A x 68740	8.52	3.55	10.86	8.88	2.52	11.59	18.39**	17.37*	16.96*	-12.32	-13.55	-19.33**	5.47	2.80	3.99
296A x 68918	13.03*	9.69	13.37	3.79	2.89	-1.08	17.32*	15.39	13.01	11.59	-0.26	-6.92	11.47**	8.45*	4.16
296A x 68786	16.14**	8.44	21.59**	5.67	1.69	5.74	5.4	-4.58	15.29	-16.18**	-19.53**	-18.37**	2.43	-3.76	5.13
296A x 68814	14.96**	6.45	21.51**	20.62**	19.99*	15.35	16.15*	7.13	24.22**	-1.03	-4.86	-11.21	12.49**	9.11*	11.50**
296A x FS211	17.71**	14.60*	17.66*	1.79	0.29	-0.65	15.65*	14.80	14.11	3.65	1.96	-4.85	9.67**	8.81*	6.16
296A x FS205	6.67	5.41	2.51	4.33	4.26	0.23	26.79**	23.72**	27.33**	-6.21	-13.86	-19.61**	7.84*	5.76	1.58
296A x FS401	1.11	-2.12	1.69	4.46	-1.68	7.11	13.04*	2.63	23.22**	-6.56	-9.49	-9.88	2.87	-2.69	4.77
296A x SS003	14.37*	12.93	9.83	10.04	9.67	6.15	14.90*	10.88	16.78*	-18.53**	-27.48**	-13.28*	3.71	-0.58	4.10
296A x SS012	0.54	-1.10	-3.82	4.17	-2.24	-6.01	20.07**	16.41*	21.41**	-8.02	-8.37	-13.84*	3.86	2.83	-1.24
296A x SS020	10.26	4.13	13.93*	35.86**	28.38**	23.43**	14.90*	2.76	27.62**	-5.05	-12.22*	-3.5	12.57**	6.64	14.49**
296A x SRV605	0.23	-0.51	-3.25	24.52**	17.73*	13.18	3.25	-8.98	16.81*	3.82	1.66	-1.01	7.31*	4.45	5.98
296A x FS9604	4.77	3.99	1.13	21.17**	12.50	8.16	21.16**	16.11*	24.06**	-5.82	-9.77	-15.80*	9.81**	7.68*	3.42
296A x FS9605	1.58	-6.75	8.47	3.91	-3.50	8.22	16.28*	7.24	24.38**	-7.48	-11.49	-9.58	3.29	-3.78	7.07
296A x FS9601	10.22	9.00	6.01	6.09	5.66	2.41	17.94**	11.81	22.21**	8.57	6.39	-0.71	10.74**	10.02*	7.07
296A x FS9603	13.93*	10.31	7.27	1.52	-2.02	1.26	16.38*	7.20	24.67**	-5.73	-9.82	-7.84	6.18	2.59	5.68
296A x 68710	17.42**	9.00	23.76**	2.87	-9.19	14.05	9.47	-0.29	18.85*	19.47**	16.57*	8.78	12.27**	4.81	16.10**
296A x 68724	12.31*	2.14	21.29**	11.17	9.83	8.20	28.32**	21.13**	18.64*	2.23	-0.96	-1.43	12.79**	9.97**	11.19**
296A x 68726	7.78	-1.70	16.01*	-1.53	-8.97	3.09	0.71	-4.86	4.77	-19.90**	-25.40**	-19.30**	-3.61	-10.58**	0.40
296A x Co27	8.86	7.36	7.36	8.21	6.12	6.12	30.57**	29.23**	29.23**	-5.84	-8.98	-8.98	9.78**	7.60*	7.60*
296A x SS032	5.26	-4.37	-2.25	18.98*	8.20	8.66	10.6	-4.63	9.27	4.90	-14.42*	-18.50**	-0.92	-4.14	-1.53
2219A x 68716	17.90**	7.98	8.42	17.24*	1.32	14.36	19.95**	1.93	20.98**	35.75**	15.92*	-1.51	22.32**	6.46	9.99**
2219A x 68740	4.95	-6.59	0.00	20.99**	6.20	15.59	22.60**	12.37	11.98	14.05	-5.15	-13.98*	15.47**	1.41	2.58
2219A x 68918	14.78*	3.76	7.24	16.27*	8.73	2.72	26.58**	18.76*	12.49	39.63**	26.94**	-6.69	23.66**	13.92**	3.49
2219A x 68786	6.64	-6.97	4.31	16.89*	4.65	8.83	20.89**	1.98	23.21**	29.46**	3.11	4.60	18.32**	0.60	9.89**
2219A x 68814	16.73**	1.06	15.36*	30.46**	21.61*	15.69	21.78**	4.49	21.15**	14.93	-2.4	-15.96*	20.87**	5.69	8.00*
2219A x FS211	8.55	-1.58	1.04	16.20*	6.32	5.33	12.50	3.23	2.61	19.13*	-0.75	-10.40	13.98**	1.69	-0.79
2219A x FS205	11.51	4.79	-0.51	12.69	4.59	0.42	23.57**	11.62	14.88	37.89**	22.05*	-4.69	20.98**	10.63*	2.14
2219A x FS9401	9.33	-1.40	2.44	7.26	-5.9	2.52	19.32**	0.91	21.17**	10.82	-11.12	-11.50	11.77**	-4.40	2.93
2219A x SS003	20.23**	13.06	7.20	22.76**	13.52	9.88	28.20**	14.63	20.72**	7.2	-19.44**	-3.67	19.14**	3.11	7.95*
2219A x SS012	13.75*	7.35	1.00	7.61	6.28	-10.40	6.52	-4.34	-0.24	15.39*	-5.40	-11.05	10.88**	0.51	-5.38
2219A x SS020	12.45*	-0.87	8.47	20.78*	18.42*	1.33	13.39*	-5.41	17.47*	19.38**	-7.66	1.52	16.30**	-0.41	6.93

282

Appendix 40 (contd...)

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
2219A x SRV605	13.24*	5.97	1.53	21.46**	19.03*	1.95	13.16*	-6.82	19.58*	9.12	-11.74	-14.05*	14.03**	0.02	1.48
2219A x FS9604	18.38**	10.78	6.14	10.47	10.36	-9.08	29.85**	15.37*	23.27**	32.06**	12.48	-3.83	22.89**	12.38**	3.75
2219A x FS9605	-0.59	-14.61*	-0.68	12.79	-2.25	9.62	23.15**	5.65	22.54**	10.55	-12.18	-10.29	11.30**	-6.08	4.51
2219A x FS9601	11.82	5.00	-0.14	14.04	5.39	2.15	13.35	-0.27	9.00	22.17**	2.10	-8.54	15.26**	2.95	0.19
2219A x FS9603	23.95**	18.81*	8.18	3.89	-6.73	-3.60	7.02	-8.29	6.65	7.66	-14.49*	-12.61	10.49**	-3.72	-0.81
2219A x 68710	17.24**	1.74	15.51*	-3.42	-20.10**	0.36	16.30*	-1.34	17.59*	24.61**	4.51	-7.21	13.22**	-4.29	6.03
2219A x 68724	17.94**	0.44	19.27**	21.25**	11.21	9.57	44.00**	40.74**	22.39**	16.67*	-6.41	-6.85	24.26**	9.16*	10.37**
2219A x 68726	5.45	-9.97	6.25	7.04	-7.62	4.62	18.29*	3.74	14.24	17.52*	-8.57	-1.10	11.94**	-5.88	5.67
2219A x Co27	14.19*	4.77	4.77	18.56*	8.02	8.02	28.22**	17.34*	17.34*	12.67	-9.78	-9.78	18.28**	4.40	4.40
2219A x SS032	1.88	-7.44	-5.39	13.56	3.27	3.7	8.74	-6.24	7.43	16.42*	-5.03	-9.56	10.01**	-4.02	-1.40
2077A x 68716	11.75*	7.18	17.22*	5.01	-3.50	8.91	18.14**	1.84	20.88**	33.95**	25.68**	6.78	16.75**	9.55*	13.18**
2077A x 68740	-5.00	-6.01	2.80	12.60	5.22	14.53	28.85**	19.98*	19.57*	8.66	-1.06	-10.27	10.41**	4.54	5.84
2077A x 68918	7.49	4.53	14.33*	21.24**	21.17*	14.59	27.45**	21.54*	15.12	4.52	3.85	-22.67**	14.87**	14.69**	4.19
2077A x 68786	16.10**	14.67*	28.58**	25.72**	20.03**	24.82**	19.11**	1.91	23.13**	-7.68	-19.96**	-18.80**	13.22**	3.54	13.10**
2077A x 68814	14.06**	11.67	27.47**	26.57**	26.20**	20.06*	33.45**	16.17*	34.71**	23.48**	15.13	-0.86	23.94**	16.90**	19.45**
2077A x FS211	14.31*	10.81	21.20**	20.84**	18.09*	16.99*	21.70**	13.45	12.77	17.76*	7.45	-3.00	18.46**	14.21**	11.43**
2077A x FS205	4.11	-2.76	6.35	7.05	6.24	2.01	34.91**	23.78**	27.39**	9.42	6.88	-16.54*	13.53**	12.45**	3.83
2077A x FS9401	-0.92	-3.40	5.65	4.05	-2.81	5.88	14.08*	-2.13	17.51*	5.98	-7.38	-7.78	5.65	-2.74	4.71
2077A x SS003	6.05	-1.01	8.27	10.95	9.68	6.16	17.94*	4.22	9.77	1.74	-17.45**	-1.29	7.99*	0.70	5.44
2077A x SS012	-11.52*	-17.71**	-9.99	8.54	2.65	-2.92	14.79*	7.57	12.18	8.56	-2.74	-8.54	5.34	3.34	-2.71
2077A x SS020	9.14	9.12	19.40**	10.08	4.84	-0.85	33.77**	13.17*	40.54**	28.32**	7.62	18.31**	20.49**	11.06**	19.25**
2077A x SRV605	-2.82	-8.85	-0.30	10.40	5.20	-0.51	19.93**	0.12	28.48**	-1.23	-12.85	-15.13*	6.47	0.75	2.23
2077A x FS9604	3.10	-3.30	5.77	4.85	-1.91	-7.23	13.03	1.97	8.95	4.15	-2.57	-16.70*	6.21	5.20	-2.88
2077A x FS9605	1.24	-1.78	14.25*	6.06	-2.25	9.62	29.60**	12.81	30.85**	23.62**	6.86	9.17	14.56**	3.90	15.62**
2077A x FS9601	6.09	-0.83	8.47	13.38	12.01	8.57	16.84*	4.35	14.05	18.78**	8.76	-2.58	13.58**	9.65*	6.70
2077A x FS9603	7.56	-1.44	7.79	7.44	2.88	6.33	21.97**	6.05	23.33**	-3.45	-16.55*	-14.71*	8.24*	1.70	4.77
2077A x 68710	12.08*	10.02	24.92**	5.24	-7.76	15.85*	27.47**	9.69	30.73**	25.57**	15.44*	2.50	17.05**	6.38	17.84**
2077A x 68724	10.86*	6.48	26.45**	20.35**	17.94*	16.20*	38.19**	37.38**	19.47*	15.60*	1.05	0.57	20.12**	13.86**	15.12**
2077A x 68726	1.23	-2.48	15.09*	15.42*	5.90	19.93*	2.58	-8.68	0.56	24.48**	5.08	13.67*	10.86**	0.15	12.43**
2077A x Co27	4.95	0.46	9.87	15.58*	12.45	12.45	9.90	2.17	2.17	22.97**	7.27	7.27	13.29**	7.95*	7.95*
2077A x SS032	9.48	5.90	15.83*	1.73	-1.24	-0.82	1.45	-11.23	1.72	-8.70	-18.66**	-22.54**	1.19	-4.80	-2.20
1111A x 68716	15.41*	11.30	11.76	13.99*	1.37	14.41	12.10*	5.78	25.56**	10.22	6.81	-9.25	12.93**	6.21	9.72*
1111A x 68740	12.15*	4.92	12.33	12.29	1.47	10.44	22.62**	19.33*	25.67**	15.78*	8.78	-1.35	15.71**	9.91**	11.17**
1111A x 68918	6.61	1.40	4.81	4.64	0.99	-4.60	13.53*	7.82	13.55	25.42**	20.54*	-3.91	12.38**	12.28**	2.18
1111A x 68786	10.19	0.91	13.15	11.96	3.28	7.40	4.57	-2.14	18.24*	7.05	-4.41	-3.03	8.31*	-0.73	8.44*
1111A x 68814	21.13**	10.04	25.61**	29.85**	24.89**	18.81*	17.83**	12.43	30.36**	37.25**	32.16**	13.80*	26.09**	19.19**	21.80**

Appendix 40 (contd...)

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
111A x FS211	12.11*	6.97	9.82	19.09*	12.36	11.31	5.68	2.71	8.18	13.2	6.58	-3.79	12.39**	8.61*	5.97
111A x FS205	5.26	4.32	-0.95	12.88	8.09	3.78	8.34	7.10	12.80	23.05**	21.79**	-2.91	12.19**	11.38**	2.84
111A x FS9401	5.59	0.19	4.08	12.79	1.88	10.99	4.19	-2.21	17.41*	5.35	-5.15	-5.56	6.85*	-1.42	6.14
111A x SS003	13.56*	12.63	6.79	4.71	-0.11	-3.32	1.49	1.49	6.89	-6.38	-21.98**	-6.71	2.84	-3.89	0.63
111A x SS012	14.90*	14.39*	7.62	2.19	0.12	-12.03	2.30	1.80	7.21	1.16	-6.53	-12.12	5.13	3.38	-2.68
111A x SS020	10.45	2.30	11.93	13.50	12.01	-1.58	14.82*	6.10	31.76**	3.30	-10.89	-2.04	10.35**	1.94	9.45*
111A x SRV605	5.19	3.78	-0.56	8.88	7.50	-5.54	0.53	-8.49	17.44*	-4.13	-12.82	-15.11*	2.24	-3.03	-1.61
111A x FS9604	14.29*	12.77	8.04	20.49*	16.73	2.57	14.68*	13.87	21.66**	9.12	5.43	-9.86	14.45**	13.64**	4.91
111A x FS9605	4.45	-5.90	9.45	-3.43	-13.88	-3.42	13.54*	8.32	25.64**	20.31**	7.10	9.41	8.94**	-0.98	10.18**
111A x FS9601	-3.22	-4.17	-8.85	-3.41	-7.92	-10.75	14.94*	12.85	23.34**	5.19	-0.60	-10.96	3.71	0.35	-2.35
111A x FS9603	8.55	7.27	0.03	10.45	2.18	5.60	6.59	1.56	18.11*	-7.78	-17.92**	-16.12*	4.17	-1.90	1.06
111A x 68710	16.05**	5.68	19.99**	9.45	-6.99	16.82*	4.05	-2.01	16.80*	22.95**	16.67*	3.58	12.88**	2.81	13.88**
111A x 68724	15.09**	2.74	22.00**	23.92**	17.22*	15.49	33.32**	21.70**	28.18**	18.78**	6.96	6.45	22.37**	16.25**	17.54**
111A x 68726	16.92**	4.66	23.51**	6.35	-5.56	6.95	14.23*	11.73	23.04**	17.78**	2.29	10.64	14.00**	3.20	15.86**
111A x Co27	8.8	5.13	5.13	13.81	6.9	6.9	21.73**	18.65*	24.96**	8.45	-2.55	-2.55	13.13**	8.04*	8.04*
111A x SS032	0.45	-3.95	-1.82	2.58	-3.83	-3.42	10.30	5.84	21.27**	-1.21	-9.26	-13.59*	3.14	-2.74	-0.09
S.E.(d)	3.650	4.215	4.215	4.081	4.713	4.713	3.970	4.584	4.584	4.034	4.659	4.659	20.602	23.789	23.789
CD at 5%	7.194	8.307	8.307	8.044	9.288	9.288	7.824	9.034	9.034	7.951	9.181	9.181	40.452	46.710	46.710
CD at 1%	9.486	10.953	10.953	10.605	12.246	12.246	10.315	11.911	11.911	10.484	12.105	12.105	53.220	61.454	61.454

* Significant at 5 per cent level

** Significant at 1 per cent level

Appendix 41. Relative heterosis (di), heterobeltiosis (dii) and standard heterosis (diii) in individual environments and pooled data for leaf breadth

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
296A x 68716	-16.60	-37.05**	-1.54	24.11**	11.11	22.44*	25.87**	13.19	29.62**	-5.96	-6.46	0.19	6.31	-6.58	12.91*
296A x 68740	-22.65*	-37.47**	-2.21	21.67**	15.30	27.05*	32.67**	15.62	32.41**	5.77	-5.58	1.12	8.51	-4.94	14.90*
296A x 68918	-10.70	-10.77	39.56*	12.50	7.41	30.13*	48.33**	38.89**	59.05**	45.81**	35.25**	44.86**	21.15**	18.65**	43.40**
296A x 68876	-10.66	-24.17*	18.60	19.55**	18.62*	30.71**	9.32	7.69	27.10**	-17.42*	-20.15*	-8.41	-0.08	-3.47	16.67**
296A x 68814	-2.56	-18.57	27.35	15.96*	7.97	18.97*	30.67**	19.21*	36.51**	23.29*	5.00	12.46	16.12**	2.19	23.52**
296A x FS211	-4.45	-17.16	29.56	2.09	1.91	12.69	24.83**	20.60*	38.10**	10.45	10.19	18.57	7.88	2.93	24.41**
296A x FS205	11.21	-8.79	42.65**	18.37*	16.27*	32.82**	21.60**	13.62	49.77**	8.61	-1.28	5.73	15.23**	9.27*	32.07**
296A x FS9401	-14.23	-26.47*	15.00	-0.60	-2.36	11.54	28.37**	22.69*	40.49**	7.48	3.61	10.97	4.69	-1.21	19.41**
296A x SS003	-12.30	-25.06*	17.21	10.02	7.62	18.59*	27.78**	27.67**	46.45**	3.86	-1.40	5.61	7.12	0.77	21.73**
296A x SS012	-14.75	-26.75*	14.56	-1.08	-3.69	12.05	24.94**	24.09**	44.07**	13.89	8.49	16.2	5.35	0.71	21.73**
296A x SS020	-14.18	-27.88**	12.79	33.33**	20.65*	32.95**	28.24**	18.00*	35.12**	14.74	12.10	20.06	14.54**	3.85	25.52**
296A x SRV605	-12.61	-30.61**	8.53	-4.69	-13.67	-4.87	13.14	12.62	28.96**	18.18*	13.09	21.12	3.62	-6.05	13.52*
296A x FS9604	-13.16	-24.78*	17.65	32.26**	28.68**	41.79**	28.53**	25.41**	43.61**	19.12*	13.79	21.87*	15.96**	8.80	31.50**
296A x FS9605	-13.39	-31.73**	6.76	18.03*	2.27	12.69	15.52	3.59	18.62	-11.05	-17.10	-11.21	1.70	-11.90*	6.48
296A x FS9601	-17.42	-32.58**	5.44	5.73	-0.64	9.49	30.28**	18.40*	35.59**	13.31	2.50	9.78	7.29	-4.70	15.18*
296A x FS9603	-14.01	-30.04**	9.41	5.67	-1.80	8.21	25.96**	18.63*	35.85**	2.98	0.47	7.6	4.83	-4.66	15.23**
296A x 68710	-0.25	-13.96	34.56*	4.26	2.59	16.79	19.55*	17.13	34.13**	12.60	6.81	14.39	8.78	3.00	24.49**
296A x 68724	-3.46	-24.68*	17.79	10.77	-4.60	5.13	27.65**	6.60	22.07*	8.34	2.39	9.66	10.25	-6.16	13.42*
296A x 68726	-7.91	-30.23**	9.12	11.41	-7.45	1.99	10.75	-4.63	9.21	-8.44	-17.98	-12.15	1.08	-15.91**	1.64
296A x Co27	-10.98	-27.03*	14.12	1.25	-3.43	6.41	31.23**	22.92*	40.76**	7.46	3.90	11.28	6.88	-2.34	18.03**
296A x SS032	12.22	11.98	19.56	2.16	-5.35	21.41*	37.02**	31.17**	52.55**	14.12	5.88	5.48	6.64	3.04	24.54**
2219A x 68716	-3.63	-15.84	-10.15	14.42	2.75	12.44	22.88*	14.27	21.54*	12.48	1.47	7.54	12.15*	6.59	8.32
2219A x 68740	-10.56	-14.88	-9.12	17.44*	11.66	22.18*	35.55**	21.99*	29.75**	25.61*	24.78	6.36	17.19**	11.01*	12.81*
2219A x 68918	-23.60*	-35.69**	0.44	-6.37	-10.90	7.95	22.45*	18.75	26.31*	23.04*	18.78	8.79	2.13	-4.15	11.07
2219A x 68786	-16.21	-17.12	-9.56	0.26	-0.18	9.23	7.03	1.74	20.08	17.54	2.44	17.51	2.58	-2.44	9.91
2219A x 68814	-12.64	-13.36	-7.5	-6.55	-12.71	-4.49	8.32	2.24	8.75	21.85	14.77	-2.18	2.07	-2.82	-1.24
2219A x FS211	-12.38	-15.44	-2.94	-3.96	-4.46	5.64	3.30	3.10	10.07	15.15	3.18	11.03	0.52	-3.22	6.25
2219A x FS205	-15.14	-17.77	-12.21	-2.32	-4.38	9.23	10.63	-0.05	31.74**	18.46	16.86	2.37	3.05	-0.15	8.20
2219A x FS9401	-0.27	-2.50	8.97	-2.32	-4.38	9.23	11.7	10.65	17.69	18.87	10.41	9.72	6.68	3.88	11.42
2219A x SS003	-6.35	-8.09	1.91	0.15	-1.7	7.56	8.93	4.97	20.41	21.04*	14.11	9.84	5.80	3.36	10.11
2219A x SS012	-9.66	-11.91	-1.03	-5.74	-8.54	6.41	3.43	-0.91	15.04	15.32	8.35	5.05	0.57	-3.35	6.53
2219A x SS020	-22.34	-22.45	-17.21	14.23	3.69	13.46	24.30**	18.38	25.91*	19.22	9.33	11.71	9.23	7.45	9.20

Appendix 41 (contd..)

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
2219A x SRV605	4.33	-2.89	3.68	13.35	2.99	12.69	15.35	11.74	26.77*	9.29	2.23	0.06	10.89*	9.05	10.82
2219A x FS9604	-12.69	-15.66	-3.38	13.05	10.37	20.77*	34.93**	33.33**	45.26**	7.26	0.51	-1.99	11.19*	8.92	15.40*
2219A x FS9605	-11.43	-18.32	-12.79	10.21	-4.22	4.81	15.46	7.04	13.85	13.85	9.36	1.18	7.43	0.51	2.14
2219A x FS9601	-9.65	-12.95	-7.06	-2.95	-8.49	0.13	4.44	-1.81	4.44	17.65	16.68	1.12	2.17	-1.74	-0.15
2219A x FS9603	-8.40	-12.12	-6.18	0.79	-6.03	2.82	8.94	6.29	13.05	7.63	-1.16	0.69	2.48	1.14	2.78
2219A x 68710	-3.27	-6.10	6.47	-7.61	-9.40	3.14	0.40	-1.21	8.55	13.13	6.74	2.55	0.25	-2.72	5.09
2219A x 68724	-1.66	-10.47	-4.41	8.24	-6.50	2.31	17.41	1.06	7.49	10.90	5.03	0.12	8.85	-0.11	1.51
2219A x 68726	3.77	-8.95	-2.79	-4.92	-20.80*	-13.33	11.04	-1.31	4.97	12.57	12.28	-4.3	5.60	-5.51	-3.98
2219A x Co27	-12.52	-15.29	-9.56	-14.97*	-18.63*	-10.96	13.81	10.40	17.43	1.78	-5.73	-5.73	-2.94	-3.72	-2.15
2219A x SS032	-8.21	-8.40	-2.21	-0.11	-7.45	18.72*	5.6	1.08	17.56	12.37	4.25	3.86	2.42	-2.62	9.76
2077A x 68716	16.56	-7.26	25.00	38.35**	34.87**	23.72*	42.76**	38.02**	35.19**	39.15**	17.64	24.67*	34.10**	29.64**	27.13**
2077A x 68740	2.26	-12.27	18.24	48.69**	43.47**	41.54**	45.69**	36.13**	33.33**	30.69*	22.22	2.80	31.17**	26.38**	23.93**
2077A x 68918	4.42	-2.73	51.91**	31.53**	15.56*	40.00**	49.70**	48.21**	48.11**	36.11**	22.45	12.15	28.36**	18.49**	37.31**
2077A x 68786	20.95	9.44	47.50**	37.56**	26.95**	37.69**	12.67	3.09	21.67*	-11.47	-27.49**	-16.82	15.22**	7.75	21.40**
2077A x 68814	11.74	-0.60	33.97*	24.96**	22.81*	16.67	47.57**	44.93**	41.95**	49.75**	47.64**	11.21	32.08**	27.92**	25.44**
2077A x FS211	7.72	-0.27	34.41*	25.98**	15.25	27.44**	26.25**	21.04*	29.22**	22.61*	3.01	10.84	20.33**	13.90*	25.04**
2077A x FS205	2.16	-10.97	20.00	8.93	-1.80	12.18	34.99**	17.65*	55.07**	19.33	9.53	-4.05	16.60**	11.06	20.35**
2077A x FS9401	0.33	-8.24	23.68	14.16	2.92	17.56	20.54*	16.83	21.94*	26.28*	9.66	8.97	14.70**	9.78	17.75**
2077A x SS003	5.48	-3.87	29.56	18.11*	10.46	16.41	14.55	6.18	21.80*	28.38*	13.01	8.79	16.03**	11.42	18.69**
2077A x SS012	-6.69	-14.46	15.29	10.54	-1.16	15.00	19.88*	10.50	28.30**	29.26**	13.43	9.97	12.40*	6.19	17.05**
2077A x SS020	7.53	-3.76	29.71	28.94**	27.18**	16.67	32.15**	30.99**	28.30**	25.97*	8.11	10.47	23.10**	22.94**	20.87**
2077A x SRV605	0.13	-15.77	13.53	36.02**	34.31**	23.21*	13.79	6.02	20.28	10.63	-3.31	-5.36	14.81**	14.69*	12.69*
2077A x FS9604	5.81	-2.13	31.91	14.75	7.87	12.44	27.03**	20.62*	31.41**	22.99*	7.67	4.98	17.24**	12.87*	19.59**
2077A x FS9605	9.91	-8.29	23.6	31.40**	23.55*	13.33	27.06**	22.46*	19.95	28.57*	15.15	6.54	23.79**	17.76**	15.50*
2077A x FS9601	5.95	-8.13	23.82	9.55	6.61	3.33	15.95	13.40	11.07	30.32*	20.20	4.17	14.76**	12.29*	10.11
2077A x FS9603	10.14	-4.86	28.24	15.72	13.96	7.82	17.20	15.32	16.70	29.18**	11.01	13.08	17.79**	17.25**	16.04*
2077A x 68710	11.88	3.00	38.82*	23.11**	11.15	26.54**	16.14	9.83	20.68*	14.83	1.17	-2.80	16.49**	11.12	20.04**
2077A x 68724	8.83	-10.20	21.03	30.42**	21.80*	11.73	31.41**	17.19	14.78	25.99*	11.37	6.17	23.65**	15.35**	13.11*
2077A x 68726	9.66	-12.38	18.09	22.43*	9.85	0.77	13.21	4.40	2.25	36.36**	27.04*	7.73	19.90**	9.01**	6.89
2077A x Co27	12.12	-2.35	31.62	31.06**	25.64**	25.64**	16.71	15.51	15.51	33.81**	15.89	15.89	23.05**	21.86**	21.86**
2077A x SS032	21.99	9.11	47.06**	11.66	-4.25	22.82*	10.73	1.99	18.62	13.12	-1.88	-2.24	14.40**	6.97	20.57**
1111A x 68716	11.6	-15.48	30.88	26.95**	10.39	30.13**	14.17	-5.13	31.08**	-17.78*	-24.03**	-5.05	7.85	-9.01**	21.18**
1111A x 68740	1.46	-17.66	27.50	16.52*	7.01	26.15**	8.76	-12.13	21.40*	16.21	-2.79	21.50*	10.70*	-6.87**	24.03**
1111A x 68918	-16.5	-16.85	29.85	13.54*	12.01	35.71**	18.45*	2.06	41.02**	11.62	-3.29	20.87	5.82	-1.06*	31.77**
1111A x 68786	19.72	2.04	58.01**	21.95**	17.07*	38.01**	1.19	-6.19	29.62**	-3.77	-7.73	15.33	9.33*	0.91	34.39**
1111A x 68814	-2.55	-18.23	26.62	8.64	-1.900	15.64	7.58	-9.45	25.12*	21.31*	-2.79	21.50*	8.45	-8.36*	22.04**

Appendix 41 (contd..)

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
111A x FS211	2.97	-10.35	38.82*	17.51*	13.87	34.23**	1.95	-9.64	24.85*	7.74	0.25	25.30*	7.46	-1.98	30.54**
111A x FS205	-1.61	-18.99	25.44	24.94**	23.00**	45.00**	0.74	-1.58	35.98**	14.54	-2.59	21.74*	9.42*	-0.77	32.15**
111A x FS9401	-1.38	-15.10	31.47	13.67*	11.91	31.92**	9.84	-3.60	33.20**	3.69	-6.93	16.32	6.47	-3.89	27.99**
111A x SS003	11.68	-4.18	48.38**	7.84	2.12	20.38*	4.82	-4.08	32.54**	7.07	-5.23	18.44	7.81	-2.97	29.22**
111A x SS012	-10.40	-22.70*	19.71	6.19	5.49	24.36**	3.41	-4.84	31.48**	12.52	-0.10	24.86*	2.89	-5.97	25.22**
111A x SS020	-17.61	-30.48**	7.65	16.50*	2.34	20.64*	18.74*	0.72	39.17**	2.25	-7.08	16.14	4.67	-9.03*	21.15**
111A x SRV605	-18.56	-35.09**	0.51	10.82	-2.56	14.87	10.40	0.53	38.90**	-4.56	-14.91	6.36	-0.29	-13.36**	15.38*
111A x FS9604	-19.43	-29.91**	8.53	7.24	1.03	19.10*	9.09	-2.45	34.79**	6.24	-5.43	18.19	0.70	-9.59*	20.40**
111A x FS9605	1.08	-20.04	23.82	28.94**	8.65	28.08**	11.92	-7.24	28.16**	8.85	-5.28	18.38	12.36*	-6.47	24.56**
111A x FS9601	-2.43	-20.04	23.82	14.35	4.19	22.82*	23.16**	3.31	42.74**	3.62	-12.26	9.66	9.71*	-6.50	24.53**
111A x FS9603	-0.47	-18.71	25.88	22.59**	10.49	30.26**	14.51	-0.82	37.04**	-5.69	-14.41	6.98	7.50	-6.31	24.78**
111A x 68710	4.17	-9.78	39.71*	7.55	5.71	24.62**	1.42	-8.97	25.78*	10.03	-2.69	21.62*	5.73	-4.26	27.51**
111A x 68724	6.37	-16.71	28.97	22.95**	2.99	21.41*	16.81*	-9.16	25.51*	8.77	-4.14	19.81	13.47**	-7.11	23.72**
111A x 68726	4.18	-20.80*	22.65	4.57	-15.39*	-0.26	3.93	-16.93*	14.78	4.31	-12.46	9.41	4.24	-16.48**	11.24
111A x Co27	-2.25	-19.56	24.56	13.09	4.51	23.21*	13.52	-2.16	35.19**	-4.18	-13.76	7.79	4.99	-8.09	22.41**
111A x SS032	3.60	-12.63	35.29*	-3.75	-7.65	18.46*	12.19	3.31	42.74**	10.79	-0.45	24.42*	5.67	-2.45	29.91**
S.E.(d)	0.641	0.740	0.740	0.413	0.477	0.477	0.454	0.525	0.525	0.500	0.577	0.577	0.2738	0.3162	0.3162
CD at 5%	1.264	1.459	1.459	0.814	0.940	0.940	0.895	1.034	1.034	0.985	1.138	1.138	0.5377	0.6209	0.6209
CD at 1%	1.666	1.924	1.924	1.073	1.239	1.239	1.180	1.363	1.363	1.299	1.500	1.500	0.7074	0.8169	0.8169

* Significant at 5 per cent level

** Significant at 1 per cent level

Appendix 42. Relative heterosis (di), heterobeltiosis (dii) and standard heterosis (diii) in individual environments and pooled data for leaf stem ratio

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
296A x 68716	-42.86**	-55.00**	-15.62*	-25.00**	-44.07**	-13.16**	-6.45	-9.38	-3.33	-38.06**	-44.19**	-5.88	-27.46**	-39.87**	-9.72**
296A x 68740	-25.81**	-42.50**	7.81	-38.46**	-52.54**	-26.32**	-6.45	-9.38	-3.33	4.19	1.16	70.59**	-19.46**	-31.73**	2.51
296A x 68918	-35.29**	-45.00**	3.12	-34.78**	-49.15**	-21.05**	-31.25**	-31.25**	-26.67**	0.62	-5.81	58.82**	-27.25**	-36.74**	-5.02
296A x 68786	-38.24**	-47.50**	-1.56	-44.83**	-59.32**	-36.84**	-3.23	-6.25	0.00	-4.35	-10.47	50.98**	-25.62**	-36.95**	-5.33
296A x 68814	-29.58**	-37.50**	17.19*	-33.33**	-49.15**	-21.05**	-15.15**	-17.65**	-6.67	40.51**	19.07**	117.65**	-14.18**	-24.84**	12.85**
296A x FS211	-33.67**	-45.00**	3.12	-22.27**	-45.76**	-15.79**	-20.75**	-34.38**	-30.00**	-15.85**	29.77**	35.29**	-23.54**	-38.62**	-7.84*
296A x FS205	-38.46**	-50.00**	-6.25	-33.33**	-50.85**	-23.68**	-12.90**	-15.62**	-10.00	-21.74**	-26.74**	23.53*	-27.52**	-39.25**	-8.78**
296A x FS9401	-41.54**	-52.50**	-10.94	-31.82**	-49.15**	-21.05**	-4.92	-9.38	-3.33	-13.16*	-23.26**	29.41**	-24.43**	-37.37**	-5.96
296A x SS003	-36.23**	-45.00**	3.12	-31.82**	-49.15**	-21.05**	-12.28*	-21.87**	-16.67**	-20.25**	-26.74**	23.53*	-26.50**	-38.62**	-7.84*
296A x SS012	-42.86**	-55.00**	-15.62*	-24.70**	-47.46**	-18.42**	-32.20**	-37.50**	-33.33**	-26.45**	-33.72**	11.76	-31.25**	-44.89**	-17.24**
296A x SS020	-33.68**	-47.50**	-1.56	-27.71**	-49.15**	-21.05**	-7.41	-21.87**	-16.67**	-13.70*	-26.74**	23.53*	-22.09**	-39.25**	-8.78**
296A x SRV605	-39.68**	-52.50**	-10.94	-2.33	-28.81**	10.53*	-17.24**	-25.00**	-20.00**	24.29**	1.16	70.59**	-10.12**	-28.60**	7.21*
296A x FS9604	-42.86**	-55.00**	-15.62*	-34.78**	-49.15**	-21.05**	43.86**	28.13**	36.67**	-19.40**	-37.21**	5.88	-16.62**	-32.99**	0.63
296A x FS9605	-39.39**	-50.00**	-6.25	-40.91**	-55.93**	-31.58**	-12.90**	-15.62**	-10.00	-3.50	-19.77**	35.29**	-27.18**	-39.87**	-9.72**
296A x FS9601	-35.48**	-50.00**	-6.25	-33.33**	-52.54**	-26.32**	-11.54*	-28.12**	-23.33**	-7.10	-16.28**	41.18**	-23.90**	-40.50**	-10.66**
296A x FS9603	-25.00**	-40.00**	12.50	-32.58**	-49.15**	-21.05**	-11.11*	-12.50*	-6.67	-27.85**	-33.72**	11.76	-24.81**	-36.74**	-5.02
296A x 68710	-38.71**	-52.50**	-10.94	-45.65**	-57.63**	-34.21**	-38.89**	-45.00**	-26.67**	-7.94	-15.53**	70.59**	-34.26**	-40.50**	-10.66**
296A x 68724	-45.45**	-55.00**	-15.62*	-36.26**	-50.85**	-23.68**	-38.24**	-41.67**	-30.00**	-7.69	-23.26**	29.41**	-33.99**	-43.63**	-15.36**
296A x 68726	-35.38**	-47.50**	-1.56	-42.86**	-59.32**	-36.84**	-30.16**	-41.67**	-26.67**	-1.37	-16.28**	41.18**	-30.18**	-43.01**	-14.42**
296A x Co27	-28.26**	-45.00**	3.12	-34.02**	-45.76**	-15.79**	-12.90**	-15.62**	-10.0	-16.79**	-33.72**	11.76	-24.81**	-37.37**	-5.96
296A x SS032	-36.36**	-38.24**	-1.56	-12.90**	-22.86**	-28.95**	-10.34*	-18.75**	-13.33*	-34.48**	-48.65**	11.76	-29.99**	-41.75**	-12.54**
2219A x 68716	-19.30**	-32.35**	7.81	-12.50**	-20.00**	-26.32**	0.00	-3.12	3.33	-20.00**	-35.14**	41.18**	-12.76**	-23.19**	-0.31
2219A x 68740	-25.00**	-38.24**	12.50	0.00	-2.86	-10.53*	-9.68*	-12.50*	-6.67	-25.00**	-35.14**	41.18**	-17.27**	-25.36**	-3.13
2219A x 68918	-25.81**	-32.35**	7.81	1.59	-8.57	-15.79**	-18.75**	-18.75**	-13.33*	-29.03**	-40.54**	29.41**	-17.19**	-23.19**	-0.31
2219A x 68786	-35.38**	-38.24**	-1.56	-9.09*	-14.29**	-21.05**	-18.18**	-20.59**	-10.00	-32.26**	-43.24**	23.53*	-14.86**	-23.19**	-0.31
2219A x 68814	-17.13**	-26.47**	17.19*	-4.00	-20.00**	-26.32**	-16.98**	-31.25**	-26.67**	-27.87**	-40.54**	29.41**	-22.48**	-27.54**	-5.96
2219A x FS211	-11.86*	-23.53**	21.87**	4.76	-5.71	-13.16**	0.00	-3.12	3.33	-33.33**	-43.24**	23.53*	-18.18**	-30.43**	-9.72**
2219A x FS205	-18.64**	-29.41**	12.50	-3.12	-11.43*	-18.42**	-1.64	-6.25	0.00	-15.25**	-48.65**	11.76	-11.38**	-21.01**	2.51
2219A x FS9401	-23.81**	-29.41**	12.50	-3.12	-11.43*	-18.42**	12.28*	0.00	6.67	-34.43**	-45.95**	17.65	-9.47**	-20.29**	3.45
2219A x SS003	-33.33**	-44.12**	-10.94	-0.57	-17.14**	-23.68**	-8.47	-15.62**	-10.00	-40.00**	-51.35**	5.88	-12.65**	-22.46**	0.63
2219A x SS012	-16.28**	-29.41**	12.5	8.47	-8.57	-15.79**	11.11*	-6.25	0.00	-33.33**	-48.65**	11.76	-7.62**	-23.91**	-1.25

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
2219A x SRV605	-19.30**	-32.35**	7.81	-6.45	-17.14**	-23.68**	-6.9	-15.62**	-10	-34.55**	-51.35**	5.88	-16.38**	-29.71**	-8.78**
2219A x FS9604	-8.77	-32.53**	21.87**	-2.94	-5.71	-13.16**	-1.75	-12.50*	-6.67	-32.08**	-51.35**	5.88	-10.64**	-23.91**	-1.25
2219A x FS9605	-6.67	-17.65**	31.25**	-3.12	-11.43*	-18.42**	-3.23	-6.25	0.00	-17.86**	-37.84**	35.29**	-7.44**	-18.84**	5.33
2219A x FS9601	-25.00**	-38.24**	-1.56	-16.67**	-28.57**	-34.21**	3.85	-15.62**	-10.00	-26.67**	-40.54**	29.41**	-16.67**	-31.16**	-10.66**
2219A x FS9603	-20.69**	-32.35**	7.81	-13.85**	-20.00**	-26.32**	-20.63**	-21.87**	-16.67**	-34.43**	-45.95**	17.65	-22.27**	-30.43**	-9.72**
2219A x 68710	-17.86**	-32.35**	7.81	-2.94	-5.71	-13.16**	-33.33**	-40.00**	-20.00**	-52.34**	-54.05**	0.00	-27.43**	-29.71**	-8.78**
2219A x 68724	-20.00**	-29.41**	12.5	-13.43**	-17.14**	-23.68**	-32.35**	-36.11**	-23.33**	-25.00**	-43.24**	23.53*	-22.71**	-29.71**	-8.78**
2219A x 68726	-22.03**	-32.35**	7.81	-3.33	-17.14**	-23.68**	-26.98**	-28.12**	-23.33**	-22.81**	-40.54**	29.41**	-18.83**	-29.71**	-8.78**
2219A x Co27	-6.02	-23.53**	21.87**	-20.55**	-23.68**	-23.68**	-29.03**	-31.25**	-26.67**	-7.41	-32.43**	47.06**	-16.51**	-26.09**	-4.08
2219A x SS032	-33.33**	-35.29**	3.12	-3.23	-14.29**	-21.05**	-6.90	-15.62**	-10.00	-24.14**	-40.54**	29.41**	-17.21**	-26.81**	-5.02
2077A x 68716	-3.85	-13.79*	17.19*	-16.67**	-30.23**	-21.05**	-37.14**	-45.00**	-26.67**	-46.15**	-51.72**	17.65	-26.02**	-35.46**	-14.42**
2077A x 68740	-21.57**	-31.03**	-6.25	-17.33**	-27.91**	-18.42**	-22.86**	-32.50**	-10.00	-18.57**	-31.03**	17.65	-22.22**	-30.50**	-7.84*
2077A x 68918	-15.79**	-17.24**	12.50	-23.68**	-32.56**	-23.68**	-30.56**	-37.50**	-16.67**	-29.63**	-20.69**	105.88**	-12.74**	-19.86**	6.27*
2077A x 68786	-26.32**	-27.59**	-1.56	-26.76**	-39.53**	-31.58**	-20.00**	-30.00**	-6.67	-18.52**	-24.14**	29.41**	-23.02**	-31.21**	-8.78**
2077A x 68814	-23.33**	-25.81**	7.81	-18.92**	-30.23**	-21.05**	-13.51**	-20.00**	6.67	-32.08**	-37.93**	5.88	-21.07**	-26.95**	-3.13
2077A x FS211	1.20	-3.45	31.25**	-21.61**	-39.53**	-31.58**	-31.15**	-47.50**	-30.00**	-30.91**	-34.48**	11.76	-20.90**	-33.33**	-11.60**
2077A x FS205	-22.22**	-27.59**	-1.56	-9.86*	-25.58**	-15.79**	-31.43**	-40.00**	-20.00**	-22.22**	-27.59**	23.53*	-21.29**	-30.50**	-7.84*
2077A x FS9401	-29.63**	-34.48**	-10.94	-25.00**	-37.21**	-28.95**	-42.03**	-50.00**	-33.33**	-21.57**	-31.03**	17.65	-30.08**	-39.01**	-19.12**
2077A x SS003	-20.69**	-20.69**	7.81	-19.44**	-32.56**	-23.68**	-32.31**	-45.00**	-26.67**	-35.85**	-41.38**	0.00	-26.61**	-35.46**	-14.42**
2077A x SS012	-11.54*	-20.69**	7.81	-3.52	-25.58**	-15.79**	-34.33**	-45.00**	-26.67**	-30.77**	-37.93**	5.88	-19.94**	-32.62**	-10.66**
2077A x SS020	-23.57**	-31.03**	-6.25	-22.39**	-39.53**	-31.58**	-3.23	-25.00**	0.00	18.37**	0.00	70.59**	-8.83**	-25.53**	-1.25
2077A x SRV605	-46.15**	-51.72**	-34.38**	-28.57**	-41.86**	-34.21**	-9.09*	-25.00**	0.00	-23.40**	-37.93**	5.88	-25.96**	-38.30**	-18.18**
2077A x FS9604	-26.92**	-34.48**	-10.94	-15.79**	-25.58**	-15.79**	-7.69	-25.00**	0.00	-20.00**	-37.93**	5.88	-16.81**	-29.79**	-6.90*
2077A x FS9605	-9.09	-13.79*	17.19*	-19.44**	-32.56**	-23.68**	-37.14**	-45.00**	-26.67**	-12.50*	-27.59**	23.53*	-20.82**	-31.21**	-8.78**
2077A x FS9601	-17.65**	-27.59**	-1.56	-17.65**	-34.88**	-26.32**	-13.33**	-35.00**	-13.33*	-7.69	-17.24**	41.18**	-14.29**	-29.79**	-6.90*
2077A x FS9603	-20.75**	-27.59**	-1.56	-28.77**	-39.53**	-31.58**	-23.94**	-32.50**	-10.00	-28.30**	-34.48**	11.76	-25.60**	-34.04**	-12.54**
2077A x 68710	-13.73*	-24.14**	3.12	-28.95**	-37.21**	-28.95**	-30.00**	-30.00**	-6.67	-33.68**	-38.83**	23.53*	-27.50**	-30.50**	-7.84*
2077A x 68724	-9.09	-13.79*	17.19*	-28.00**	-37.21**	-28.95**	-39.47**	-42.50**	-23.33**	-25.00**	-37.93**	5.88	-26.77**	-34.04**	-12.54**
2077A x 68726	-40.74**	-44.83**	-25.00**	-26.47**	-41.86**	-34.21**	-26.76**	-35.00**	-13.33*	-14.29*	-27.59**	23.53*	-27.27**	-37.59**	-17.24**
2077A x Co27	-8.61	-20.69**	7.81	-40.74**	-44.19**	-36.84**	-28.57**	-37.50**	-16.67**	-13.04*	-31.03**	17.65	-25.61**	-34.75**	-13.48**
2077A x SS032	-47.54**	-50.00**	-25.00**	-20.00**	-34.88**	-26.32**	-24.24**	-37.50**	-16.67**	-24.00**	-34.48**	11.76	-28.74**	-37.59**	-17.24**
1111A x 68716	-20.75**	-30.00**	-1.56	-24.64**	-35.00**	-31.58**	-25.00**	-29.41**	-20.00**	-10.34*	-25.71**	52.94**	-20.49**	-30.22**	-8.78**
1111A x 68740	-15.38**	-26.67**	3.12	-13.89**	-22.50**	-18.42**	-12.50**	-17.65**	-6.67	-25.81**	-34.29**	35.29**	-16.80**	-25.18**	-2.19
1111A x 68918	-6.9	-10	26.56**	-23.29**	-30.00**	-26.32**	-48.48**	-50.00**	-43.33**	-23.33**	-34.29**	35.29**	-26.07**	-31.65**	-10.66**
1111A x 68786	-27.59**	-30.00**	-1.56	-14.71**	-27.50**	-23.68**	-15.62**	-20.59**	-10.00	-20.00**	-31.43**	41.18**	-19.20**	-27.34**	-5.02
1111A x 68814	-31.15**	-32.26**	-1.56	-29.58**	-37.50**	-34.21**	-26.47**	-26.47**	-16.67**	-25.42**	-37.14**	29.41**	-28.19**	-33.09**	-12.54**

Appendix 42 (contd...)

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
111A x FS211	-25.44**	-30.00**	-1.56	-21.05**	-37.50**	-34.21**	-34.55**	-47.06**	-40.00**	-31.15**	-40.00**	23.53*	-27.86**	-38.85**	-20.06**
111A x FS205	-16.36**	-23.33**	7.81	-23.53**	-35.00**	-31.58**	-12.50**	-17.65**	-6.67	-40.00**	-48.57**	5.88	-23.08**	-31.65**	-10.66**
111A x FS9401	-34.55**	-40.00**	-15.62*	-24.64**	-35.00**	-31.58**	-14.29**	-20.59**	-10.00	-33.33**	-45.71**	11.76	-26.23**	-35.25**	-15.36**
111A x SS003	-32.20**	-33.33**	-6.25	-10.14*	-22.50**	-18.42**	-25.42**	-35.29**	-26.67**	-25.42**	-37.14**	29.41**	-22.76**	-31.65**	-10.66**
111A x SS012	-20.75**	-30.00**	-1.56	-11.58**	-30.00**	-26.32**	-34.43**	-41.18**	-33.33**	-34.48**	-45.71**	11.76	-25.21**	-36.69**	-17.24**
111A x SS020	-13.75*	-23.33**	7.81	9.38*	-12.50**	-7.89	-3.57	-20.59**	-10.00	-38.18**	-51.43**	0.00	-10.66**	-26.62**	-4.08
111A x SRV605	-28.30**	-36.67**	-10.94	-13.43**	-27.50**	-23.68**	-3.33	-14.71**	-3.33	-32.08**	-48.57**	5.88	-18.45**	-31.65**	-10.66**
111A x FS9604	-9.43	-20.00**	12.50	1.37	-7.50	-2.63	1.69	-11.76*	0.00	-29.41**	-48.57**	5.88	-7.63**	-21.58**	2.51
111A x FS9605	-25.00**	-30.00**	-1.56	-10.14*	-22.50**	-18.42**	-28.12**	-32.35**	-23.33**	-40.74**	-54.29**	-5.88	-25.10**	-34.33**	-14.42**
111A x FS9601	-26.92**	-36.67**	-10.94	-29.23**	-42.50**	-39.47**	11.11*	-11.76*	0.00	-27.59**	-40.00**	23.53*	-18.78**	-33.09**	-12.54**
111A x FS9603	-25.93**	-33.33**	-6.25	-22.86**	-32.50**	-28.95**	-10.77*	-14.71**	-3.33	-25.42**	-37.14**	29.41**	-20.97**	-29.50**	-7.84*
111A x 68710	-15.38**	-26.67**	3.12	-26.03**	-32.50**	-28.95**	-34.05**	-57.50**	-43.33**	-45.19**	-45.71**	11.76	-36.65**	-38.85**	-20.06**
111A x 68724	-17.86**	-23.33**	7.81	-22.22**	-30.00**	-26.32**	-37.14**	-38.89**	-26.67**	-25.93**	-42.86**	17.65	-26.19**	-33.09**	-12.54**
111A x 68726	-20.00**	-26.67**	3.12	-10.77*	-27.50**	-23.68**	-29.23**	-32.35**	-23.33**	-20.00**	-37.14**	29.41**	-20.00**	-30.94**	-9.72**
111A x Co27	-10.39	-23.33**	7.81	-28.21**	-30.00**	-26.32**	-21.87**	-26.47**	-16.67**	-26.92**	-45.71**	11.76	-22.55**	-31.65**	-10.66**
111A x SS032	-25.81**	-28.12**	7.81	-16.42**	-30.00**	-26.32**	-26.67**	-35.29**	-26.67**	-21.43**	-37.14**	29.41**	-22.45**	-31.65**	-10.66**
S.E.(d)	0.014	0.017	0.017	0.014	0.016	0.016	0.014	0.016	0.016	0.014	0.016	0.016	0.0070	0.0081	0.0081
CD at 5%	0.028	0.033	0.033	0.027	0.031	0.031	0.028	0.032	0.032	0.028	0.032	0.032	0.0137	0.0159	0.0159
CD at 1%	0.037	0.043	0.043	0.036	0.041	0.041	0.036	0.042	0.042	0.036	0.042	0.042	0.0181	0.0209	0.0209

* Significant at 5 per cent level

** Significant at 1 per cent level

Appendix 43. Relative heterosis (di), heterobeltosis (dii) and standard heterosis (diii) in individual environments and pooled data for stem thickness

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
296A x 68716	-1.81	-23.18*	6.15	1.13	-8.18	-0.68	8.33	0.00	3.66	5.66	-2.77	1.53	3.18	-9.42	2.57
296A x 68740	2.25	-20.22*	10.24	7.64	7.39	16.16	22.02	11.13	15.20	5.02	-9.77	-5.78	8.93	-3.91	8.81
296A x 68918	-0.79	-7.41	27.93*	-13.89	-17.61	-10.88	28.43*	21.9	40.66*	22.62*	21.82	27.21*	8.69	6.61	20.72**
296A x 68786	11.93	-7.68	27.56*	-3.99	-5.35	2.38	23.02	21.03	29.67	-0.27	-9.77	-5.78	7.55	-0.35	12.84
296A x 68814	20.33	-1.48	36.13**	-5.76	-15.09	-8.16	16.51	10.95	15.02	10.82	8.47	13.27	10.54	0.27	13.55
296A x FS211	6.25	-10.65	23.46	-0.75	-6.13	1.53	33.84*	25.44	30.04	2.80	1.63	6.12	9.78	1.41	14.83*
296A x FS205	-15.23	-31.00**	-4.66	-2.35	-5.35	2.38	27.29*	26.84	32.42	13.81	4.72	9.35	5.37	-3.05	9.78
296A x FS9401	-9.15	-25.07*	3.54	-18.55	-18.55	-11.90	26.09	25.00	31.87	11.58	-0.33	4.08	1.63	-5.94	6.51
296A x SS003	2.14	-16.31	15.64	-20.10	-24.69*	-18.54	33.21*	27.21	31.87	-2.20	-5.70	-1.53	2.52	-6.22	6.20
296A x SS012	-8.49	-21.56*	8.38	-17.91	-18.55	-11.90	21.95	21.73	26.19	14.34	-4.56	-0.34	1.30	-7.15	5.14
296A x SS020	1.47	-16.31	15.64	10.47	8.65	17.52	30.95*	29.26	37.55*	15.92	2.61	7.14	14.38*	5.28	19.21**
296A x SRV605	3.50	-20.35*	10.06	-24.72*	-25.31*	-19.22	16.90	0.38	45.05**	20.85	6.68	11.39	3.78	-1.76	11.24
296A x FS9604	10.68	-11.99	21.60	7.15	3.62	12.07	58.50**	49.82**	55.31**	20.41	5.21	9.86	23.26**	9.70	24.21**
296A x FS9605	-6.14	-20.62*	9.68	-20.65*	-21.33	-13.44	14.47	11.84	15.93	-12.26	-22.48	-19.05	-6.66	-13.72*	-2.30
296A x FS9601	-10.97	-22.91*	6.52	-14.10	-18.55	-11.90	25.81	20.14	24.54	16.70	1.30	5.78	3.15	-6.49	5.89
296A x FS9603	-2.23	-20.22*	10.24	-6.73	-12.89	-5.78	5.13	4.95	8.79	0.18	-9.61	-5.61	-1.01	-10.28	1.59
296A x 68710	19.15	-5.66	30.35*	-23.03*	-23.57*	-16.16	0.92	-3.99	10.26	-3.57	-5.37	-1.19	-2.10	-7.11	5.18
296A x 68724	5.47	-9.03	25.70	-16.06	-24.37*	-18.20	20.08	3.53	7.33	-7.46	-14.17	-10.37	-0.07	-11.30*	0.44
296A x 68726	7.27	-12.53	20.86	-14.54	-25.63*	-19.56	-10.30	-11.48	-8.24	-7.43	-19.87	-16.33	-5.94	-17.32**	-6.37
296A x Co27	0.23	-13.61	19.37	-15.20	-18.40	-11.73	16.19	14.13	18.32	-16.47	-18.24	-14.63	-4.17	-9.77	2.17
296A x SS032	22.59	15.44	25.33	-13.97	-21.60*	0.00	17.09	10.95	29.85	7.90	-4.82	-5.95	0.06	-1.37	11.69
2219A x 68716	15.97	-0.34	8.19	2.46	-5.67	-1.02	30.73*	20.10	25.82	26.46*	17.64	3.23	18.44**	10.88	8.76
2219A x 68740	-1.90	-15.95	-8.75	-10.40	-11.53	-4.76	32.50*	20.10	25.82	25.88	25.45	-5.27	10.00	3.52	1.55
2219A x 68918	-4.24	-8.71	9.31	-4.67	-7.46	-2.89	5.16	0.32	15.75	25.52*	8.75	12.07	4.75	-0.45	8.41
2219A x 68786	1.78	-7.03	0.93	-11.58	-11.65	-7.14	8.73	7.52	15.20	38.79**	31.39*	11.05	7.78	6.95	4.91
2219A x 68814	4.36	-5.49	2.61	-8.07	-16.05	-11.90	5.54	0.00	4.76	10.47	-3.06	-3.06	2.86	-0.23	-2.12
2219A x FS211	-3.95	-10.29	-2.61	-8.95	-12.64	-8.33	13.40	5.77	10.81	20.31	4.67	6.80	4.70	3.56	1.59
2219A x FS205	-5.82	-15.27	-8.01	-6.10	-7.62	-3.06	7.71	7.52	12.64	18.54	10.27	-3.23	3.00	1.44	-0.49
2219A x FS9401	-13.05	-20.58	-13.78	-11.25	-12.58	-5.44	7.49	7.12	13.00	28.16*	22.98	1.02	1.53	0.63	-1.28
2219A x SS003	-5.20	-14.07	-6.70	-1.86	-6.16	-1.53	16.65	10.84	16.12	17.95	4.91	1.70	6.59	4.33	2.35
2219A x SS012	-9.25	-13.38	-5.96	-12.95	-13.58	-7.99	33.10*	32.17*	38.46*	38.25*	33.11*	0.51	10.10	7.99	5.93
2219A x SS020	-11.36	-19.04	-12.10	-21.92*	-22.04	-18.20	14.31	13.43	20.70	43.73**	39.32*	12.07	4.01	2.48	0.53

Appendix 43 (contd..)

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	Di	dii	diii	Di	dii	diii	di	dii	diii	di	dii	diii
2219A x SRV605	3.56	-12.69	-5.21	-13.11	-13.74	-8.16	-4.92	-18.00	18.50	31.95*	28.30	2.55	2.16	0.61	1.77
2219A x FS9604	-12.44	-23.33	-16.76	-17.09	-18.64	-14.63	36.80*	28.67	34.80*	35.11*	32.90*	3.74	9.00	3.56	1.59
2219A x FS9605	-10.04	-15.44	-8.19	-17.88	-19.78	-11.73	6.83	3.85	8.79	25.03	21.44	-2.72	0.00	-1.71	-3.59
2219A x FS9601	-0.89	-4.29	3.91	-13.40	-16.69	-12.59	10.76	5.24	10.26	29.69*	28.54	-1.19	4.98	1.76	-0.18
2219A x FS9603	-9.70	-18.52	-11.55	-19.08	-23.34*	-19.56	13.73	12.94	18.32	21.32	15.18	-3.23	0.72	-2.39	-4.25
2219A x 68710	4.72	-8.75	-0.93	-14.26	-16.12	-7.99	17.26	12.12	28.75	8.99	-4.57	-4.08	3.72	1.92	3.59
2219A x 68724	3.66	-0.34	8.19	0.98	-7.78	-3.23	21.18	4.02	8.97	29.00*	19.05	6.29	12.88	6.95	4.91
2219A x 68726	7.71	-2.92	5.40	-6.07	-17.18	-13.10	2.58	0.70	5.49	20.04	19.38	-8.84	5.37	-1.22	-3.10
2219A x Co27	0.71	-3.26	5.03	-11.37	-13.45	-9.18	9.66	7.17	12.27	17.25	2.89	2.89	3.51	2.52	2.52
2219A x SS032	12.57	6.00	15.08	-4.17	-12.67	11.39	18.25	12.05	31.14	20.78	6.54	5.27	10.96	4.95	15.45*
2077A x 68716	15.04	-7.3	18.25	17.37	11.65	9.18	38.68*	34.98	25.09	26.45*	24.61	9.35	23.95**	14.82**	15.23*
2077A x 68740	23.71*	-0.58	26.82	13.91	8.69	17.01	44.80**	38.93*	28.75	26.11	18.56	1.02	26.29**	17.60**	18.02*
2077A x 68918	9.49	6.13	35.38*	19.55	18.93	17.52	29.75*	16.98	34.98*	7.50	-1.82	1.19	16.35**	11.79	21.74**
2077A x 68786	34.36**	14.45	46.00**	10.65	6.8	12.24	45.74**	35.90*	45.60**	20.24	19.76	2.04	27.62**	25.23**	25.68**
2077A x 68814	15.20	-2.63	24.21	11.89	5.57	3.23	50.29**	49.41**	40.11*	1.93	-5.61	-5.61	19.26**	14.42**	14.83*
2077A x FS211	4.95	-8.76	16.39	6.83	6.09	3.74	43.66**	42.09*	31.68	6.99	-1.83	0.17	14.68*	12.17	12.57
2077A x FS205	-4.78	-20.00	2.05	0.51	-1.34	0.17	48.70**	40.35*	46.52**	2.26	0.78	-11.56	11.28	8.38	8.76
2077A x FS9401	3.17	-12.12	12.10	5.04	0.00	8.16	28.47	20.66	27.29	12.20	10.18	-6.12	11.84	9.62	10.00
2077A x SS003	-9.23	-23.21*	-2.05	4.75	3.65	1.36	36.73*	35.53*	27.84	-6.26	-11.93	-14.63	5.81	2.43	2.79
2077A x SS012	-1.56	-12.70	11.36	-2.58	-6.55	-0.51	35.51*	28.55	32.78*	15.35	4.99	-10.54	10.69	7.37	7.75
2077A x SS020	-8.65	-22.19*	-0.74	1.85	-1.46	3.06	28.43*	20.14	27.84	14.58	11.38	-5.10	8.42	5.65	6.02
2077A x SRV605	14.29	-9.49	15.46	8.74	4.31	11.05	16.29	-4.56	37.91*	0.51	-2.59	-17.01	10.46	10.02	11.29
2077A x FS9604	4.01	-14.74	8.75	-10.18	-11.62	-10.71	37.23*	36.96*	26.92	11.46	6.79	-9.01	9.67	3.09	3.45
2077A x FS9605	-6.84	-18.54	3.91	5.07	-0.77	9.18	19.12	15.37	14.10	16.05	12.57	-4.08	7.57	5.29	5.67
2077A x FS9601	19.06	6.72	36.13**	10.57	10.09	7.65	22.62	21.55	14.65	10.81	5.39	-10.20	15.85*	11.07	11.47
2077A x FS9603	45.23**	22.34*	56.05**	4.88	2.78	0.51	21.12	14.89	18.68	21.21	20.36	2.55	23.33**	18.22**	18.64**
2077A x 68710	12.88	-7.88	17.50	4.10	-1.55	7.99	19.15	7.66	23.63	1.28	-6.43	-5.95	9.31	8.62	10.40
2077A x 68724	6.95	-4.53	21.79	9.68	3.48	1.19	55.90**	41.11*	30.77	-2.92	-5.14	-15.31	15.81*	8.56	8.94
2077A x 68726	9.63	-7.74	17.69	10.52	0.52	-1.70	15.04	10.34	11.36	11.79	5.99	-9.69	11.70	3.62	3.98
2077A x Co27	33.39**	18.98	51.77**	15.56	14.29	14.29	40.87**	35.71*	35.71*	15.34	6.80	6.80	26.20**	25.98**	26.43**
2077A x SS032	35.83**	18.98	51.77**	-25.74**	-34.40**	-16.33	24.72	11.74	30.77	7.95	0.52	-0.68	9.64	4.83	15.32*
1111A x 68716	2.72	-15.33	1.86	3.78	-8.04	5.10	26.43	10.45	29.67	-17.36	-33.91**	-3.23	2.76	-13.40**	8.10
1111A x 68740	5.84	-13.00	4.66	-7.28	-9.97	2.89	19.53	3.12	21.06	-7.68	-30.20**	2.21	1.74	-13.84**	7.53
1111A x 68918	-8.92	-9.13	9.31	-5.99	-12.35	0.17	15.81	14.82	34.80*	-12.88	-25.78**	8.67	-3.37	-9.54	12.93
1111A x 68786	27.30*	11.15	33.71*	0.00	-4.02	9.69	15.33	10.30	29.49	-7.51	-27.06**	6.80	7.88	-4.33	19.43**
1111A x 68814	0.80	-12.69	5.03	-1.02	-12.95	-0.51	15.70	4.06	22.16	-16.77	-29.97**	2.55	-1.33	-14.22**	7.08

296

Appendix 43 (contd.)

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
111A x FS211	-3.12	-13.62	3.91	24.62*	14.88	31.29*	11.8	-0.94	16.30	-16.08	-28.80**	4.25	3.37	-8.56	14.12
111A x FS205	-3.24	-16.72	0.19	-6.86	-12.05	0.51	14.78	8.42	27.29	-11.26	-29.04**	3.91	-1.99	-13.65**	7.79
111A x FS9401	-1.77	-14.24	3.17	-9.79	-12.20	0.34	8.96	3.43	21.43	-16.22	-34.61**	4.25	-5.14	-15.96**	4.91
111A x SS003	21.07	4.95	26.26	-7.04	-14.58	-2.38	22.49	10.45	29.67	-10.69	-25.78**	8.67	5.18	-7.84	15.05*
111A x SS012	6.63	-2.94	16.76	-9.71	-12.80	-0.34	4.73	-1.56	15.57	12.11	-17.19*	21.26	3.29	-9.33	13.19
111A x SS020	-3.19	-15.48	1.68	-15.77	-19.35	-7.82	24.39	18.56	39.19*	-10.19	-30.43**	1.87	-1.55	-13.23**	8.32
111A x SRV605	0.57	-18.58	-2.05	-16.02	-18.90	-7.31	5.31	-4.56	37.91*	-22.61*	-40.19**	-12.41	-8.36	-17.06**	3.54
111A x FS9604	22.69	2.94	23.84	-18.80	-23.51*	-12.59	21.57	8.58	27.47	-9.55	-30.66**	1.53	2.68	-12.34*	9.43
111A x FS9605	-3.88	-13.78	3.72	-19.94*	-21.43*	-10.20	9.57	0.94	18.5	-15.77	-34.84**	4.59	-8.11	-18.69**	1.51
111A x FS9601	-8.83	-16.10	0.93	-5.80	-12.95	-0.51	28.72*	16.07	36.26*	-16.22	-36.12**	-6.46	-1.18	-14.15**	7.17
111A x FS9603	-2.78	-16.10	0.93	7.03	-2.53	11.39	17.34	10.30	29.49	-20.44*	-37.40**	-8.33	-0.27	-13.35**	8.15
111A x 68710	15.66	-3.41	16.20	-16.02	-17.71	-5.95	6.47	5.30	23.63	-11.98	-25.78**	8.67	-2.62	-11.67*	10.27
111A x 68724	-4.39	-12.38	5.40	1.18	-11.01	1.70	45.39**	19.19	39.93*	-7.36	-25.44**	9.18	7.02	-8.87	13.77
111A x 68726	0.18	-13.62	3.91	-5.34	-19.49	-7.99	6.04	-1.40	15.75	-11.76	-32.87**	-1.70	-2.96	-18.12**	2.21
111A x Co27	-15.47	-22.6	-6.89	-8.10	-13.84	-1.53	37.32**	27.15	49.27**	-25.74**	-37.51**	-8.50	-4.23	-13.76**	7.66
111A x SS032	-2.84	-12.69	5.03	-20.25*	-24.40*	-3.57	29.37*	29.17*	51.65**	-10.4	-24.97**	9.86	-1.79	-7.62	15.32*
S.E.(d)	0.215	0.249	0.249	0.208	0.240	0.240	0.261	0.302	0.302	0.211	0.244	0.244	0.1172	0.1354	0.1354
CD at 5%	0.424	0.490	0.490	0.410	0.474	0.474	0.515	0.595	0.595	0.416	0.480	0.480	0.2302	0.2658	0.2658
CD at 1%	0.559	0.646	0.646	0.541	0.624	0.624	0.679	0.784	0.784	0.548	0.633	0.633	0.3029	0.3497	0.3497

* Significant at 5 per cent level

** Significant at 1 per cent level

Appendix 44. Relative heterosis (di), heterobeltosis (dii) and standard heterosis (diii) in individual environments and pooled data for hydrocyanic acid

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
296A x 68716	48.55**	44.45**	159.95**	73.81**	66.71**	-28.55**	182.39**	140.02**	84.63**	103.18**	88.27**	-7.23**	88.37**	79.42**	7.50**
296A x 68740	79.33**	44.48**	160.01**	116.65**	100.30**	-7.15	357.14**	357.14**	146.13**	170.90**	154.53**	21.73**	149.16**	146.98**	33.91**
296A x 68918	58.61**	27.79**	129.97**	27.55**	20.00**	-46.43**	214.32**	214.32**	69.24**	70.48**	62.52**	-24.63**	67.58**	64.12**	-11.02**
296A x 68786	30.01**	18.18**	160.01**	61.41**	40.00**	-25.00**	85.73**	85.73**	0.00	66.04**	48.11**	-20.58**	55.93**	39.87**	-4.49
296A x 68814	93.55**	66.69**	199.97**	4.45	4.35	-58.93**	131.58**	83.33**	69.24**	74.58**	61.76**	-20.29**	63.29**	60.15**	-9.70**
296A x FS211	62.17**	57.85**	200.03**	15.29	0.00	-46.43**	88.25**	60.01**	23.08**	33.58**	15.39**	-33.33**	40.95**	25.41**	-12.77**
296A x FS205	6.62	-11.14*	59.92**	9.76	-30.02**	-50.01**	128.59**	128.59**	23.08**	47.34**	19.13**	-18.84**	22.16**	6.64	-22.48**
296A x FS9401	79.36**	44.49**	160.03**	36.24**	36.11**	-46.43**	276.46**	219.98**	146.13**	103.25**	93.76**	-10.15**	97.44**	93.36**	4.84
296A x SS003	84.06**	27.81**	130.00**	15.29	0.00	-46.43**	57.18**	57.18**	-15.37*	24.23**	10.82**	-40.57**	36.25**	35.21**	-25.55**
296A x SS012	23.00**	-11.15*	59.89**	53.72**	33.33**	-28.57**	328.92**	328.92**	130.94**	112.09**	89.18**	1.45	93.55**	90.56**	6.62**
296A x SS020	36.05**	-5.52	70.03**	-40.58**	-57.70**	-60.72**	57.18**	57.18**	-15.37*	-25.01**	-44.07**	-52.17**	-15.31**	-30.36**	-41.41**
296A x SRV605	184.66**	105.62**	270.03**	7.63	-25.00**	-25.00**	80.00**	17.39**	107.71**	92.65**	49.05**	14.50**	89.45**	66.25**	19.39**
296A x FS9604	-0.01	-27.78**	29.97**	-31.30**	-47.62**	-60.72**	171.45**	171.45**	46.16**	19.56**	-12.70**	-20.29**	45.69**	16.58**	5.29*
296A x FS9605	-11.09*	-11.09*	60.01**	-18.96**	-42.31**	-46.43**	271.54**	271.54**	100.05**	27.27**	-5.07*	-18.83**	19.03**	-6.09*	-11.89**
296A x FS9601	68.20**	42.30**	270.03**	31.17**	0.00	-25.00**	52.97**	-3.69	100.05**	38.77**	-1.44	-1.44	45.52**	7.34**	22.47**
296A x FS9603	-46.56**	-59.14**	38.97**	-31.30**	-47.62**	-60.72**	42.86**	42.86**	-23.08**	-17.97**	-34.70**	-53.63**	-26.78**	-42.43**	-45.47**
296A x 68710	-54.16**	-63.33**	10.02	46.33**	20.59**	-26.79**	131.56**	83.29**	69.24**	67.97**	36.95**	-8.70**	31.43**	6.56*	-7.05**
296A x 68724	0.01	-15.39**	120.01**	-33.37**	-53.57**	-53.57**	70.03**	30.79**	30.79**	-12.25**	-37.68**	-37.68**	-9.44**	-33.20**	-23.79**
296A x 68726	57.15**	22.24**	119.98**	33.26**	-7.15	-7.15	70.00**	30.76**	30.76**	40.80**	0.00	0.00	43.39**	10.57**	10.57**
296A x Co27	9.92*	-0.10	119.92**	-10.82	-36.55**	-41.07**	62.44**	25.99**	23.08**	4.32	-24.62**	-28.98**	55.26**	55.17**	-15.87**
296A x SS032	-64.12**	-68.20**	-30.00**	10.51	-19.25**	-25.00**	40.97**	25.99**	23.08**	17.16**	-10.78**	-15.94**	0.41	-21.16**	-17.18**
2219A x 68716	106.03**	54.50**	240.11**	7.73	-19.25**	-25.00**	11.70	-13.37	-15.37*	8.16**	-18.47**	-23.18**	26.34**	-4.79*	0.01
2219A x 68740	33.32**	-0.03	120.07**	-11.67*	-34.61**	-39.27**	164.00**	104.75**	100.02**	23.73**	-7.69**	-13.03**	25.71**	-6.04**	-1.30
2219A x 68918	-40.94**	-40.96**	29.97**	-17.06**	-34.61**	-39.27**	-28.94**	-44.89**	-46.16**	-19.60**	-36.92**	-40.57**	-24.25**	-37.50**	-34.35**
2219A x 68786	71.41**	36.32**	200.09**	-72.98**	-80.78**	-82.14**	43.33**	44.89**	-46.16**	-65.66**	-73.85**	-75.37**	-39.42**	-53.45**	-51.10**
2219A x FS211	104.80**	90.81**	320.04**	9.76	-13.47**	-19.63**	5.74	-5.50	-7.69	8.71**	-12.31**	-17.38**	28.69**	6.95**	12.34**
2219A x FS205	-58.84**	-68.20**	-30.00**	-8.71	-19.25**	-25.00**	-28.94**	-44.89**	-46.16**	-12.51**	-24.62**	-28.98**	-20.19**	-32.48**	-29.08**
2219A x FS9401	-33.35**	-50.02**	10.02	8.09	-23.10**	-28.57**	5.74	-5.50	-7.69	7.21**	-20.01**	-24.63**	-0.12	-25.35**	-21.58**
2219A x SS003	-24.15**	-50.02**	10.02	-2.45	-23.10**	-28.57**	-28.94**	-44.89**	-46.16**	-7.86**	-20.71**	-31.89**	-10.30**	-31.64**	-28.19**
2219A x SS012	-13.37*	-40.94**	30.00**	2.43	-19.25**	-25.00**	-28.94**	-44.89**	-46.16**	-3.93	-24.62**	-28.98**	-5.32	-27.45**	-23.79**
2219A x SS020	-3.47	-36.39**	40.02**	-19.24**	-19.25**	-25.00**	-28.94**	-44.89**	-46.16**	-20.97**	-24.62**	-28.98**	-18.50**	-26.61**	-22.91**

Appendix 44 (contd..)

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
2219A x SRV605	3.00	-22.76**	70.03**	-6.87	-34.63**	-39.29**	-60.79**	-69.57**	-46.16**	-30.52**	-36.94**	-40.58**	-21.79**	-34.16	-30.84**
2219A x FS9604	13.29*	-22.76**	70.03**	-38.90**	-41.07**	-41.07**	-28.94**	-44.89**	-46.16**	-37.50**	-38.47**	-42.03**	-30.54**	-35.42**	-32.16**
2219A x FS9605	-46.68**	-63.65**	-19.98*	-65.95**	-69.23**	-71.42**	1.52	-21.26**	-23.08**	-54.38**	-60.00**	-62.31**	-53.16**	-60.57**	-58.58**
2219A x FS9601	-65.02**	-68.02**	-30.03**	-38.46**	-42.85**	-42.85**	1.52	-21.26**	-23.08**	-32.23**	-35.39**	-39.12**	-37.97**	-41.29**	-38.32**
2219A x FS9603	33.30**	23.07**	220.02**	-29.80**	-36.55**	-41.07**	36.02**	0.00	107.71**	-10.45**	-13.04**	-13.04**	-1.90	-5.79**	7.49**
2219A x 68710	-75.01**	-79.42**	-30.00**	-31.91**	-38.47**	-42.85**	-20.80**	-38.58**	-40.00**	-30.18**	-38.77**	-42.31**	-41.16**	-44.05**	-41.23**
2219A x 68724	-73.10**	-76.68**	-30.03**	-48.85**	-57.71**	-60.72**	-19.04**	-21.26**	-23.08**	-42.33**	-50.78**	-53.63**	-49.60**	-53.88**	-51.55**
2219A x 68726	-54.17**	-57.69**	10.02	-44.45**	-46.43**	-46.43**	-22.18**	-23.08**	-23.08**	-40.30**	-42.03**	-42.03**	-42.91**	-40.45**	-37.44**
2219A x Co27	37.49**	-0.03	120.07**	-44.45**	-46.43**	-46.43**	-45.53**	-46.16**	-46.16**	-49.23**	-50.72**	-50.72**	-34.68**	-36.25**	-33.03**
2219A x SS032	-64.98**	-68.18**	-29.94**	10.79	-21.17**	-26.79**	-29.26**	-45.14**	-46.40**	-4.20	-30.78**	-34.78**	-14.25**	-35.02**	-31.74**
2077A x 68716	-60.80**	-70.60**	0.00	-15.14*	-33.32**	-49.99**	67.97**	39.94**	61.55**	7.70**	-14.03**	-28.97**	-10.93**	-30.12**	-26.42**
2077A x 68740	-37.79**	-58.83**	40.02**	-2.88	-21.43**	-41.07**	153.66**	85.99**	114.70**	35.35**	6.85**	-11.72**	17.09**	-11.84**	-7.17**
2077A x 68918	-20.02**	-47.08**	80.02**	-4.48	-23.81**	-42.86**	-36.39**	-53.36**	-46.16**	-12.36**	-31.59**	-43.48**	-14.30**	-36.00**	-32.60**
2077A x 68786	-71.44**	-76.48**	-20.01*	-11.12	-23.81**	-42.86**	-36.39**	-53.36**	-46.16**	-17.03**	-31.59**	-43.48**	-32.50**	-44.36**	-41.41**
2077A x 68814	-57.46**	-70.60**	0.00	-50.00**	-61.91**	-71.43**	18.48**	6.62	23.08**	-29.68**	-43.87**	-53.63**	-36.80**	-51.48*	-48.90**
2077A x FS211	-47.19**	-58.84**	39.99**	8.33	-7.14	-30.36**	11.96	-6.72	7.69	9.42**	-7.03**	-23.19**	-5.78*	-21.77**	-17.62**
2077A x FS205	-69.58**	-79.42**	-30.00**	-46.35**	-47.63**	-60.72**	-36.39**	-53.36**	-46.16**	-44.24**	-49.13**	-57.97**	-50.01**	-57.75**	-55.51**
2077A x FS9401	-55.57**	-70.60**	0.00	-31.25**	-47.62**	-60.72**	-44.02**	-53.36**	-46.16**	-34.84**	-49.13**	-57.97**	-40.07**	-55.24**	-52.87**
2077A x SS003	-51.23**	-70.60**	0.00	-11.12	-23.82**	-42.86**	-9.12	-33.37**	-23.08**	-10.66**	-26.33**	-39.14**	-19.80**	-38.93**	-35.69**
2077A x SS012	-33.36**	-58.84**	39.99**	-38.89**	-47.62**	-60.72**	99.94**	46.59**	69.23**	-6.40*	-22.82**	-36.23**	-12.58**	-33.07**	-29.52**
2077A x SS020	-46.35**	-67.65**	10.02	-53.19**	-57.69**	-60.72**	-36.39**	-53.36**	-46.16**	-50.01**	-50.85**	-57.97**	-49.31**	-54.40**	-51.98**
2077A x SRV605	-51.12**	-67.65**	10.02	-17.46*	-38.10**	-53.57**	-63.17**	-69.57**	-46.16**	-39.92**	-42.03**	-52.10**	-39.79**	-49.36**	-46.68**
2077A x FS9604	4.71	-35.33**	119.98**	-30.60**	-39.28**	-39.28**	45.41**	6.62	23.08**	-16.66**	-20.63**	-27.53**	-12.62**	-18.84**	-14.53**
2077A x FS9605	-47.61**	-67.65**	10.05	-33.34**	-33.34**	-50.00**	45.14**	6.42	22.85**	-16.99**	-22.82**	-36.23**	-23.42**	-35.60**	-32.18**
2077A x FS9601	-46.16**	-58.83**	40.02**	-53.19**	-57.69**	-60.72**	-36.39**	-53.36**	-46.16**	-50.01**	-50.85**	-57.97**	-49.12**	-51.89**	-49.34**
2077A x FS9603	-46.68**	-52.96**	60.01**	-11.91*	-11.91*	-33.93**	-47.64**	-59.27**	-15.39*	-23.81**	-30.43**	-30.43**	-29.33**	-32.05**	-22.47**
2077A x 68710	-61.78**	-61.78**	30.00**	-21.43**	-21.43**	-41.07**	-36.39**	-53.36**	-46.16**	-24.53**	-29.83**	-42.03**	-35.69**	-38.92**	-35.68**
2077A x 68724	-75.02**	-76.49**	-20.04*	10.53	0.00	-25.00**	-18.54**	-26.69**	-15.37*	2.91	-7.02**	-23.18**	-19.92**	-26.79**	-22.91**
2077A x 68726	-43.36**	-50.03**	69.97**	-55.10**	-60.72**	-60.72**	-50.02**	-53.36**	-46.16**	-53.97**	-57.97**	-57.97**	-51.42**	-49.39**	-46.70**
2077A x Co27	-68.19**	-79.42**	-30.00**	-34.70**	-42.86**	-42.86**	-50.02**	-53.36**	-46.16**	-38.10**	-43.48**	-43.48**	-43.78**	-45.20**	-42.29**
2077A x SS032	-73.09**	-79.42**	-30.00**	-37.51**	-52.39**	-64.30**	-9.12	-33.37**	-23.08**	-30.20**	-47.38**	-56.53**	-42.55**	-56.50**	-54.19**
1111A x 68716	-16.28**	-30.77**	80.02**	17.22*	-0.04	-39.29**	52.18**	34.62**	34.62**	27.14**	9.55**	-25.37**	15.79**	-1.31	-16.08**
1111A x 68740	-62.17**	-73.08**	-30.00**	30.07**	14.67*	-30.36**	150.01**	92.31**	92.31**	59.98**	36.15**	-7.24**	31.23**	6.72**	-9.25**
1111A x 68918	-45.95**	-61.54**	0.00	8.41	-5.95	-42.88**	120.01**	69.24**	69.24**	36.70**	14.87**	-21.74**	17.01**	-5.73**	-19.84**
1111A x 68786	-66.69**	-69.25**	-20.04*	-18.81**	-23.60**	-53.60**	0.00	-23.08**	-23.08**	-14.30**	-23.42**	-47.83**	-28.76**	-35.78**	-45.39**
1111A x 68814	-64.11**	-73.08**	-30.00**	14.26	-5.92	-42.86**	-20.00**	-23.08**	-23.08**	3.69	-10.66**	-39.13**	-12.79**	-27.48**	-38.33**

Appendix 44 (contd...)

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
111A x FS211	-55.61**	-61.58**	-0.09	-15.64*	-20.61**	-51.79**	47.82**	30.76**	30.76**	1.29	-6.41*	-36.23**	-13.38**	-21.27**	-33.05**
111A x FS205	-63.16**	-73.08**	-30.00**	-54.09**	-57.53**	-69.66**	-3.00	-25.39**	-25.39**	-42.56**	-42.57**	-60.87**	-47.28**	-51.11**	-58.42**
111A x FS9401	-40.53**	-57.69**	10.02	60.71**	32.33**	-19.63**	-13.04	-23.08**	-23.08**	39.25**	17.01**	-20.28**	20.26**	-3.11	-17.61**
111A x SS003	-3.03	-38.47**	60.01**	-0.02	-5.92	-42.86**	0.00	-23.08**	-23.08**	-0.01	-10.66**	-39.13**	-0.64	-18.15**	-30.40**
111A x SS012	-58.88**	-73.12**	-30.09**	21.85**	14.67*	-30.36**	80.02**	38.47**	38.47**	35.69**	21.25**	-17.39**	15.60**	-4.17	-18.51**
111A x SS020	-57.58**	-73.08**	-30.00**	13.74**	-5.93	-12.66**	9.99	-15.39*	-15.39*	13.03**	1.55	-13.17**	0.90	0.36	-14.66**
111A x SRV605	18.91**	-15.39**	120.01**	52.70**	23.49**	-25.00**	-5.57	-26.10**	30.76**	17.98**	11.31**	-14.50**	24.14**	14.48**	-2.65
111A x FS9604	58.81**	3.84	170.03**	-28.90**	-42.86**	-42.86**	-30.00**	-46.16**	-46.16**	-29.10**	-38.10**	-43.48**	-14.08**	-16.59**	-24.67**
111A x FS9605	-58.83**	-73.08**	-30.00**	-5.28	-14.29*	-35.72**	-30.00**	-46.16**	-46.16**	-10.42**	-12.24**	-37.68**	-19.67**	-25.92**	-37.00**
111A x FS9601	-54.54**	-61.54**	0.00	-25.59**	-38.46**	-42.86**	80.02**	38.47**	38.47**	-5.67*	-15.25**	-27.54**	-16.26**	-20.18**	-25.11**
111A x FS9603	-50.01**	-50.01**	30.00**	47.35**	33.34**	0.00	70.03**	25.94**	161.60**	55.17**	30.44**	30.44**	30.97**	14.29**	30.40**
111A x 68710	-76.67**	-79.42**	-30.00**	2.62	-7.14	-30.36**	209.39**	137.99**	137.99**	45.83**	42.87**	1.46	9.73**	4.12	-1.37
111A x 68724	7.14*	0.00	200.03**	-5.90	-5.92	-42.86**	35.98**	30.76**	30.76**	5.35	4.22	-28.99**	5.87*	4.54	-8.82**
111A x 68726	-0.02	-0.02	159.98**	-55.58**	-64.30**	-64.30**	-15.37**	-15.37*	-15.37*	-46.55**	-55.07**	-55.07**	-35.86**	-44.02**	-36.13**
111A x Co27	-61.12**	-73.08**	-30.00**	-28.90**	-42.86**	-42.86**	-46.16**	-46.16**	-46.16**	-32.76**	-43.48**	-43.48**	-37.63**	-42.29**	-42.29**
111A x SS032	-68.19**	-73.08**	-30.00**	39.26**	14.67*	-30.36**	170.03**	107.71**	107.71**	73.82**	40.40**	-4.35*	34.19**	9.83**	-6.61**
S.E.(d)	2.587	2.988	2.988	7.251	8.373	8.373	2.562	2.958	2.958	2.108	2.434	2.434	20.821	24.042	24.042
CD at 5%	5.100	5.889	5.889	14.292	16.503	16.503	5.049	5.830	5.830	4.154	4.796	4.796	40.882	47.206	47.206
CD at 1%	6.724	7.764	7.764	18.843	21.758	21.758	6.657	7.686	7.686	5.476	6.324	6.324	53.785	62.106	62.106

* Significant at 5 per cent level

** Significant at 1 per cent level

Appendix 45. Relative heterosis (di), heterobeltiosis (dii) and standard heterosis (diii) in individual environments and pooled data for total soluble solids

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
296A x 68716	-2.13	-25.81**	0.00	-11.83	-14.58	-14.58	21.21	11.11	-4.76	7.94	-5.56	-33.33**	1.90	-1.83	-13.90*
296A x 68740	63.16**	40.91**	34.78**	33.33**	25.00*	25.00*	6.67	2.56	-4.76	-4.00	-7.69	-29.41**	25.32**	20.73**	5.88
296A x 68918	-14.81*	-39.47**	0.00	-5.56	-15.00	6.25	6.67	2.56	-4.76	1.33	-2.56	-25.49**	-4.37	-18.22**	-6.42
296A x 68786	-30.77**	-50.00**	-21.74**	11.11	4.17	4.17	33.33*	22.22	4.76	33.33*	22.22	-13.73	6.75	0.00	-6.95
296A x 68814	31.58**	13.64	8.70	0.00	0.00	0.00	53.83**	42.86**	42.86**	43.59**	33.33**	9.80	30.49**	21.59**	14.44*
296A x FS211	28.81**	-11.63**	65.22**	-12.28	-24.24**	4.17	0.00	-20.00	14.29	0.00	-20.00*	-5.88	4.72	-18.38**	18.72**
296A x FS205	80.49**	48.00**	60.87**	-18.52*	-26.67**	-8.33	-27.27*	-42.86**	-14.29	-25.00**	-40.00**	-29.41**	-1.30	-18.45**	1.60
296A x FS9401	-25.49**	-45.71**	-17.39*	4.17	4.17	4.17	-27.27*	-42.86**	-14.29	-31.31**	-46.03**	-33.33**	-20.20**	-35.25**	-15.51*
296A x SS003	55.00**	29.17**	34.78**	-8.33	-8.33	-8.33	27.54	22.22	4.76	15.94	11.11	-21.57*	21.02**	17.28*	1.60
296A x SS012	12.82	-4.35	-4.35	-29.41**	-33.33**	-25.00*	39.13*	33.33	14.29	27.54*	22.22	-13.73	8.18	3.61	-8.02
296A x SS020	88.89**	70.00**	47.83**	3.33	-13.89	29.17*	16.67	16.67	0.00	11.11	11.11	-21.57*	26.19**	15.22*	13.37*
296A x FS9605	86.67**	75.00**	21.74**	4.76	-15.38*	37.50**	-9.52	-20.83	-9.52	-20.99*	-28.89**	-37.25**	9.40	-3.52	2.67
296A x FS9604	-5.00	-20.83**	-17.39*	-28.89**	-44.83**	0.00	2.22	-14.81	9.52	-24.44*	-37.04**	-33.33**	-15.95**	-31.69**	-11.23
296A x FS9605	24.32**	9.52	0.00	33.33**	29.17*	29.17*	0.00	-20.00	14.29	-4.17	-23.33**	-9.80	12.53*	-2.42	8.02
296A x FS9601	44.68**	9.68	47.83**	11.11	0.00	25.00*	66.67**	66.67**	42.86**	61.11**	61.11**	13.73	42.20**	26.80**	31.55**
296A x FS9603	52.63**	31.82**	26.09**	18.52*	6.67	33.33**	27.78	27.78	9.52	11.11	11.11	-21.57*	26.83**	18.18**	11.23
296A x 68710	33.33**	13.04	13.04	14.81	3.33	29.17*	38.10**	20.83	38.10**	38.10**	20.83*	13.73	29.94**	13.86*	22.99**
296A x 68724	0.00	-30.95**	26.09**	33.33**	29.17*	29.17*	43.21**	28.89*	38.10**	38.27**	24.44*	9.80	26.15**	6.85	25.13**
296A x 68726	-5.66	-32.43**	8.70	29.63**	16.67	45.83**	17.33	12.82	4.76	6.67	2.56	-21.57*	12.09*	-3.77	9.09
296A x Co27	28.21**	8.70	8.70	20.83*	20.83	20.83	43.59**	33.33*	33.33*	19.54*	1.96	1.96	27.43**	15.51*	15.51*
296A x SS032	28.57**	17.39*	17.39*	-0.78	-7.25	33.33**	-24.79**	-30.16**	4.76	-23.81**	-36.51**	-21.57*	13.80*	-0.49	8.02
2219A x 68716	0.00	-12.90*	17.39*	-33.33**	-44.93**	-20.83	14.29	-11.11	14.29	-6.67	-33.33**	-17.65	-8.08	-21.55**	-2.67
2219A x 68740	-24.44**	-26.09**	-26.09**	-2.7	-21.74**	12.5	-9.68	-22.22	0.00	-17.65*	-33.33**	-17.65	-13.13**	-25.86**	-8.02
2219A x 68918	-21.31**	-36.84**	4.35	-37.98**	-42.03**	-16.67	-5.38	-18.52	4.76	-21.57*	-36.51**	-21.57*	-22.87**	-25.86**	-8.02
2219A x 68786	-35.59**	-47.22**	-17.39*	-31.53**	-44.93**	-20.83	-14.29	-33.33**	-14.29	-31.18**	-49.21**	-37.25**	-29.06**	-37.93**	-22.99**
2219A x 68814	64.44**	60.87**	60.87**	5.98	-10.14	29.17*	-29.17**	-37.04**	-19.05	-35.24**	-46.03**	-33.33**	0.00	-12.07*	9.09
2219A x FS211	-42.42**	-55.81**	-17.39*	-31.85**	-33.33**	-4.17	-8.77	-13.33	23.81	-5.69	-7.94	13.73	-23.02**	-28.68**	3.74
2219A x FS205	29.17**	24.00**	34.78**	-44.19**	-47.83**	-25.00*	-0.85	-7.94	38.10**	-12.2	-14.29	5.88	-9.68*	-9.87*	12.30*
2219A x FS9401	-31.03**	-42.86**	-13.04	5.98	-10.14	29.17*	-28.21**	-33.33**	0.00	-36.51**	-36.51**	-21.57*	-22.69**	-24.59**	-1.60
2219A x SS003	-27.66**	-29.17**	-26.09**	-11.11	-24.64**	8.33	47.13**	18.52	52.38**	20.83*	-7.94	13.73	5.58	-10.34*	11.23
2219A x SS012	21.74**	21.74**	21.74**	7.32	-4.35	37.50**	33.33**	7.41	38.10**	8.33	-17.46*	1.96	16.58**	0.00	24.06**
2219A x SS020	2.33	-4.35	-4.35	-17.73*	-19.44*	20.83	-6.67	-22.22	0.00	-11.11	-30.16**	-13.73	-9.62*	-18.97**	0.53

Appendix 45 (contd..)

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
2219A x SRV605	-2.7	-21.74**	-21.74**	-40.14**	-43.59**	-8.33	-17.65	-22.22	0.00	-29.63**	-39.68**	-25.49**	-25.75**	-31.03**	-14.44*
2219A x FS9604	31.91**	29.17**	34.78**	-10.26	-19.54**	45.83**	-22.22*	-22.22	0.00	-31.62**	-36.51**	-21.57*	-9.89*	-11.73*	14.44*
2219A x FS9605	-22.73**	-26.09**	-26.09**	40.35**	15.94	66.67**	1.75	-3.33	38.10**	-12.2	-14.29	5.88	2.96	-2.59	20.86**
2219A x FS9601	-29.63**	-38.71**	-17.39*	-6.98	-13.04	25.00*	20.00	0.00	28.57	5.05	-17.46*	1.96	-4.23	-12.07*	9.09
2219A x FS9603	-20.00**	-21.74**	-21.74**	-25.58**	-30.43**	0.00	-2.22	-18.52	4.76	-15.15	-33.33**	-17.65	-16.67**	-26.72**	-9.09
2219A x 68710	-4.35	-4.35	-4.35	-22.48**	-27.54**	4.17	17.65	11.11	42.86**	-2.7	-14.29	5.88	-4.15	-10.34*	11.23
2219A x 68724	-41.54**	-54.76**	-17.39*	1.75	-15.94	20.83	37.37**	25.93*	61.90**	18.52*	1.59	25.49**	1.11	-1.72	21.93**
2219A x 68726	6.67	-13.51**	39.13**	-10.08	-15.94	20.83	20.43	3.70	33.33*	9.8	-11.11	9.8	5.41	0.86	25.13**
2219A x Co27	-26.09**	-26.09**	-26.09**	29.91**	10.14	58.33**	-4.17	-14.81	9.52	-22.81**	-30.16**	-13.73	-4.53	-13.79**	6.95
2219A x SS032	4.76	-4.35	-4.35	5.43	-1.45	41.67**	5.98	-1.59	47.62**	6.67	-11.11	9.8	5.75	-0.86	22.99**
2077A x 68716	-20.83**	-38.71**	-17.39*	-33.33**	-33.33**	-37.50**	-26.88*	-46.03**	-19.05	-33.33**	-52.38**	-41.18**	-28.46**	-35.61**	-29.41**
2077A x 68740	69.23**	50.00**	43.48**	-3.45	-6.67	-12.50	-41.18**	-52.38**	-28.57	-41.18**	-52.38**	-41.18**	-8.94	-18.05**	-10.16
2077A x 68918	-41.82**	-57.89**	-30.43**	-12.38	-23.33*	-4.17	-41.18**	-52.38**	-28.57	-45.10**	-55.56**	-45.10**	-35.08**	-36.45**	-27.27**
2077A x 68786	-35.85**	-52.78**	-26.09**	-31.03**	-33.33**	-37.50**	-35.48**	-52.38**	-28.57	-44.09**	-58.73**	-49.02**	-36.68**	-41.46**	-35.83**
2077A x 68814	38.46**	22.73**	17.39*	16.13	12.50	12.5	-27.62**	-39.68**	-9.52	-31.43**	-42.86**	-29.41**	-4.46	-11.22*	-2.67
2077A x FS211	10.00	23.26**	43.48**	8.11	-9.09	25.00*	-38.21**	-39.68**	-9.52	-47.97**	-49.21**	-37.25**	-17.82**	-27.94**	4.81
2077A x FS205	-9.52	-24.00**	-17.39*	-39.05**	-46.67**	-33.33**	-50.79**	-50.79**	-26.19	-46.34**	-47.62**	-35.29**	-38.81**	-42.49**	-28.34**
2077A x FS9401	-19.23**	-40.00**	-8.70	-5.38	-8.33	-8.33	-42.86**	-42.86**	-14.29	-42.86**	-42.86**	-29.41**	-29.62**	-35.25**	-15.51*
2077A x SS003	31.71**	12.5	17.39*	3.23	0.00	0.00	-25.00*	-42.86**	-14.29	-37.50**	-52.38**	-41.18**	-8.45	-18.05**	-10.16
2077A x SS012	40.00**	21.74**	21.74**	-15.15	-22.22*	-12.5	-37.50**	-52.38**	-28.57	-41.67**	-55.56**	-45.10**	-15.90**	-23.90**	-16.58**
2077A x SS020	24.32**	15.00	0.00	-0.85	-19.44*	20.83	-23.23*	-39.68**	-9.52	-31.31**	-46.03**	-33.33**	-9.51	-14.15**	-5.88
2077A x SRV605	16.13	5.88	-21.74**	-25.20**	-41.03**	-4.17	-35.14**	-42.86**	-14.29	-40.74**	-49.21**	-37.25**	-25.74**	-26.83**	-19.79**
2077A x FS9604	51.22**	29.17**	34.78**	24.24**	-5.75	70.83**	-52.14**	-55.56**	-33.33*	-55.56**	-58.73**	-49.02**	-11.61**	-18.52**	5.88
2077A x FS9605	63.16**	47.62**	34.78**	55.56**	55.56**	45.83**	-44.72**	-46.03**	-19.05	-51.22**	-52.38**	-41.18**	-4.85	-5.31	4.81
2077A x FS9601	12.50	-12.90*	17.39*	-8.57	-20.00*	0.00	-15.15	-33.33**	0.00	-19.19*	-36.51**	-21.57*	-7.77	-10.24	-1.60
2077A x FS9603	23.08**	9.09	4.35	-8.57	-20.00*	0.00	-19.19	-36.51**	-4.76	-27.27**	-42.86**	-29.41**	-9.71	-16.10**	-8.02
2077A x 68710	-25.00**	-34.78**	-34.78**	-12.38	-23.33*	-4.17	-24.32*	-33.33**	0.00	-27.93**	-36.51**	-21.57*	-22.36**	-22.93**	-15.51*
2077A x 68724	-55.93**	-69.05**	-43.48**	37.78**	37.78**	29.17*	-40.74**	-49.21**	-23.81	-25.93**	-36.51**	-21.57*	-24.53**	-26.94**	-14.44*
2077A x 68726	18.52**	-13.51**	39.13**	2.86	-10.00	12.50	-29.41**	-42.86**	-14.29	-29.41**	-42.86**	-29.41**	-8.87	-10.38	1.60
2077A x Co27	35.00**	17.39*	17.39*	16.13	12.50	12.50	-4.76	-20.63*	19.05	-19.30*	-26.98**	-9.80	4.08	-0.49	9.09
2077A x SS032	0.00	-5.26	-21.74**	6.67	-6.67	16.67	-42.86**	-42.86**	-14.29	-35.24**	-46.03**	-33.33**	-20.59**	-20.98**	-13.37*
111A x 68716	40.00**	12.90*	52.17**	-47.37**	-56.52**	-37.50**	-20.00	-40.00**	-14.29	-21.84*	-43.33**	-33.33**	-13.04**	-25.11**	-9.09
111A x 68740	21.95**	13.64	8.70	-31.53**	-44.93**	-20.83	-35.35**	-46.67**	-23.81	-19.19*	-33.33**	-21.57*	-18.16**	-29.52**	-14.44*
111A x 68918	-8.77	-31.58**	13.04	-28.68**	-33.33**	-4.17	-23.23*	-36.67**	-9.52	-23.23**	-36.67**	-25.49**	-21.09**	-23.35**	-6.95
111A x 68786	12.73*	-13.89**	34.78**	-20.72*	-36.23**	-8.33	-46.67**	-60.00**	-42.86**	-46.67**	-60.00**	-52.94**	-23.19**	-32.16**	-17.65**
111A x 68814	2.44	-4.55	-8.7	-28.21**	-39.13**	-12.50	-41.18**	-50.00**	-28.57	-41.18**	-50.00**	-41.18**	-28.54**	-36.56**	-22.99**

302

Appendix 45 (contd.)

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
111A x FS211	-29.03**	-48.84**	-4.35	-11.11	-13.04	25.00*	-36.67**	-36.67**	-9.52	-36.67**	-36.67**	-25.49**	-27.86**	-33.82**	-3.74
111A x FS205	68.18**	48.00**	60.87**	-22.48**	-27.54**	4.17	-41.46**	-42.86**	-14.29	-33.33**	-33.33**	-21.57*	-13.04**	-14.16**	6.95
111A x FS9401	29.63**	0.00	52.17**	-14.53	-27.54**	4.17	-44.72**	-46.03**	-19.05	-44.72**	-46.03**	-33.33**	-20.17**	-22.95**	0.53
111A x SS003	6.98	-4.17	0.00	-17.95*	-30.43**	0.00	-9.68	-30.00**	0.00	-9.68	-30.00**	-17.65	-8.48	-21.59**	-4.81
111A x SS012	38.10**	26.09**	26.09**	-25.20**	-33.33**	-4.17	-18.28	-36.67**	-9.52	-18.28*	-36.67**	-25.49**	-8.40	-20.70**	-3.74
111A x SS020	2.56	0.00	-13.04	-40.43**	-41.67**	-12.50	-20.83	-36.67**	-9.52	-20.83*	-36.67**	-25.49**	-23.11**	-30.40**	-15.51*
111A x SRV605	63.64**	42.11**	17.39*	-26.53**	-30.77**	12.50	-33.33**	-40.00**	-14.29	-31.43**	-40.00**	-29.41**	-15.49**	-20.70**	-3.74
111A x FS9604	39.53**	25.00**	30.43**	2.56	-8.05	66.67**	-29.82**	-33.33**	-4.76	-22.81**	-26.67**	-13.73	-4.68	-7.82	19.79**
111A x FS9605	0.00	-4.76	-13.04	43.86**	18.84*	70.83**	-10.00	-10.00	28.57	-6.67	-6.67	9.80	6.91	2.20	24.06**
111A x FS9601	-24.00**	-38.71**	-17.39*	-28.68**	-33.33**	-4.17	4.17	-16.67	19.05	4.17	-16.67*	-1.96	-12.59**	-18.94**	-1.60
111A x FS9603	7.32	0.00	-4.35	24.03**	15.94	66.67**	-20.83	-36.67**	-9.52	-20.83*	-36.67**	-25.49**	-0.74	-11.89*	6.95
111A x 68710	71.43**	56.52**	56.52**	-0.78	-7.25	33.33**	-25.93**	-33.33**	-4.76	-25.93**	-33.33**	-21.57*	0.70	-4.85	15.51*
111A x 68724	-27.87**	-47.62**	-4.35	12.28	-7.25	33.33**	-23.81*	-33.33**	-4.76	-23.81**	-33.33**	-21.57*	-15.70**	-17.18**	0.53
111A x 68726	21.43**	-8.11	47.83**	-16.28*	-21.74**	12.5	-19.19	-33.33**	-4.76	-15.15	-30.00**	-17.65	-7.06	-10.13*	9.09
111A x Co27	19.05*	8.70	8.7	-24.79**	-36.23**	-8.33	1.96	-13.33	23.81	-9.91	-16.67*	-1.96	-5.31	-13.66**	4.81
111A x SS032	47.37**	47.37**	21.74**	-0.78	-7.25	33.33**	-34.96**	-36.51**	-4.76	-17.65*	-30.00**	-17.65	-6.05	-11.01*	8.02
S.E.(d)	0.544	0.628	0.628	0.810	0.936	0.936	0.882	1.018	1.018	0.712	0.822	0.822	0.4091	0.4724	0.4724
CD at 5%	1.072	1.238	1.238	1.597	1.844	1.844	1.738	2.007	2.007	1.404	1.621	1.621	0.8033	0.9275	0.9275
CD at 1%	1.414	1.633	1.633	2.105	2.431	2.431	2.292	2.646	2.646	1.851	2.137	2.137	10.558	12.203	12.203

* Significant at 5 per cent level

** Significant at 1 per cent level

Appendix 46. Relative heterosis (di), heterobeltiosis (dii) and standard heterosis (diii) in individual environments and pooled data for crude protein

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
296A x 68716	20.44**	17.77**	10.48**	25.39**	22.14**	19.55**	29.92**	26.06**	28.55**	28.53**	24.73**	21.94**	26.12**	22.73**	20.13**
296A x 68740	15.48**	10.57**	8.33**	17.44**	16.13**	10.25**	19.40**	17.01**	12.24**	19.66**	18.08**	11.56**	17.96**	16.57**	10.58**
296A x 68918	13.56**	11.04**	4.17*	23.82**	21.07**	12.37**	28.24**	25.52**	20.40**	23.71**	23.71**	13.80**	22.37**	21.67**	12.70**
296A x 68786	24.98**	22.21**	14.64**	8.73**	7.58**	2.00	-6.44**	-6.44**	-10.26**	9.87**	8.50**	2.37	9.00**	7.79**	2.12*
296A x 68814	14.25**	8.33**	8.33**	19.95**	16.85**	14.37**	25.52**	25.52**	20.40**	22.44**	18.82**	16.16**	20.53**	17.29**	14.81**
296A x FS211	4.65**	4.65*	-6.19**	19.82**	17.77**	9.31**	34.09**	29.77**	24.48**	22.27**	20.00**	10.38**	20.36**	18.28**	9.55**
296A x FS205	-6.81**	-8.88**	-14.52**	8.61**	8.33**	1.06	21.26**	21.26**	16.32**	9.92**	9.84**	1.18	8.43**	7.73**	1.09
296A x FS9401	20.85**	20.85**	8.33**	26.76**	23.22**	14.37**	32.61**	25.52**	20.40**	30.38**	26.29**	16.16**	27.62**	23.96**	14.81**
296A x SS003	-7.04**	-7.04**	-16.67**	7.49**	4.17*	3.06	19.93**	13.15**	22.38**	8.47**	4.65**	3.55*	7.70**	4.25**	3.17**
296A x SS012	11.04**	6.32**	4.17*	19.55**	17.01**	13.43**	27.58**	27.58**	22.38**	21.95**	19.05**	14.98**	20.07**	17.45**	13.75**
296A x SS020	-3.49*	-4.65*	-14.52**	12.83**	12.18**	4.12*	27.66**	27.58**	22.38**	14.45**	13.71**	4.60**	13.22**	12.53**	4.23**
296A x SRV605	-9.15**	-11.17**	-16.67**	15.21**	12.76**	9.31**	37.42**	34.62**	34.62**	17.07**	14.29**	10.38**	15.60**	13.08**	9.52**
296A x FS9604	5.91**	4.65*	-6.19**	13.53**	10.59**	8.24**	19.93**	13.15**	22.38**	15.10**	11.69**	9.20**	13.87**	10.81**	8.46**
296A x FS9605	0.00	-4.25*	-6.19**	-3.28*	-7.23**	-6.24**	-6.18**	-9.85**	-6.18**	-3.54*	-7.92**	-6.83**	-3.31**	-7.36**	-6.35**
296A x FS9601	24.98**	22.21**	14.64**	21.59**	20.98**	13.43**	18.30**	17.01**	12.24**	24.20**	23.41**	14.98**	22.17**	21.50**	13.78**
296A x FS9603	-12.76**	-19.60**	-14.52**	8.09**	5.29**	3.06	18.06**	11.43**	20.40**	9.14**	5.91**	3.55*	5.71**	0.56	3.20**
296A x 68710	-11.17**	-14.95**	-16.67**	-6.06**	-6.53**	-12.37**	3.48	-4.25	-8.16**	-6.88**	-7.48**	-13.80**	-5.19**	-5.74**	-12.70**
296A x 68724	4.10**	-5.71**	4.17*	15.63**	12.64**	10.25**	28.11**	21.26**	16.32**	17.59**	14.11**	11.56**	16.09**	12.97**	10.58**
296A x 68726	14.25**	8.33**	8.33**	7.83**	6.60**	-1.06	1.12	-6.44**	-10.26**	8.89**	7.57**	-1.05	8.07**	6.82**	-1.06
296A x Co27	9.86**	4.17*	4.17*	18.63**	14.37**	14.37**	27.07**	24.48**	24.48**	21.01**	16.16**	16.16**	19.21**	14.81**	14.81**
296A x SS032	14.00**	3.92*	10.48**	9.54**	8.42**	6.12**	5.29**	-1.91	1.98	5.17**	-0.97	6.96**	10.28**	6.09**	6.35**
2219A x 68716	14.90**	11.04**	4.17*	11.73**	10.59**	8.24**	9.00**	7.96**	12.24**	13.06**	11.69**	9.20**	12.04**	10.81**	8.46**
2219A x 68740	23.62**	17.01**	14.64**	23.21**	22.60**	17.55**	22.83**	15.81**	20.40**	25.95**	25.34**	19.58**	23.84**	23.27**	18.02**
2219A x 68918	21.86**	17.77**	10.48**	31.84**	26.90**	21.67**	35.48**	27.58**	32.63**	32.54**	30.17**	24.18**	30.54**	27.69**	22.25**
2219A x 68786	14.90**	11.04**	4.17*	19.95**	19.29**	14.37**	24.55**	19.73**	24.48**	22.44**	21.76**	16.16**	20.55**	19.92**	14.81**
2219A x 68814	24.44**	16.67**	16.67**	22.31**	21.06**	18.49**	20.47**	15.81**	20.40**	25.03**	23.52**	20.76**	22.97**	24.34**	19.04**
2219A x FS211	34.14**	32.54**	18.81**	24.44**	20.39**	15.43**	15.88**	7.96**	12.24**	27.57**	23.00**	17.35**	25.19**	21.06**	15.90**
2219A x FS205	26.46**	22.21**	14.64**	28.64**	26.90**	21.67**	28.63**	23.65**	28.55**	32.45**	30.17**	24.18**	28.97**	27.69**	22.25**
2219A x FS9401	29.44**	27.89**	14.64**	29.14**	23.59**	18.49**	29.07**	17.71**	22.38**	33.00**	26.58**	20.76**	30.07**	24.34**	19.04**
2219A x SS003	-3.49*	-4.65*	-14.52**	6.89**	5.24**	4.12*	15.38**	13.15**	22.38**	7.64**	5.71**	4.60**	7.06**	5.31**	4.23**
2219A x SS012	23.62**	17.01**	14.64**	19.73**	19.08**	15.43**	16.38**	11.88**	16.32**	22.25**	21.50**	17.35**	20.36**	19.66**	15.90**
2219A x SS020	26.26**	26.26**	10.48**	25.30**	22.60**	17.55**	24.62**	19.73**	24.48**	28.44**	25.34**	19.58**	26.06**	23.27**	18.02**

39

Appendix 46 (contd.)

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
2219A x SRV605	21.86**	17.77**	10.48**	21.93**	21.26**	17.55**	10.06**	7.96**	12.24**	24.57**	23.81**	19.58**	19.26**	18.57**	14.84**
2219A x FS9604	38.10**	38.10**	20.83**	28.75**	27.44**	24.73**	21.21**	18.86**	28.55**	32.11**	30.51**	27.60**	29.52**	28.10**	25.39**
2219A x FS9605	12.32**	6.32**	4.17*	15.19**	12.24**	13.43**	17.65**	17.78**	22.38**	16.98**	13.64**	14.98**	15.59**	12.53**	13.75**
2219A x FS9601	21.86**	17.77**	10.48**	6.46**	5.28**	0.94	-7.25**	-11.77**	-8.28**	7.32**	6.06**	1.18	6.69**	5.53**	1.03
2219A x FS9603	14.00**	3.92*	10.48**	14.89**	13.72**	11.31**	5.88**	3.88	12.24**	16.73**	15.32**	12.75**	12.59**	8.81**	11.67**
2219A x 68710	23.62**	17.01**	14.64**	28.32**	26.90**	21.67**	38.57**	23.65**	28.55**	31.71**	30.17**	24.18**	30.56**	27.68**	22.25**
2219A x 68724	11.61**	0	10.48**	17.08**	15.88**	13.43**	22.68**	11.88**	16.32**	19.05**	17.61**	14.98**	17.53**	16.24**	13.78**
2219A x 68726	22.29**	14.64**	14.64**	26.01**	22.60**	17.55**	16.58**	4.04	8.16**	29.17**	25.34**	19.58**	23.34**	19.96**	14.84**
2219A x Co27	15.56**	8.33**	8.33**	14.73**	12.37**	12.37**	14.06**	11.88**	16.32**	16.48**	13.80**	13.80**	15.15**	12.70**	12.70**
2219A x SS032	18.30**	7.84**	14.64**	21.34**	20.10**	17.55**	24.31**	15.81**	20.40**	17.57**	10.71**	19.58**	20.44**	17.73**	18.02**
2077A x 68716	-3.19*	-6.19**	-6.19**	6.12**	2.94	7.18**	14.65**	11.43**	20.40**	6.88**	3.39*	8.15**	6.33**	3.10**	7.44**
2077A x 68740	15.81**	14.64**	14.64**	19.05**	13.80**	18.49**	22.31**	13.27**	22.38**	21.32**	15.45**	20.76**	19.61**	14.24**	19.04**
2077A x 68918	7.49**	4.17*	4.17*	14.36**	5.88**	10.25**	16.38**	7.66**	16.32**	13.50**	6.66**	11.56**	12.97**	6.12**	10.58**
2077A x 68786	14.00**	10.48**	10.48**	2.55	-2.04	2.00	-8.00**	-13.16**	-6.18**	2.91	-2.14	2.37	2.66**	-2.00*	2.12*
2077A x 68814	20.83**	20.83**	20.83**	19.42**	15.84**	20.61**	18.06**	11.43**	20.40**	21.56**	17.59**	23.00**	19.91**	16.28**	21.16**
2077A x FS211	27.43**	20.83**	20.83**	10.64**	2.94	7.18**	-5.13**	-13.16**	-6.18**	11.97**	3.39*	8.15**	10.94**	3.08**	7.41**
2077A x FS205	7.49**	4.17*	4.17*	15.87**	9.84**	14.37**	22.06**	15.21**	24.48**	18.10**	11.06**	16.16**	15.95**	10.18**	14.81**
2077A x FS9401	-9.86**	-14.52**	-14.52**	-2.21	-9.95**	-6.24**	5.29**	-5.61**	1.98	-2.34	-10.93**	-6.83**	-2.19*	-10.12**	-6.35**
2077A x SS003	16.51**	10.48**	10.48**	11.72**	8.94**	13.43**	7.60**	7.54**	16.32**	12.98**	9.92**	14.98**	12.01**	9.20**	13.78**
2077A x SS012	11.61**	10.48**	10.48**	16.93**	12.90**	17.55**	22.06**	15.21**	24.48**	18.88**	14.32**	19.58**	17.40**	13.26**	18.02**
2077A x SS020	0.06	-6.19**	-6.19**	-4.27**	-9.95**	-6.24**	-7.95**	-13.16**	-6.18**	-4.64**	-10.93**	-6.83**	-4.29**	-10.12**	-6.35**
2077A x SRV605	-16.09**	-18.69**	-18.69**	-13.88**	-16.86**	-13.43**	-11.71**	-14.99**	-8.16**	-15.35**	-18.59**	-14.85**	-14.18**	-17.20**	-13.72**
2077A x FS9604	-8.83**	-14.52**	-14.52**	4.14**	1.02	5.18**	15.15**	15.09**	24.48**	4.55**	1.13	5.78**	4.23**	1.07	5.32**
2077A x FS9605	15.81**	14.64**	14.64**	12.51**	10.86**	15.43**	9.67**	7.66**	16.32**	14.05**	12.19**	17.35**	12.91**	11.23**	15.90**
2077A x FS9601	7.49**	4.17*	4.17*	9.40**	3.96*	8.24**	11.20**	3.88	12.24**	10.43**	4.40**	9.20**	9.64**	4.09**	8.46**
2077A x FS9603	0.98	-2.02	4.17*	-2.04	-4.98**	-1.06	-13.16**	-13.16**	-6.18**	-2.21	-5.40**	-1.05	-4.33**	-5.05	-1.06
2077A x 68710	9.44**	8.33**	8.33**	6.31**	1.02	5.18**	7.56**	-5.61**	1.98	6.98**	1.13	5.78**	7.58**	1.04	5.29**
2077A x 68724	8.94**	3.77*	14.64**	7.17**	3.96*	8.24**	5.29**	-5.61**	1.98	7.92**	4.40**	9.20**	7.34**	4.09**	8.46**
2077A x 68726	-6.19**	-6.19**	-6.19**	1.33	-5.20**	-1.30	9.16**	-4.21*	3.50	1.42	-5.78**	-1.45	1.37	-5.31**	-1.33
2077A x Co27	10.48**	10.48**	10.48**	2.71	0.68	4.83**	-4.54*	-8.09**	-0.70	3.02*	0.75	5.39**	2.80**	0.73	4.96**
2077A x SS032	-15.18**	-17.69**	-12.50**	-0.99	-3.96*	0.00	13.49**	3.88	12.24**	-5.93**	-7.42**	0.00	-2.17**	-4.03**	0.00
111A x 68716	7.49**	4.17*	4.17*	2.13	1.08	-1.06	-3.19	-8.00**	-6.18**	2.45	1.21	-1.05	2.19**	1.08	-1.06
111A x 68740	9.44**	8.33**	8.33**	20.99**	20.39**	15.43**	33.08**	32.91**	22.38**	23.60**	23.00**	17.35**	21.57**	20.99**	15.87**
111A x 68918	1.11	-2.02	-2.02	13.98**	9.71**	5.18**	22.21**	22.91**	12.24**	12.90**	10.88**	5.78**	12.44**	9.97**	5.32**
111A x 68786	7.49**	4.17*	4.17*	15.63**	14.99**	10.25**	23.90**	21.26**	16.32**	17.59**	16.94**	11.56**	16.09**	15.47**	10.58**
111A x 68814	4.17**	4.17*	4.17*	7.11**	6.02**	3.77*	10.24**	7.90**	3.5	8.03**	6.72**	4.34*	7.34**	6.18**	3.93**

39

Appendix 46 (contd..)

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
111A x FS211	9.86**	4.17*	4.17*	11.87**	8.23**	3.77*	13.99**	12.69**	3.50	13.43**	9.37**	4.34*	12.24**	8.52**	3.93**
111A x FS205	14.00**	10.48**	10.48**	7.85**	6.39**	2.00	-0.06	-2.19	-6.18**	9.18**	7.30**	2.37	7.72**	6.63**	2.12*
111A x FS9401	-12.12**	-16.67**	-16.67**	-3.34*	-7.49**	-11.31**	5.71**	2.16	-6.18**	-3.76*	-8.40**	-12.61**	-3.47**	-7.73**	-11.64**
111A x SS003	-1.07	-6.19**	-6.19**	11.12**	9.40**	8.24**	22.38**	13.15**	22.38**	12.37**	10.36**	9.20**	11.39**	9.59**	8.46**
111A x SS012	5.23**	4.17*	4.17*	12.28**	11.66**	8.24**	19.55**	17.01**	12.24**	13.76**	13.06**	9.20**	12.62**	11.99**	8.46**
111A x SS020	17.84**	10.48**	10.48**	29.69**	26.90**	21.67**	41.37**	38.44**	32.63**	33.38**	30.17**	24.18**	30.56**	27.63**	22.25**
111A x SRV605	-11.79**	-14.52**	-14.52**	4.83**	4.25*	1.06	21.26**	16.32**	16.32**	5.41**	4.76**	1.18	4.96**	4.37**	1.09
111A x FS9604	22.29**	14.64**	14.64**	28.75**	27.44**	24.73**	34.62**	24.46**	34.62**	32.11**	30.51**	27.60**	29.50**	28.10**	25.39**
111A x FS9605	5.23**	4.17*	4.17*	15.19**	12.24**	13.43**	24.93**	17.58**	22.38**	16.98**	13.64**	14.98**	15.57**	12.53**	13.75**
111A x FS9601	-11.79**	-14.52**	-14.52**	-7.58**	-8.60**	-12.37**	-3.33	-4.35	-10.26**	-8.57**	-9.64**	-13.80**	-7.82**	-8.84**	-12.70**
111A x FS9603	-9.06**	-11.76**	-6.19**	1.03	0.00	-2.12	2.04	-5.61**	1.98	1.22	0.00	-2.23	-1.33	-4.62**	-2.12*
111A x 68710	9.44**	8.33**	8.33**	10.93**	9.71**	5.18**	17.61**	11.04**	1.98	12.20**	10.88**	5.78**	12.43**	9.94**	5.29**
111A x 68724	4.98**	0.00	10.48**	14.89**	13.72**	11.31**	26.46**	22.21**	12.24**	16.73**	15.32**	12.75**	15.33**	14.08**	11.67**
111A x 68726	8.33**	8.33**	8.33**	20.45**	17.20**	12.37**	34.14**	26.65**	16.32**	22.92**	19.28**	13.80**	21.02**	17.68**	12.70**
111A x Co27	10.48**	10.48**	10.48**	13.65**	11.31**	11.31**	17.01**	12.24**	12.24**	15.40**	12.75**	12.75**	14.08**	11.67**	11.67**
111A x SS032	7.10**	3.92*	10.48**	14.89**	13.72**	11.31**	23.62**	22.21**	12.24**	10.85**	4.38**	12.75**	13.94**	11.40**	11.67**
S.E.(d)	0.127	0.146	0.146	0.132	0.152	0.152	0.162	0.188	0.188	0.114	0.131	0.131	0.0676	0.0780	0.0780
CD at 5%	0.249	0.288	0.288	0.259	0.299	0.299	0.320	0.370	0.370	0.224	0.259	0.259	0.1327	0.1532	0.1532
CD at 1%	0.329	0.380	0.380	0.342	0.395	0.395	0.422	0.487	0.487	0.295	0.341	0.341	0.1746	0.2016	0.2016



Appendix 47. Relative heterosis (di), heterobeltosis (dii) and standard heterosis (diii) in individual environments and pooled data for dry fodder yield

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
296A x 68716	70.01**	22.77**	-26.23**	49.93**	25.40*	16.74	15.41	-23.48*	-25.00*	13.97	7.67	-19.23	33.56**	0.80	-16.84**
296A x 68740	83.41**	42.78**	-31.56**	84.44**	27.62**	108.14**	70.15**	9.05	23.70*	-16.91*	-43.68**	5.67	51.35**	2.89	20.23**
296A x 68918	62.14**	6.4	-9.09*	59.71**	25.13*	38.18**	29.52	2.99	-44.23**	81.11**	72.76**	26.98*	56.72**	21.46**	-7.20
296A x 68786	27.73**	-19.06**	-19.18**	5.72	-34.88**	75.81**	-14.41	-49.47**	-10.59	-48.32**	-67.20**	-18.79	-10.66**	-45.14**	1.09
296A x 68814	95.39**	38.38**	-11.28**	63.68**	19.24*	63.38**	65.56**	19.55	-13.96	116.53**	83.31**	22.31*	79.78**	38.96**	6.98
296A x FS211	10.40	-27.56**	-38.09**	38.24**	3.14	31.19**	86.37**	33.96*	-2.14	41.16**	14.40	22.93*	46.15**	6.37	-1.89
296A x FS205	45.55**	4.20	-35.57**	10.58	-22.66**	21.42	76.10**	20.73	4.00	40.96**	9.27	32.46**	44.06**	2.88	4.93
296A x FS9401	37.65**	-2.68	-37.24**	29.48**	-5.91	29.94**	76.16**	15.01	20.22	19.56	-12.63	14.99	43.69**	0.87	0.96
296A x SS003	1.60	-31.52**	-47.48**	71.28**	62.05**	13.71	184.05**	137.38**	13.02	49.20**	47.82**	0.49	78.37**	48.34**	-6.01
296A x SS012	37.86**	3.24	-44.63**	48.93**	38.58*	-13.24	75.96**	54.02*	-34.41**	38.26**	29.99	-13.27	51.69**	38.94**	-29.80**
296A x SS020	23.86**	-11.56	-44.85**	118.79**	94.88**	56.13**	94.99**	32.84*	17.12	37.64**	9.36	23.86*	71.47**	28.71**	7.91
296A x SRV605	91.36**	41.87**	-21.54**	10.83	-21.58**	18.28	158.47**	100.54**	16.19	-22.99**	-47.26**	-4.85	49.19**	7.54	2.32
296A x FS9604	0.30	-29.33**	-53.89**	138.00**	95.24**	90.79**	253.62**	163.51**	71.79**	17.64	-7.78	8.35	111.06**	60.88**	28.91**
296A x FS9605	27.78**	-6.12	-46.60**	80.51**	37.72**	63.97**	84.57**	35.51*	-7.52	16.95	0.33	-6.47	56.84**	20.39**	-5.46
296A x FS9601	84.41**	36.27**	-23.88**	112.22**	83.10**	57.99**	95.32**	27.28*	34.16**	63.27**	29.90**	46.60**	89.23**	39.11**	24.31**
296A x FS9603	58.95**	16.66*	-33.43**	40.20**	12.20	16.97	73.68**	14.49	14.95	34.56**	-12.19*	91.94**	51.98**	5.17	15.10**
296A x 68710	111.95**	52.92**	-7.84*	23.69**	-16.13*	47.44**	191.58**	118.68**	39.82**	55.44**	41.19**	15.35	92.90**	43.54**	23.57**
296A x 68724	143.02**	56.50**	45.11**	84.12**	42.46**	62.91**	248.34**	169.06**	57.87**	-31.99**	-57.62**	14.78	88.06**	28.37**	47.71**
296A x 68726	151.88**	64.86**	42.41**	109.73**	47.08**	128.76**	189.25**	93.11**	84.14**	35.14**	-10.16	81.86**	119.22**	47.29**	80.05**
296A x Co27	40.61**	-10.92**	-10.92**	98.07**	61.04**	61.04**	51.67**	0.08	0.08	81.37**	51.19**	51.19**	64.50**	16.82**	16.82**
296A x SS032	78.76**	1.00	-26.29**	168.43**	61.46**	106.69**	45.61**	-17.41**	40.54**	23.68*	4.06	21.02*	55.10**	3.42	30.28**
2219A x 68716	81.38**	5.00	-36.90**	294.69**	152.44**	135.01**	95.16**	20.34	17.95	202.85**	194.51**	133.83**	156.66**	74.20**	43.70**
2219A x 68740	95.95**	17.36*	-43.75**	114.05**	24.08**	102.37**	23.44	-25.84**	-15.88	20.72**	-14.09*	61.18**	51.60**	-5.08	10.92*
2219A x 68918	53.42**	-14.78**	-27.19**	21.47	-24.97*	-17.14	169.90**	91.92**	3.93	81.32**	74.59**	38.62**	84.04**	27.53**	-2.57
2219A x 68786	18.65**	-35.04**	-35.14**	14.80*	-37.07**	69.88**	9.98	-37.91**	9.87	32.31**	-12.63**	116.33**	18.35**	-31.36**	26.50**
2219A x 68814	200.81**	72.66**	10.69**	61.80**	-3.75	31.89**	74.70**	15.1	-17.16	179.73**	121.35**	75.74**	117.14**	50.15**	15.59**
2219A x FS211	33.39**	-25.90**	-36.67**	61.50**	-2.75	23.70*	92.72**	26.51	-7.57	62.90**	41.63**	52.19**	64.73**	8.69	0.25
2219A x FS205	45.32**	-16.19*	-48.18**	12.25	-34.59**	2.71	53.41**	-2.94	-16.39	26.93**	5.04	27.32*	34.31**	-12.67*	-14.29**
2219A x FS9401	76.91**	1.47	-34.56**	85.16**	10.01	51.92**	95.78**	19.3	24.70*	37.50**	10.22	45.07**	74.51**	11.99*	16.49**
2219A x SS003	5.99	-40.45**	-54.33**	114.30**	46.84**	3.03	227.27**	142.21**	15.32	51.36**	40.49**	11.54	100.13**	46.63**	-7.09
2219A x SS012	101.19**	18.39*	-36.51**	128.16**	69.08**	-8.85	117.54**	67.16*	-28.81*	71.22**	48.95**	18.26	101.94**	59.90**	-19.21**
2219A x SS020	83.02**	5.42	-34.25**	113.49**	41.37**	13.26	146.23**	55.04**	36.70**	24.36*	5.77	19.79	93.50**	30.78**	9.64

Appendix 47 (contd..)

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
2219A x SRV605	40.17**	-17.90*	-54.59**	15.28	-32.43**	1.91	162.37**	82.95**	6	-35.93**	-53.87**	-16.78	35.28**	-11.40*	-15.70**
2219A x FS9604	15.44	-33.89**	-56.86**	17.59	-25.57*	-27.27*	29.57	-12.5	-42.95**	4.72	-12.26	3.09	16.69*	-20.19**	-36.05**
2219A x FS9605	132.65**	35.72**	-22.80**	92.64**	17.35	39.71**	127.99**	52.18**	3.86	50.06**	38.93**	29.52**	98.64**	36.62**	7.27
2219A x FS9601	143.64**	42.50**	-20.40**	153.65**	65.03**	42.40**	62.61**	-1.06	4.29	63.82**	39.53**	57.47**	90.90**	26.95**	13.44*
2219A x FS9603	93.57**	12.87	-35.59**	105.45**	28.34**	33.79**	59.51**	-2.09	-1.7	-36.02**	-56.39**	-4.68	36.25**	-13.52**	-5.35
2219A x 68710	105.31**	18.81**	-28.39**	17.68	-32.46**	18.73	134.10**	58.90**	1.6	107.63**	104.70**	67.24**	86.30**	25.05**	7.66
2219A x 68724	30.80**	-27.91**	-33.16**	118.72**	34.22**	53.49**	112.54**	47.68*	-13.35	-3.91	-37.87**	68.27**	48.41**	-6.78	7.27
2219A x 68726	36.83**	-24.07**	-34.41**	19.35	-30.35**	8.32	117.54**	34.85**	28.58*	12.53	-21.67**	58.56**	48.26**	-7.99	12.47*
2219A x Co27	60.22**	-12.29**	-12.29**	70.45**	7.38	7.38	29.88	-20.22	-20.22	23.25*	10.55	10.55	42.58**	-7.69	-7.69
2219A x SS032	121.59**	25.19**	-8.63*	99.15**	19.79*	53.35**	16.07	-34.17**	12.03	20.28*	1.20	17.70	47.49**	-9.00*	14.64**
2077A x 68716	234.76**	123.69**	34.41**	179.94**	138.92**	122.42**	56.39**	32.81**	30.17**	183.17**	154.98**	138.85**	136.07**	102.20**	66.80**
2077A x 68740	284.27**	173.16**	30.93**	66.82**	17.07*	90.92**	42.26**	14.06	29.38**	97.64**	48.15**	177.97**	89.75**	42.63**	66.67**
2077A x 68918	75.45**	8.48	-7.31	71.04**	36.48**	50.72**	72.05**	54.08**	5.48	28.56**	14.72	7.46	63.23**	44.45**	10.36*
2077A x 68786	91.80**	15.32**	15.14**	41.18**	-12.20**	137.03**	7.34	-25.56**	31.71**	70.90**	17.78**	191.62**	42.94**	-5.72*	73.74**
2077A x 68814	115.84**	41.95**	-9.00*	133.98**	73.17**	137.29**	99.69**	94.82**	40.21**	405.88**	277.83**	253.92**	166.48**	135.04**	80.95**
2077A x FS211	41.76**	-12.36**	-25.10**	62.67**	23.41**	56.98**	78.92**	73.29**	26.60*	24.64**	16.65	25.34*	55.35**	27.21**	17.33**
2077A x FS205	99.24**	32.19**	-18.27**	37.60**	-2.36	53.30**	62.40**	45.73**	25.54*	96.62**	74.28**	111.26**	69.61**	35.64**	33.11**
2077A x FS9401	133.94**	53.63**	-0.92	66.46**	22.89**	69.72**	44.93**	19.92	25.35*	47.68**	26.39**	66.36**	63.43**	27.92**	33.07**
2077A x SS003	132.56**	46.93**	12.69**	85.46**	79.70**	26.09*	51.03**	28.03	-12.35	107.79**	79.30**	67.95**	89.10**	82.32**	15.52**
2077A x SS012	32.18**	-9.00	-51.20**	97.61**	79.75**	18.29	76.94**	43.51**	-1.76	162.77**	113.77**	100.24**	93.29**	79.66**	5.68
2077A x SS020	101.59**	33.47**	-16.76**	113.21**	94.17**	55.56**	17.63	4.48	-7.88	34.98**	23.31*	39.66**	53.20**	30.35**	9.28
2077A x SRV605	89.11**	29.12**	-28.59**	29.13**	-7.26	39.87**	34.42*	24.09	-15.05	32.25**	0.46	81.23**	39.94**	13.23*	7.73
2077A x FS9604	64.62**	7.81	-29.66**	24.92*	4.53	2.14	77.64**	73.41**	18.71	83.03**	64.48**	93.25**	65.67**	43.64**	15.10**
2077A x FS9605	79.40**	21.58**	-30.85**	122.83**	73.00**	105.97**	24.83	24.64	-14.67	147.29**	146.71**	131.10**	86.06**	62.72**	27.77**
2077A x FS9601	91.47**	30.38**	-27.17**	84.56**	62.66**	40.35**	45.60**	20.08	26.57*	85.38**	69.62**	91.43**	69.02**	40.14**	25.22**
2077A x FS9603	88.30**	27.50**	-27.24**	130.36**	87.89**	95.87**	44.37**	21.41	21.89	29.61**	-7.43	102.35**	60.89**	23.68**	35.36**
2077A x 68710	419.32**	246.75**	108.98**	12.95	-22.38**	36.45**	122.87**	115.52**	47.54**	144.56**	128.93**	114.45**	140.72**	102.59**	74.41**
2077A x 68724	132.89**	41.83**	31.51**	162.73**	106.96**	136.68**	94.21**	80.34**	23.45*	31.24**	-11.69**	139.18**	91.09**	44.39**	66.15**
2077A x 68726	272.29**	129.70**	98.43**	124.21**	59.54**	148.14**	49.73**	28.61*	22.64*	157.73**	88.50**	281.57**	133.53**	72.95**	111.41**
2077A x Co27	36.03**	-18.24**	-18.24**	141.12**	99.90**	99.90**	96.84**	65.80**	65.80**	178.32**	169.51**	169.51**	109.48**	66.35**	66.35**
2077A x SS032	12.14	-28.40**	-47.74**	-4.06	-27.37**	-7.02	-42.01**	-59.34**	-30.81**	-1.49	-11.08	3.42	-19.20**	-40.74**	-25.35**
111A x 68716	104.19**	46.36**	-12.05**	65.42**	26.19*	17.47	102.08**	51.22**	48.21**	21.50*	6.88	5.58	77.26**	43.50**	18.38**
111A x 68740	112.51**	64.01**	-21.39**	107.14**	34.65**	119.59**	52.83**	9.20	23.87*	19.57**	-8.74	71.23**	62.68**	16.89**	36.59**
111A x 68918	19.38**	-22.11**	-33.45**	52.05**	9.71	21.15	56.27**	48.37*	-19.66	144.18**	112.93**	110.34**	66.89**	39.23**	6.37
111A x 68786	70.07**	7.22	7.06	28.84**	-23.90**	105.44**	3.72	-33.87**	17.01	5.58	-26.15**	82.86**	20.27**	-23.20**	41.54**
111A x 68814	134.56**	64.94**	5.75	109.33**	42.04**	94.63**	99.51**	67.22**	20.35	405.88**	271.37**	266.85**	169.24**	123.93**	72.39**

Appendix 47 (contd..)

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
111A x FS211	24.36**	-18.86**	-30.66**	53.19**	6.06	34.91**	70.31**	41.89**	3.66	163.36**	152.73**	171.57**	79.74**	39.64**	28.79**
111A x FS205	62.85**	15.73*	-28.44**	58.07**	3.67	62.76**	98.55**	55.37**	33.84**	25.80**	14.15	38.38**	63.99**	24.66**	22.34**
111A x FS9401	69.43**	18.95**	-23.28**	64.23**	11.21	53.58**	81.52**	33.03**	39.05**	16.78*	2.21	34.53**	59.10**	18.61**	23.38**
111A x SS003	32.28**	-11.39*	-32.04**	84.33**	56.44**	9.77	115.51**	113.15**	3.75	50.21**	26.79*	25.25*	72.19**	55.49**	-1.48
111A x SS012	67.63**	24.53**	-33.22**	119.49**	109.36**	12.87	84.41**	72.88**	-15.85	147.15**	97.06**	94.66**	103.99**	102.89**	3.62
111A x SS020	28.82**	-8.68	-43.05**	40.87**	13.46	-9.10	74.54**	35.45**	19.42	76.93**	65.63**	87.58**	61.00**	29.54**	8.60
111A x SRV605	96.53**	44.55**	-20.06**	36.08**	-9.89	35.92**	194.82**	171.25**	57.16**	-31.47**	-46.97**	-4.34	65.50**	27.17**	20.99**
111A x FS9604	14.68*	-19.77**	-47.65**	72.35**	29.33*	26.38*	137.72**	107.60**	35.34**	126.68**	108.64**	145.12**	97.40**	61.61**	29.50**
111A x FS9605	50.50**	9.72	-37.59**	84.29**	30.02**	54.80**	171.57**	132.63**	58.77**	197.13**	188.78**	185.26**	136.08**	94.81**	52.97**
111A x FS9601	26.18**	-7.49	-48.33**	156.52**	100.99**	73.43**	86.23**	36.11**	43.47**	54.06**	44.46**	63.03**	80.14**	41.55**	26.48**
111A x FS9603	67.01**	21.63**	-30.59**	206.73**	125.35**	134.92**	185.64**	112.06**	112.90**	10.38	-19.87**	75.14**	111.85**	55.35**	70.03**
111A x 68710	89.02**	35.37**	-18.42**	73.51**	10.90	94.97**	127.93**	100.73**	28.34*	165.48**	142.52**	139.57**	113.62**	70.18**	46.50**
111A x 68724	30.95**	-16.13**	-22.23**	131.18**	65.05*	88.75**	157.19**	135.27**	38.05**	7.79	-26.45**	99.20**	69.56**	22.41**	40.85**
111A x 68726	35.81**	-11.61*	-23.65**	70.66**	12.17	74.47**	110.61**	59.06**	51.67**	124.22**	66.82**	237.69**	92.63**	36.56**	66.92**
111A x Co27	20.63**	-23.97**	-23.97**	97.64**	47.17**	47.17**	69.25**	25.81*	25.81*	85.79**	84.65**	84.65**	66.67**	25.89**	25.89**
111A x SS032	42.39**	-3.39	-29.49**	120.75**	52.57**	95.30**	79.29**	15.29*	96.18**	112.28**	96.29**	128.30**	87.90**	32.04**	66.33**
S.E.(d)	2.678	3.092	3.092	5.015	5.791	5.791	10.072	11.630	11.630	4.495	5.190	5.190	32.298	37.295	37.295
CD at 5%	5.278	6.095	6.095	9.884	11.413	11.413	19.851	22.921	22.921	8.859	10.229	10.229	63.418	73.229	73.229
CD at 1%	6.959	8.035	8.035	13.032	15.048	15.048	26.172	30.221	30.221	11.680	13.487	13.487	83.434	96.342	96.342

* Significant at 5 per cent level

** Significant at 1 per cent level

Appendix 48. Relative heterosis (di), heterobeltiosis (dii) and standard heterosis (diii) in individual environments and pooled data for green fodder yield per plant

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
296A x 68716	100.95**	100.57**	33.61**	45.10**	30.74**	68.95**	30.87**	-10.74**	10.51**	13.64**	0.73	-18.86**	44.10**	19.09**	21.18**
296A x 68740	69.82**	59.59**	20.88**	60.72**	30.06**	117.96**	72.50**	19.93**	38.49**	-24.55**	-46.85**	-19.09**	42.98**	9.11**	37.75**
296A x 68918	90.77**	51.80**	70.97**	38.90**	16.37**	78.54**	27.72**	-2.55	-16.47**	64.57**	47.05**	16.27**	53.41**	25.43**	31.17**
296A x 68786	55.34**	19.92**	46.84**	35.83**	-6.39**	156.47**	18.07**	-24.29**	20.83**	-37.49**	-59.03**	-17.82**	16.32**	-20.98**	46.34**
296A x 68814	96.84**	82.44**	42.36**	20.44**	-4.09**	67.73**	52.61**	20.77**	-6.55**	72.50**	49.70**	-6.81**	52.94**	32.45**	20.19**
296A x FS211	41.19**	8.64**	34.29**	40.29**	20.06**	74.89**	105.83**	56.86**	34.92**	45.22**	19.25**	15.58**	57.44**	26.38**	38.68**
296A x FS205	19.67**	13.16**	-15.42**	16.60**	-3.11*	51.74**	85.98**	40.27**	24.40**	48.75**	22.34**	18.09**	42.32**	17.60**	19.72**
296A x FS9401	21.04**	7.63**	-7.89**	32.87**	9.65**	74.74**	74.33**	27.79**	23.61**	20.05**	-8.66**	8.99**	38.20**	9.79**	23.88**
296A x SS003	21.13**	5.59*	-5.38**	33.61**	25.81**	47.64**	105.68**	67.22**	20.44**	24.80**	7.57**	-7.49**	46.47**	27.95**	13.77**
296A x SS012	29.57**	15.07**	-1.23	36.68**	19.82**	24.20**	61.23**	31.93**	-6.55**	35.19**	31.81**	-13.63**	41.20**	33.55**	-0.50
296A x SS020	29.46**	9.04**	6.11**	80.51**	71.37**	77.63**	106.38**	53.86**	41.27**	23.08**	-1.54	2.16	62.11**	37.05**	31.79**
296A x SRV605	48.69**	45.43**	-3.12	28.13**	15.09**	49.77**	104.29**	58.21**	29.96**	-10.03**	-32.72**	-15.50**	40.64**	17.78**	15.94**
296A x FS9604	61.08**	49.35**	16.45**	129.32**	126.29**	134.55**	221.63**	133.65**	132.61**	20.04**	-1.30	-4.67*	116.95**	84.92**	74.32**
296A x FS9605	53.46**	45.99**	7.74**	58.38**	39.11**	90.56**	88.65**	42.28**	26.19**	6.26*	-7.80**	-21.96**	54.35**	31.36**	24.29**
296A x FS9601	40.41**	25.53**	6.10**	58.96**	55.93**	68.04**	78.43**	26.56**	36.35**	33.76**	4.67*	-15.31**	54.88**	27.35**	31.27**
296A x FS9603	65.93**	61.94**	7.88**	34.22**	32.74**	37.59**	69.39**	16.81**	38.89**	40.28**	-4.17**	62.87**	51.56**	19.66**	37.28**
296A x 68710	125.90**	82.31**	97.76**	48.61**	22.64**	95.43**	155.75**	87.49**	81.35**	58.16**	45.49**	7.85**	96.43**	59.01**	70.66**
296A x 68724	104.76**	69.45**	72.31**	87.33**	70.84**	114.92**	224.15**	179.84**	73.65**	-28.17**	-54.59**	6.94**	73.26**	32.47**	66.32**
296A x 68726	135.76**	81.06**	125.03**	114.80**	75.12**	187.87**	175.67**	97.16**	106.55**	40.47**	-4.04**	63.09**	113.77**	58.62**	117.69**
296A x Co27	45.13**	20.91**	20.91**	59.94**	57.12**	62.86**	73.13**	25.60**	25.60**	39.28**	12.99**	12.99**	55.57**	29.46**	29.46**
296A x SS032	110.61**	48.63**	49.86**	163.41**	61.41**	171.23**	33.58**	-23.45**	58.33**	2.82	-5.37**	12.40**	53.90**	10.18**	69.51**
2219A x 68716	69.75**	37.93**	-8.47**	240.62**	120.26**	184.63**	117.71**	35.42**	67.66**	135.08**	112.34**	112.06**	143.47**	82.59**	85.79**
2219A x 68740	46.02**	12.99**	-14.42**	121.33**	35.69**	127.40**	55.53**	-1.89	13.29**	8.85**	-9.87**	37.20**	54.59**	8.43**	36.90**
2219A x 68918	51.46**	3.62*	16.70**	34.89**	-15.90**	29.04**	129.36**	55.09**	32.94**	74.22**	56.06**	55.85**	72.24**	28.00**	33.86**
2219A x 68786	41.34**	-5.39**	15.85**	30.80**	-25.55**	103.96**	47.96**	-12.02**	40.42**	26.88**	-4.99**	90.66**	35.76**	-13.48**	60.23**
2219A x 68814	167.83**	105.09**	60.04**	59.37**	-3.05*	69.56**	94.01**	34.87**	4.37*	130.86**	68.37**	68.14**	106.00**	60.73**	45.85**
2219A x FS211	17.82**	-21.32**	-2.75	63.85**	3.24*	50.38**	85.75**	25.49**	7.94**	40.96**	38.89**	38.70**	51.69**	11.00**	21.81**
2219A x FS205	35.86**	5.63*	-21.05**	42.41**	-11.57**	38.51**	64.21**	10.07**	-2.38	29.15**	26.98**	26.81**	42.77**	7.05**	8.98**
2219A x FS9401	41.83**	5.28*	-9.90**	75.00**	8.31**	72.60**	82.94**	20.04**	16.11**	13.77**	4.50*	24.69**	51.80**	10.11**	24.25**
2219A x SS003	14.77**	-16.05**	-24.77**	71.76**	13.62**	33.33**	134.06**	66.12**	19.64**	17.27**	9.13**	8.99**	57.39**	23.71**	10.00**
2219A x SS012	61.54**	19.80**	2.83	121.63**	64.60**	28.53**	92.44**	37.26**	-2.78	48.02**	22.58**	22.41**	77.22**	49.10**	11.09**
2219A x SS020	28.40**	-8.43**	-10.90**	107.20**	45.75**	35.77**	140.33**	59.70**	46.63**	5.89**	3.90	7.80**	66.16**	27.02**	22.15**

Appendix 48 (contd..)

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
2219A x SRV605	53.66**	26.86**	-19.20**	51.81**	-1.99	27.55**	96.38**	34.30**	10.32**	-30.97**	-38.04**	-22.19**	33.45**	1.20	-0.38
2219A x FS9604	25.29**	-4.03	-25.17**	65.13**	13.57**	14.61**	39.02**	-9.40**	-9.80**	16.28**	14.37**	14.22**	34.49**	3.52**	-2.41*
2219A x FS9605	59.80**	24.81**	-7.89**	82.23**	16.33**	59.36**	73.62**	16.38**	3.21	21.11**	11.88**	11.73**	57.59**	21.15**	14.63**
2219A x FS9601	66.63**	24.20**	4.98	106.90**	39.83**	50.68**	86.41**	19.34**	28.57**	21.11**	15.45**	27.19**	65.79**	23.80**	27.61**
2219A x FS9603	86.53**	54.26**	-2.18	133.66**	60.51**	62.71**	15.50**	-27.58**	-13.89**	-35.58**	-48.86**	-13.09**	27.05**	-8.31**	5.20**
2219A x 68710	40.96**	-2.57	5.69**	47.22**	-8.88**	45.21**	77.88**	16.72**	12.90**	76.01**	53.33**	53.13**	61.38**	18.93**	27.64**
2219A x 68724	36.54**	-3.88	-2.26	129.10**	49.06**	87.52**	107.31**	54.12**	-4.37*	-6.64**	-33.33**	56.54**	47.39**	3.55**	30.01**
2219A x 68726	38.74**	-7.48**	14.99**	39.35**	-14.26**	40.95**	99.63**	28.60**	34.72**	12.83**	-10.44**	52.22**	44.31**	-1.10	35.73**
2219A x Co27	68.30**	19.05**	19.05**	90.07**	31.05**	31.05**	46.29**	-4.76*	-4.76*	2.00	1.93	1.93	45.56**	9.80**	9.80**
2219A x SS032	90.95**	34.75**	35.87**	79.45**	9.96**	84.78**	3.28*	-40.82**	22.42**	-0.51	-8.43**	8.76**	32.34**	-11.95**	35.45**
2077A x 68716	171.54**	166.33**	76.74**	234.21**	168.08**	246.42**	53.87**	29.65**	60.51**	167.14**	129.97**	156.65**	142.44**	122.46**	126.36**
2077A x 68770	165.79**	144.86**	85.46**	90.71**	39.78**	134.25**	69.39**	46.91**	69.64**	86.03**	61.21**	145.39**	93.95**	62.25**	104.84**
2077A x 68918	129.78**	79.98**	102.71**	104.86**	54.56**	137.14**	55.32**	54.51**	32.44**	21.16**	3.49	15.49**	75.68**	59.22**	66.51**
2077A x 68786	117.57**	65.47**	102.63**	105.45**	32.00**	261.64**	67.71**	28.42**	104.96**	95.76**	52.31**	205.66**	93.57**	41.20**	161.50**
2077A x 68814	123.27**	102.93**	58.35**	118.89**	58.31**	176.86**	146.61**	135.79**	100.00**	279.01**	167.27**	198.28**	161.94**	153.63**	130.15**
2077A x FS211	58.63**	20.26**	48.65**	89.93**	45.87**	112.48**	97.45**	96.08**	68.65**	14.57**	7.03**	19.45**	66.18**	47.44**	61.80**
2077A x FS205	89.39**	75.55**	31.21**	61.87**	21.28**	89.95**	71.76**	68.01**	49.01**	79.07**	66.97**	86.35**	74.00**	59.63**	62.51**
2077A x FS9401	81.05**	58.03**	35.24**	86.67**	39.06**	121.61**	41.86**	33.13**	28.77**	33.31**	29.00**	53.92**	57.59**	38.14**	55.88**
2077A x SS003	93.70**	65.82**	48.59**	83.96**	53.18**	79.76**	75.33**	62.11**	37.50**	68.91**	49.54**	66.89**	79.32**	75.35**	55.92**
2077A x SS012	31.12**	14.30**	-1.89	134.50**	134.50**	83.11**	106.30**	89.29**	60.56**	139.69**	90.22**	112.29**	105.00**	92.36**	63.48**
2077A x SS020	64.42**	36.12**	32.46**	148.89**	128.76**	113.09**	32.10**	27.07**	16.67**	27.73**	23.24**	37.54**	60.79**	51.44**	45.63**
2077A x SRV605	80.53**	80.37**	15.10**	74.12**	39.30**	81.28**	55.79**	53.33**	30.06**	40.43**	32.61**	66.55**	59.39**	48.50**	46.18**
2077A x FS9604	60.54**	45.96**	13.81**	44.22**	27.90**	29.07**	131.80**	114.65**	113.69**	67.21**	55.96**	74.06**	82.77**	73.77**	63.81**
2077A x FS9605	52.65**	42.33**	5.03	120.81**	73.33**	137.44**	37.33**	34.34**	19.14**	96.52**	72.79**	92.83**	76.49**	67.50**	58.49**
2077A x FS9601	56.13**	37.01**	15.80**	73.79**	49.86**	61.49**	49.00**	33.15**	43.45**	40.97**	40.06**	56.31**	53.23**	39.78**	44.08**
2077A x FS9603	104.59**	103.95**	30.15**	152.42**	123.42**	126.48**	37.03**	17.40**	39.58**	22.18**	1.20	72.01**	63.79**	42.56**	63.56**
2077A x 68710	183.00**	124.74**	143.79**	63.08**	21.49**	93.61**	123.93**	110.15**	103.27**	122.89**	85.47**	106.99**	119.70**	96.84**	111.25**
2077A x 68724	101.14**	63.68**	66.44**	172.04**	120.45**	177.32**	86.96**	61.87**	37.30**	16.03**	-14.49**	101.36**	79.30**	50.33**	88.74**
2077A x 68726	157.88**	95.15**	142.53**	141.81**	78.33**	193.15**	69.23**	53.13**	60.42**	130.79**	91.17**	224.91**	121.42**	79.27**	146.03**
2077A x Co27	66.54**	36.41**	36.41**	172.14**	142.32**	142.32**	106.98**	91.27**	91.27**	121.94**	110.40**	134.82**	116.25**	100.01**	100.01**
2077A x SS032	9.10**	-10.92**	-10.19**	-2.78	-28.80**	19.63**	-36.60**	-55.30**	-7.54**	-19.82**	-22.24**	-7.65**	-18.26**	-36.56**	-2.40*
1111A x 68716	126.16**	124.67**	51.08**	106.71**	63.25**	110.96**	117.75**	69.07**	109.32**	23.49**	2.22	25.60**	91.90**	73.67**	76.71**
1111A x 68740	63.19**	54.04**	16.67**	89.83**	37.33**	130.14**	28.37**	2.23	18.06**	-4.22**	-13.45**	31.74**	38.75**	14.66**	44.76**
1111A x 68918	43.98**	14.97**	29.49**	39.47**	3.77**	59.21**	51.61**	36.34**	16.87**	71.06**	40.55**	72.69**	51.77**	35.69**	41.90**
1111A x 68786	101.57**	56.13**	91.19**	61.08**	2.55**	180.97**	24.59**	-10.99**	42.06**	23.81**	-0.19	100.29**	46.78**	6.05**	96.40**
1111A x 68814	133.98**	117.81**	69.96**	119.86**	57.00**	174.58**	134.56**	121.03**	71.03**	287.43**	165.93**	226.73**	165.17**	153.01**	129.59**

311

Appendix 48 (contd...)

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
111A x FS211	24.96**	-3.53*	19.25**	59.28**	20.59**	75.65**	67.50**	50.40**	29.37**	120.07**	96.84**	141.85**	70.18**	49.00**	63.51**
111A x FS205	59.83**	51.81**	13.47**	76.46**	30.41**	104.26**	83.33**	62.42**	44.05**	15.95**	3.52	27.19**	58.43**	33.34**	45.93**
111A x FS9401	71.11**	52.78**	30.75**	64.78**	21.11**	93.00**	75.63**	49.96**	45.05**	14.42**	12.77**	38.56**	54.11**	33.33**	50.46**
111A x SS003	46.03**	27.80**	14.53**	55.19**	27.11**	49.16**	89.27**	84.57**	32.94**	5.89**	-9.99**	10.59**	48.17**	42.75**	26.94**
111A x SS012	62.41**	44.82**	24.31**	106.97**	102.73**	58.30**	63.02**	60.28**	13.53**	107.36**	58.97**	95.32**	84.57**	75.71**	44.81**
111A x SS020	12.29**	-5.06*	-7.61**	52.54**	37.58**	28.16**	82.48**	59.26**	46.23**	77.11**	63.33**	100.68**	60.29**	48.83**	43.12**
111A x SRV605	74.40**	69.80**	14.18**	85.00**	45.73**	89.65**	165.47**	143.35**	99.90**	-34.80**	-35.51**	-19.00**	66.15**	52.63**	50.25**
111A x FS9604	52.73**	42.22**	10.90**	65.37**	44.04**	45.36**	120.61**	86.15**	85.32**	101.55**	80.00**	121.16**	90.75**	78.76**	68.51**
111A x FS9605	82.84**	74.73**	28.94**	87.07**	44.67**	98.17**	143.69**	115.88**	91.47**	124.12**	89.26**	132.53**	112.94**	99.21**	88.49**
111A x FS9601	21.07**	8.70**	-8.13**	127.00**	92.37**	107.31**	94.82**	59.30**	71.63**	30.25**	23.52**	51.76**	68.73**	51.82**	56.49**
111A x FS9603	79.29**	74.18**	17.13**	208.12**	167.87**	171.54**	148.45**	95.74**	132.74**	-0.11	-13.95**	46.25**	97.22**	69.45**	94.41**
111A x 68710	66.68**	35.00**	46.45**	118.84**	60.84**	156.32**	96.52**	67.79**	62.30**	137.24**	90.19**	133.68**	106.13**	82.21**	95.55**
111A x 68724	84.05**	52.88**	55.46**	167.88**	113.67**	168.80**	201.88**	187.77**	96.99**	4.84**	-20.23**	87.85**	92.99**	59.84**	100.68**
111A x 68726	41.04**	8.68**	35.07**	85.50**	35.00**	121.92**	124.97**	85.99**	94.84**	88.35**	62.25**	175.77**	87.78**	50.27**	106.23**
111A x Co27	41.44**	18.27**	18.27**	99.13**	74.12**	74.12**	50.29**	26.59**	26.59**	50.89**	36.85**	68.15**	58.57**	44.63**	44.63**
111A x SS032	57.25**	31.06**	32.15**	102.26**	46.20**	145.66**	76.00**	17.12**	142.26**	69.49**	66.67**	104.78**	77.14**	36.02**	109.25**
S.E.(d)	4.168	4.813	4.813	3.982	4.598	4.598	5.648	6.521	6.521	4.967	5.736	5.736	23.826	27.511	27.511
CD at 5%	8.215	9.486	9.486	7.848	9.062	9.062	11.131	12.853	12.853	9.790	11.304	11.304	46.782	54.019	54.019
CD at 1%	10.831	12.507	12.507	10.347	11.948	11.948	14.675	16.946	16.946	12.908	14.904	14.904	61.548	71.069	71.069

* Significant at 5 per cent level

** Significant at 1 per cent level

312

Appendix 49. Relative heterosis (di), heterobeltiosis (dii) and standard heterosis (diii) in individual environments and pooled data for green fodder yield per plot

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
296A x 68716	5.74	-7.77	-10.89	28.86**	22.57**	20.70**	35.66*	-3.3	-12.91	-51.99*	-63.94**	-63.26**	15.68**	12.24*	-7.43
296A x 68740	19.57**	10.56	6.82	54.41**	26.32**	76.47**	89.51**	33.20**	25.88*	-61.19**	-64.74**	-56.04**	38.64**	21.41**	25.32**
296A x 68918	44.30**	26.84**	22.55**	98.85**	77.07**	57.36**	149.37**	117.93**	-16.45	-23.44	-48.29*	-47.32*	71.12**	47.53**	14.43**
296A x 68786	-55.68**	-60.64**	-51.00**	-49.24**	-65.52**	-14.50**	-55.96**	-72.16**	-59.62**	-82.54**	-87.53**	-70.36**	-56.23**	-68.11**	-45.91**
296A x 68814	28.84**	13.00*	9.18	-10.17*	-34.69**	27.85**	17.85	-16.38	-23.51*	-5.47	-33.5	-32.25	9.60*	-5.38	1.00
296A x FS211	24.98**	24.83**	20.90**	59.74**	48.08**	54.10**	173.17**	127.76**	30.80**	-9.98	-27.75	-26.4	59.08**	52.76**	28.71**
296A x FS205	-11.35	-29.95**	-32.32**	13.90**	-3.14	22.84**	108.93**	61.74**	13.09	54.55**	37.16	39.73	27.68**	26.13**	0.26
296A x FS9401	9.69	-4.66	-7.89	93.43**	69.77**	99.75**	211.32**	144.08**	64.73**	-10.74	-12.59	-10.96	74.33**	68.03**	40.48**
296A x SS003	6.78	-3.68	-6.94	44.23**	32.48**	40.65**	152.89**	100.41**	31.34**	-22.72	-25.79	-24.41	44.05**	39.92**	15.13**
296A x SS012	5.29	4.92	2.07	42.68**	13.14	0.54	101.99**	91.00**	-17.83	-25.12	-53.91**	-53.05**	29.22**	18.26**	-8.28
296A x SS020	-41.95**	-46.97**	-38.06**	-3.71	-16.79**	1.52	6.36	-31.23**	-10.09	-60.52**	-71.39**	-35.12	-22.62**	-38.27**	-19.60**
296A x SRV605	-75.93**	-79.90**	-80.58**	-74.04**	-80.13**	-66.75**	-48.34**	-65.52**	-60.52**	-73.07**	-75.62**	-69.36**	-68.27**	-72.91**	-70.30**
296A x FS9604	-74.37**	-77.18**	-77.96**	-32.48**	-35.80**	-36.73**	-14.8	-41.00**	-41.25**	-47.18*	-57.70**	-56.91**	-45.63**	-48.69**	-55.15**
296A x FS9605	13.96*	-8.9	-11.99*	63.09**	35.73**	81.54**	122.64**	59.42**	41.43**	-36.48	-51.47*	-50.56*	52.55**	45.30**	24.53**
296A x FS9601	18.33**	-1.13	-4.48	129.69**	125.36**	108.12**	205.44**	116.74**	98.20**	58.70**	33.86	36.36	99.66**	96.56**	57.33**
296A x FS9603	-37.88**	-47.85**	-49.62**	-7.98	-11.51	-21.36**	27.56	-10.12	-15.79	-6.88	-31.55**	48.32*	-10.38*	-16.17**	-25.33**
296A x 68710	33.94**	29.65**	25.26**	13.36**	-5.40	25.67**	105.72**	52.65**	20.89	-50.22**	-52.08**	-51.18*	35.11**	21.08**	18.52**
296A x 68724	1.39	-1.15	0.55	49.01**	22.55**	68.89**	168.16**	105.96**	47.28**	-55.97**	-73.23**	26.4	29.56**	3.90	33.46**
296A x 68726	-66.74**	-71.62**	-61.20**	-52.53**	-65.70**	-31.51**	-52.22**	-69.40**	-58.24**	-42.35**	-61.70**	18.68	-56.39**	-67.93**	-47.14**
296A x Co27	18.91**	16.90**	16.90**	84.83**	74.55**	74.55**	85.07**	28.01*	28.01*	12.03	11.00	13.08	51.27**	34.30**	34.30**
296A x SS032	35.08**	-2.95	-20.07**	57.22**	-6.15	61.49**	-20.19*	-58.41**	-8.83	15.47	-20.02	12.45	-6.88	-29.37**	5.95
2219A x 68716	69.70**	27.30**	-8.44	414.25**	244.22**	238.98**	370.17**	159.30**	133.53**	817.26**	791.95**	383.19**	303.44**	171.73**	124.12**
2219A x 68740	40.24**	0.87	-17.23**	150.32**	55.05**	116.61**	166.24**	46.19**	38.16**	221.59**	130.67**	187.55**	123.79**	42.93**	47.53**
2219A x 68918	142.20**	80.61**	32.27**	163.16**	94.83**	35.21**	727.69**	447.75**	57.04**	658.17**	529.20**	240.85**	266.84**	176.88**	55.55**
2219A x 68786	39.59**	-10.03*	12.01*	45.04**	-17.72**	104.02**	109.46**	11.43	61.60**	114.25**	31.53**	212.70**	65.82**	-3.10	64.33**
2219A x 68814	218.59**	137.98**	73.38**	79.78**	5.2	105.95**	182.42**	55.53**	42.27**	540.89**	465.75**	206.48**	168.55**	70.29**	81.77**
2219A x FS211	58.63**	8.78	5.36	139.79**	58.33**	64.76**	301.98**	133.46**	34.07**	227.10**	207.27**	89.41**	138.93**	60.05**	34.85**
2219A x FS205	51.54**	24.39*	-30.24**	81.21**	14.44**	45.14**	158.38**	46.33**	2.31	212.25**	163.25**	107.85**	100.32**	36.23**	8.29
2219A x FS9401	79.13**	34.75**	-3.88	194.02**	88.69**	122.01**	348.96**	155.34**	72.32**	244.22**	167.60**	161.27**	189.20**	94.11**	62.28**
2219A x SS003	34.59**	-1.53	-23.50**	141.22**	58.50**	68.27**	345.59**	154.33**	66.68**	316.16**	228.29**	207.85**	158.17**	73.99**	43.17**
2219A x SS012	44.06**	-1.32	-4.00	222.50**	164.55**	37.74**	339.38**	167.06**	14.89	559.94**	373.33**	156.41**	165.91**	92.06**	23.67**
2219A x SS020	41.94**	-7.16	8.44	128.94**	45.77**	77.85**	217.11**	69.80**	122.01**	123.76**	38.61**	214.32**	119.96**	34.15**	74.73**

33

Appendix 49 (contd...)

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
2219A x SRV605	76.49**	37.27**	-11.08	54.40**	-7.41	54.93**	148.31**	34.22**	53.68**	41.69*	1.39	27.4	84.55**	16.37**	27.58**
2219A x FS9604	27.61**	-5.75	-28.91**	90.32**	27.37**	25.53**	100.88**	9.8	9.34	314.46**	290.45**	139.23**	86.66**	23.90**	8.30
2219A x FS9605	109.45**	69.88**	-1.74	108.94**	30.52**	74.58**	155.33**	41.02**	25.10*	182.58**	181.61**	52.55*	126.08**	50.79**	29.24**
2219A x FS9601	104.87**	59.30**	3.27	185.49**	94.31**	79.44**	240.21**	87.36**	71.33**	235.81**	197.86**	108.47**	176.59**	87.75**	50.28**
2219A x FS9603	92.63**	49.16**	-2.17	215.61**	121.96**	82.12**	112.83**	16.95	9.58	40.23**	-12.36	89.91**	119.20**	44.83**	29.00**
2219A x 68710	28.24**	-10.36	-18.95**	24.78**	-21.94**	3.7	93.42**	8.04	-14.44	162.92**	107.00**	95.14**	52.25**	-1.61	-3.70
2219A x 68724	32.54**	-10.29	-8.75	166.13**	65.27**	127.77**	222.78**	82.33**	30.38*	62.67**	-9.34*	328.14**	105.45**	25.62**	61.36**
2219A x 68726	50.93**	-4.67	30.34**	75.73**	2.54	104.75**	213.49**	67.40**	128.46**	159.25**	52.29**	371.86**	109.91**	23.18**	103.06**
2219A x Co27	92.64**	30.98**	30.98**	176.18**	84.16**	84.16**	185.11**	55.78**	55.78**	225.20**	150.68**	150.68**	149.29**	60.33**	60.33**
2219A x SS032	110.51**	51.24**	24.57**	97.11**	17.66**	102.47**	29.81**	-32.35**	48.30**	144.12**	69.09**	137.73**	78.32**	6.17	59.27**
2077A x 68716	-47.66**	-49.44**	-63.63**	41.69**	-5.08	-6.53	-45.99**	-51.40**	-56.23**	39.79**	-10.55	63.64**	-17.89**	-24.81**	-37.99**
2077A x 68740	70.04**	54.49**	26.76**	80.40**	11.81*	56.20**	35.82**	19.66	13.09	74.41**	46.63**	168.24**	63.24**	35.85**	40.22**
2077A x 68918	39.76**	33.84**	-1.98	97.67**	46.50**	1.67	11.75	-21.88	-43.74**	-23.23	-54.12**	-16.06	36.85**	24.47**	-14.64**
2077A x 68786	12.85*	-13.19**	8.08	34.66**	-23.59**	89.49**	3.02	-22.91**	11.8	32.39**	17.13*	178.46**	19.07**	-16.39**	41.78**
2077A x 68814	20.78**	15.96	-15.51**	61.09**	-5.69	84.63**	92.66**	72.17**	57.49**	287.57**	137.71**	334.87**	78.76**	46.80**	56.70**
2077A x FS211	39.10**	17.69**	13.99*	187.00**	89.65**	97.35**	121.01**	98.62**	43.05**	51.22**	1.09	84.93**	94.45**	76.36**	48.59**
2077A x FS205	27.91**	17.45*	-21.26**	69.33**	7.00	35.71**	59.05**	56.73**	12.88	34.19*	-3.95	75.72**	48.84**	38.62**	10.19*
2077A x FS9401	30.35**	26.43**	-9.82	137.52**	52.54**	79.48**	62.21**	57.11**	13.15	130.00**	76.38**	222.66**	78.90**	62.83**	36.13**
2077A x SS003	26.66**	17.98*	-8.34	90.08**	25.00**	32.70**	57.49**	50.40**	8.32	9.9	-16.88	52.05*	47.48**	35.19**	11.25*
2077A x SS012	-26.32**	-37.78**	-39.47**	226.24**	167.97**	39.52**	136.80**	89.12**	36.21**	106.03**	16.27	112.70**	71.36**	66.14**	13.93**
2077A x SS020	5.70	-16.81**	-2.84	115.44**	37.27**	67.48**	4.62	-18.87*	6.06	34.59**	21.58*	175.72**	31.03**	0.01	30.26**
2077A x SRV605	45.58**	43.12**	-4.05	63.38**	-1.97	64.03**	43.67**	17.02	33.98**	67.15**	40.98**	157.91**	52.67**	24.09**	36.04**
2077A x FS9604	-6.76	-11.94	-33.58**	16.4	-22.04**	-23.17**	58.43**	36.51**	35.94**	120.81**	47.38**	169.61**	34.12**	19.68**	4.61
2077A x FS9605	34.62**	25.38**	-15.94**	184.08**	77.58**	137.53**	57.19**	42.40**	26.33*	211.84**	101.77**	269.12**	101.67**	81.52**	55.57**
2077A x FS9601	40.54**	38.22**	-7.34	138.44**	62.43**	50.00**	80.75**	61.56**	47.73**	113.98**	47.92**	170.61**	83.49**	70.35**	36.35**
2077A x FS9603	14.54	13.3	-24.05**	133.46**	64.34**	34.84**	7.25	-5.16	-11.14	17.61*	8.45	134.99**	34.47**	19.01**	6.00
2077A x 68710	34.22**	16.87*	5.67	10.88	-30.59**	-7.80	30.40*	24.49	-1.41	35.94**	3.00	88.42**	27.58**	8.49	6.19
2077A x 68724	21.71**	0.96	2.69	154.53**	58.17**	117.98**	35.29*	34.81*	-2.91	12.03*	-22.28**	267.00**	51.07**	15.86**	48.83**
2077A x 68726	-4.77	-29.04**	-2.98	19.78**	-30.07**	39.63**	-25.39*	-43.00**	-22.22	32.17**	5.10	225.65**	1.45	-28.18**	18.40**
2077A x Co27	-37.34**	-47.66**	-47.66**	55.61**	3.84	3.84	-5.62	-18.82	-18.82	81.43**	40.30**	156.66**	5.13	-11.39*	-11.39*
2077A x SS032	-87.97**	-89.09**	-91.02**	-86.14**	-91.72**	-85.75**	-88.43**	-92.32**	-83.16**	-74.13**	-77.13**	-58.16**	-86.24**	-89.98**	-84.97**
111A x 68716	40.68**	34.80**	5.79	41.80**	36.16**	45.69**	60.17**	46.95**	58.51**	-61.70**	-78.55**	-8.72	29.20**	9.17*	30.50**
111A x 68740	38.12**	35.11**	10.87	64.40**	45.16**	102.79**	9.60	2.81	10.9	-47.67**	-66.17**	43.96*	22.23**	13.89**	36.14**
111A x 68918	70.72**	65.02**	29.50**	63.37**	34.67**	44.09**	71.15**	8.32	16.84	-11.34	-51.95**	104.48**	53.38**	12.74**	34.76**
111A x 68786	47.59**	20.31**	49.79**	28.21**	-8.23**	127.56**	-1.31	-13.95	24.80*	-22.98**	-39.98**	155.42**	17.10**	-0.18	69.27**
111A x 68814	124.66**	116.61**	70.00**	81.44**	40.30**	174.66**	97.47**	82.47**	96.82**	155.20**	40.04*	495.89**	107.64**	96.54**	134.93**

Appendix 49 (contd..)

Hybrids	E ₁			E ₂			E ₃			E ₄			P		
	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii	di	dii	diii
111A x FS211	17.90**	6.72	3.36	74.44**	72.04**	84.08**	84.89**	41.66**	52.81**	17.59*	-32.69**	186.43**	48.73**	26.78**	51.55**
111A x FS205	43.39**	22.93**	-3.53	87.25**	72.61**	118.93**	101.22**	65.82**	78.87**	-44.90**	-67.34**	38.98	55.52**	29.47**	54.76**
111A x FS9401	57.14**	49.98**	17.71**	75.95**	67.98**	97.64**	90.41**	54.77**	66.95**	-18.02**	-49.60**	114.45**	56.93**	33.34**	59.39**
111A x SS003	56.48**	55.69**	22.19**	63.29**	62.66**	74.04**	104.33**	64.24**	77.15**	-57.41**	-74.01**	10.59	49.40**	26.12**	50.76**
111A x SS012	36.76**	23.54**	20.19**	118.01**	62.05**	73.39**	82.37**	27.55*	37.59**	-12.81	-53.99**	95.77**	56.71**	20.57**	44.12**
111A x SS020	-24.29**	-36.71**	-26.07**	11.97*	5.08	28.21**	37.34**	25.33**	63.85**	51.47**	16.10**	394.02**	16.00**	11.22**	44.87**
111A x SRV605	78.04**	62.50**	27.53**	97.59**	61.97**	171.03**	183.06**	174.86**	214.71**	-54.59**	-70.59**	25.16	91.37**	83.47**	119.28**
111A x FS9604	22.55**	20.16**	-5.7	48.21**	42.36**	52.32**	92.74**	85.33**	99.91**	32.46**	-24.23**	222.42**	51.71**	31.33**	56.98**
111A x FS9605	76.57**	53.36**	20.35**	76.45**	58.80**	112.40**	141.84**	120.37**	137.71**	50.27**	-15.36**	260.15**	90.87**	63.86**	95.87**
111A x FS9601	19.71**	9.29	-14.23*	127.86**	112.27**	127.12**	108.62**	92.74**	107.90**	-5.15	-44.78**	134.99**	68.78**	40.90**	68.43**
111A x FS9603	-45.74**	-50.20**	-60.92**	23.13**	8.78	16.39*	-9.00	-14.97	-8.29	-62.73**	-71.88**	19.68	-23.34**	-33.11**	-20.04**
111A x 68710	-47.93**	-51.37**	-56.03**	-13.50**	-21.92**	3.73	-31.60**	-40.69**	-36.03**	-34.50**	-59.99**	70.24**	-31.94**	-38.10**	-26.01**
111A x 68724	69.66**	50.28**	52.86**	140.58**	113.68**	194.49**	165.97**	121.15**	138.55**	29.70**	23.29**	482.19**	97.53**	90.67**	144.92**
111A x 68726	29.72**	2.09	39.59**	79.24**	37.64**	174.84**	126.93**	103.15**	177.24**	105.15**	77.26**	654.30**	82.22**	57.18**	159.10**
111A x Co27	25.92**	12.37*	12.37*	84.34**	78.31**	90.79**	54.94**	49.29**	61.03**	10.76	-31.61**	191.03**	45.25**	33.38**	59.43**
111A x SS032	64.32**	60.45**	32.15**	105.48**	66.62**	186.73**	92.84**	43.86**	215.37**	38.45**	-7.90	291.91**	81.38**	62.96**	144.45**
S.E.(d)	0.716	0.827	0.827	0.516	0.596	0.596	1.133	1.308	1.308	0.472	0.546	0.546	0.4009	0.4629	0.4629
CD at 5%	1.411	1.630	1.630	1.017	1.175	1.175	2.233	2.578	2.578	0.931	1.075	1.075	0.7871	0.9089	0.9089
CD at 1%	1.861	2.149	2.149	1.341	1.549	1.549	2.944	3.399	3.399	1.228	1.418	1.418	1.0356	11.958	11.958

* Significant at 5 per cent level

** Significant at 1 per cent level

35

316

Appendix 50. Number of days accounted by different cuts

Sl.no.	Month	Days	Total days	Number of cuts
1	January	28	28+29+31+5 =93	I
2	February	29		
3	March	31		
4	April	30	25+31+30+7 =93	II
5	May	31		
6	June	30		
7	July	31	24+31+11 =76	III
8	August	31		
9	September	30	19+31+21 =71	IV
10	October	31		
11	November	31	10+30+28 =68	V
12	December	30		
13	January	31		

Weekly weather during experimental period (2000-2001) Appendix 51.

Standard week	Period	Temp. (°C)		RH (%)		Evap. mm	Wind velocity Kmh ⁻¹	R.F mm	R.D. Days	Sol. Radiation Cal. cm ⁻²	Sun shine hr
		Max.	Min.	0072 hrs	1422 hrs						
1	1-7 Jan	28.3	19.9	87	52	3.4	4.9	-	-	379.2	5.7
2	8-14	28.1	20.5	87	62	3.5	6.1	5.4	-	281.5	2.9
3	15-21	30.5	18.1	91	39	4.1	6.2	-	-	405.9	9.2
4	22-28	31.6	16.9	90	35	4.7	4.1	-	-	500.7	9.5
5	29-4 Feb	31.0	18.3	89	40	4.4	6.8	-	-	420.6	6.7
6	5-11	32.0	21.9	89	48	3.5	4.4	-	-	406.6	7.4
7	12-18	32.2	19.9	88	37	4.9	5.4	-	-	425.7	9.2
8	19-25	32.7	20.9	91	52	4.0	4.5	13.5	1	366.2	5.7
9	26-4 Mar	30.5	19.6	90	45	3.6	4.8	22.7	3	383.7	8.0
10	5-11	33.9	19.8	86	35	4.6	3.6	-	-	418.0	9.4
11	12-18	35.0	21.9	86	33	4.9	4.6	-	-	425.7	9.3
12	19-26	35.0	21.9	85	33	6.4	6.2	-	-	451.9	8.4
13	26-1	35.3	22.3	87	38	6.8	6.7	-	-	391.8	7.0
14	2-8 April	34.6	23.1	85	43	5.5	3.5	2.5	1	378.5	8.0
15	9-15	35.9	22	86	44	6.8	7.1	7.0	1	418.3	9.5
16	16-22	34.6	20.2	87	41	5.9	5.8	10.4	-	382.1	8.0
17	23-29	35.5	23.7	83	42	5.8	6.9	-	-	439.6	9.6

18		30-6May	35.8	23.6	82	44	7.4	9.2	7.0	2	444.9	9.8
19		7-13	35.4	23.3	82	35	6.1	6.6	6.5	1	412.3	8.5
20		14-20	35.7	23.9	75	36	10	15.1	-	-	473.8	9.3
21		21-27	35.1	23.2	83	41	7.1	8.9	-	-	392.0	6.1
22		28-3 June	33.6	22.5	85	50	6.2	9.1	4.9	1	369.0	6.9
23		4-10	30.5	22.8	74	59	6.3	21.9	17.0	3	277.5	2.6
24		11-17	32.0	22.9	80	48	7.0	16.5	3.0	1	361.3	4.9
25		18-24	32.2	23.1	79	51	6.7	15.9	-	-	362.8	5.6
26		25-1 July	31.5	22.4	76	50	6.6	16.6	3.6	-	337.9	4.5
27		2-8	30.5	22.2	78	51	5.6	15.4	2.8	1	307.3	2.1
28		9-15	30.8	24.2	64	51	10.1	32.6	10.4	1	380.1	6.1
29		16-22	32.2	22.5	77	47	7.8	17.6	-	-	417.7	7.5
30		23-29	32.8	21.9	88	50	6.3	7.5	-	-	394.1	7.7
31		30-5 Aus	32.8	22.6	92	53	5.6	6.0	33.6	2	380.4	7.8
32		6-12	30.2	22.8	75	56	6.5	21.1	4.8	1	339.5	4.5
33		13-19	31.6	22.1	88	56	4.8	7.2	53.4	1	374.4	5.9
34		20-26	28.4	22.8	75	70	4.9	25.4	24.1	3	255.9	0.8
35		27-2 Sep	29.8	21.8	86	54	5.2	17.0	2.6	1	402.5	6.3
36		3-9	32.2	22.1	85	54	6.8	9.3	-	-	431.3	8.7
37		10-16	32.3	22.1	88	59	5.0	4.9	3.2	1	382.1	6.4

23/2/19

38	17-23	31.9	22.5	89	60	3.8	3.8	100.9	3	328.9	5.2
39	24-30	29.6	22.3	92	70	3.2	3.8	89.2	5	288.2	4.5
40	1-7 Oct	29.3	21.4	91	65	4.5	4.0	7.9	2	303.0	3.5
41	8-14	30.9	21.6	90	60	4.1	3.0	12.1	3	339.0	5.7
42	15-21	31.1	21.7	93	63	3.9	2.5	2.4	1	338.9	4.7
43	22-28	31.7	19.4	91	46	4.5	3.1	-	-	378.4	7.3
44	29-4 Nov	30.8	21.2	89	54	3.3	2.6	-	-	360.3	7.0
45	5-11	31.0	21.5	89	48	4.5	5.2	-	-	420.2	7.9
46	12-18	30.0	21.4	87	49	4.3	6.2	-	-	368.4	5.7
47	19-25	28.2	21.8	93	66	2.4	4.8	34.3	3	243.5	3.2
48	26-2 Dec	29.0	18.0	92	50	3.7	6.3	29.2	2	357.1	6.5
49	3-9	28.9	19.1	88	50	3.5	5.1	-	-	410.1	7.8
50	10-16	28.5	15.2	88	45	4.2	5.1	-	-	515.5	10.5
51	17-23	28.7	17.3	88	41	4.2	5.2	-	-	450.0	8.8
52	24-31	28.6	19.4	87	53	5.3	6.4	12.0	2	334.1	5.3
1	1-7 Jan	30.0	20.9	91	48	3.7	1.1	-	-	371.7	6.3
2	8-14	30.0	19.4	88	43	4.3	5.1	-	-	419.9	7.4
3	15-21	30.2	17.8	90	40	4.5	7.3	-	-	446.8	7.9
4	22-28	31.2	20.8	81	44	4.8	5.6	-	-	386.8	5.0