

**GENETIC ARCHITECTURE OF MORPHOLOGICAL,
PHYSIOLOGICAL GROWTH PARAMETERS AND
GRAIN YIELD IN SELECTED PARENTS AND
HYBRIDS OF QUALITY PROTEIN MAIZE
(*Zea mays* L.)**

By

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M.Sc. (Ag.)

THESIS SUBMITTED TO THE
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IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE OF

**DOCTOR OF PHILOSOPHY
IN THE FACULTY OF AGRICULTURE**



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No part of the thesis has been submitted for any other degree or diploma. The published part has been fully acknowledged. All the assistance and help received during the course of the investigation have been duly acknowledged by the author of the thesis.



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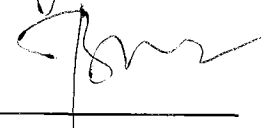
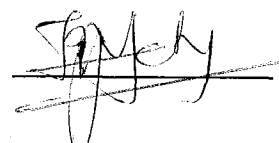
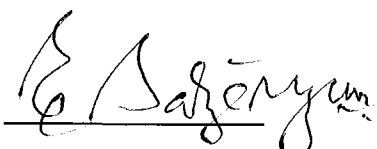
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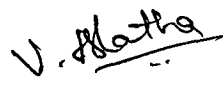
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LIST OF SYMBOLS AND ABBREVIATIONS

%	:	Per cent
°C	:	Degrees centigrade
>	:	Greater than
σ^2_g	:	genotypic variance
σ^2_p	:	phenotypic variance
ANOVA	:	Analysis of variance
bi	:	regression Coefficient
C.D	:	Critical difference
CGR	:	Crop growth rate
cm	:	Centimeter
RCBD	:	Randomized Complete Block Design
DAS	:	Days after sowing
d.f.	:	Degrees of freedom
<i>et al.</i>	:	and others
F ₁	:	first filial generation
g	:	gram
gm ⁻² d ⁻¹	:	grams per square meter per day
gg ⁻¹ d ⁻¹	:	grams per gram per day
g/16gN	:	grams per 16 grams nitrogen
<i>gca</i>	:	General Combining Ability Effect
h ²	:	Heritability in broad sense
ha	:	hectare
HI	:	Harvest index
<i>i.e.</i>	:	that is
kg ha ⁻¹	:	kg per hectare
kg	:	kilogram
LAI	:	Leaf Area Index
LDW	:	Leaf Dry Weight
L X T	:	Line X Tester
m ha	:	million hectares
m	:	meter
mg	:	milligram
NAR	:	Net Assimilation Rate
r	:	Correlation
RGR	:	Relative Growth Rate
r _g	:	genotypic correlation coefficients
r _p	:	phenotypic correlation coefficient
S ² di	:	Deviation from regression estimates
S.E	:	Standard error
<i>sca</i>	:	Specific Combining Ability
SLW	:	Specific Leaf Weight
<i>viz.</i>	:	namely
ij	:	environmental index

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ABSTRACT

In the present investigation ten elite parental lines were crossed in half diallel fashion to obtain 45 direct single crosses (with out reciprocals). The resulting 45 hybrids along with parents and two checks were evaluated in a complete block design, replicated thrice, during *Rabi* and *Kharif* 2002-03 both at Rajendranagar and Palem. The data was collected on days to 50 per cent tasseling, days to 50 per cent silking, ASI, days to maturity, plant height, ear height, LAI, LDW, CGR, RGR, NAR, SLW, total chlorophyll content, total biomass, harvest index, protein content, seed protein yield, oil per cent, oil yield, tryptophan content and grain yield per plot and subjected to statistical analysis for interpretation which involved estimation of combining ability effects and variances, correlation and path coefficient between morphological, physiological growth parameters and grain yield along with Genotype x Environment interaction and stability.

The analysis of variance revealed significant differences for all the characters except ASI. Combining ability analysis revealed importance of both additive and non-additive gene action in governing most of the characters but non-additive gene action was found to be predominant. Hence, recurrent selection was suggested to improve these characters.

Based on combining ability studies among the parents P5, P4 and P2 were found to be the best general combiners at two locations and in two seasons. Among the crosses P4 X P6, P7

X P9, P1 X P10 and P2 X P10 were the best specific combiners for most of the yield and physiological parameters.

Considering over locations and seasons on *per se* basis parental lines P5 and P8 for grain yield, P9 and P4 for protein content, tryptophan content and oil content and among crosses P4 X P6 and P2 x P8 for grain yield, P4 x P8 and P5 X P10 for protein content, P1 x P9 and P2 X P9 for tryptophan content and P1 X P8 and P1 X P10 for oil content were top ranked. While combining ability studies revealed P5 and P2 for grain yield, P4, P5 and P9 for protein content, P4, P2 and P1 for tryptophan content and P4,P1 and P8 for oil content are good general combiners while the crosses Viz., P4 X P6 P1 XP10, P4 X P5 for grain yield, P4 X P8, P5 X P10, P7 X P9 for protein content, P1 X P10, P1 X P3, P4 X P6 for tryptophan content and P1 X P8 P4 X P6 and P2 X p10 for oil content are the best specific combiners. Hence these crosses could be advanced further for isolation of transgressive segregants and also to develop good inbred lines.

Correlation analysis revealed that grain yield had significant positive correlation with LAI, CGR, NAR, total biomass at maturity, total chlorophyll content, harvest index, seed protein yield / ha and oil yield / ha both at Rajendranagar and Palem during both the seasons whereas days to maturity and ASI exhibited significant negative correlations. Grain yield had significant negative correlation with protein content.

Path coefficient analysis revealed that for grain yield, high positive direct effect was exhibited by ASI, ear height, LDW, CGR, NAR, seed protein yield, oil yield and tryptophan. Whereas the characters days to 50 silking, plant height, chlorophyll content, harvest index and protein content recorded negative significant direct effect.

The parental line P5 exhibited stable performance for grain yield, P4 for protein content, P3 and P2 for oil content and P10 for tryptophan content, among the crosses P3 X P5 for grain yield, P3 X P4, P4 X P5 for protein content and oil content P1 X P2 and P4 X P6 for tryptophan content were found to be stable.

P₁-TQPM 178-1-1-1-⊗, P₂ - PK (C103ae x B 73ae) B-3-6-1-1-1-1-⊗, P₃- QPM 46-3-1-2-1-1-1-⊗, P₄ - TQPM 34-1-2-1-⊗-2-1-1-⊗, P₅ -QPM 10-2-1-1-1-1-⊗, P₆-TQPM 42-1-2-1-⊗-2-1-1-⊗, P₇-TQPM 80-1-2-1-⊗-1-1-1-⊗ ,P₈-DMR 274-1-1-2-1-1-1-1-⊗, P₉- QPM 35-1-1-1-1-⊗-1-1-⊗, P₁₀-QPM 89E-1-1-1-⊗-5-1-1-⊗.

INTRODUCTION

CHAPTER I

INTRODUCTION

Globally, maize (*Zea mays* L.) is the second most important cereal crop after wheat, if we take into consideration statistics of dehusked edible rice instead of paddy with husk (Patil *et.al.*, 2000). The diversity of environments under which maize being grown is unmatched by any other crop as the expansion of maize to new areas and environments still continues; as it has range of plasticity. By origin, it is a tropical crop and has even adapted to temperate environments with much higher productivity. It is grown at latitudes ranging from the equator to slightly above 50° North and South, from sea level to over 3000 meters elevation (Dowswell *et.al.*, 1996).

Maize is the second most important cereal crop in the world economy. In India, maize ranked third which is next to rice and wheat with an area of 6.60m.ha, production of 11.20 million tonnes and 1950kg/ha productivity. While in Andhra Pradesh, it covers an area of 5.26 lakh hectares with a production of 14.86 lakh tonnes with an average productivity of 3180 kg/ha (Annual progress report, DMR, 2004).

It is globally the top ranking cereal in productivity and has worldwide significance as food, feed and as a good source of starch, protein, fat, oil, sucrose in addition to some of the important vitamins and minerals. In western countries maize is used in wet distilleries, which require varieties with high protein, starch and oil content. With the global acceptance of maize endosperm oil concentrate as a rich source of

nutritive oil with least detrimental effect on human health, attention has been diverted to high oil trait in maize. Corn oil contains predominantly (>88%) essential polyunsaturated fatty acids like Oleic, linoleic, linolic and arachidinic acids, which make the oil easy to digest and is very useful to the patients suffering from cardiological complications.

High oil and protein content are desirable character of the maize kernel for livestock feed as it can meet the high calorie nutrient demands of the poultry, swine and dairy cows. Therefore, it is assuming greater significance for the industrial usage in the form of many value added products in recent years.

Maize protein is considered as of poor quality because of its low lysine and tryptophan. Lysine and tryptophan content in the normal yellow maize is 2.73 and 0.48 g/16gN respectively as against to the suggested level of 5.5 and 1.0g/16gN(FAO or WHO).

Genetic Variability for most of the traits including protein in maize is incredibly high and amenable to enhancement. Attempts to improve protein content prior to 1960's was rather very limited to only screening elite maize germplasm for higher protein per cent, since, no specific gene(s) conferring enhanced nutritional value was identified. Mean while, world scientists manifested special interest in the search for new gene mutants that could provide better quality protein (Breeding for improved protein quality to phenotypes).

With the discovery of mutant gene opaque-2 (Mertz *et al*, 1964) followed by floury-2 (Nelson *et al*, 1965) which alter and enhance amino acid profile and also improve over all nutritional quality of the maize endosperm protein opened new vistas, for the development of high quality protein hybrids coupled with high grain yield and oil in maize.

The other mutants which could influence protein quality reported were opaque-6, Floury-3 and mucronate (Ma *et. al*, 1975 and Salamini *et. al*, 1983). These mutants across the globe have been experimentally tried in many ways but none offered any additional advantage over opaque-2 gene in maize breeding programme.

Pains taking concerted efforts over three decades period have helped in better understanding the complex nature of inheritance of QPM (Quality Protein Maize) and different breeding procedures for improvement of the germplasm led to the combined use of opaque-2 genes and endosperm modifier genes by applying modified back crossing cum recurrent selection breeding procedure, resulting in successful development of parental lines, gene pools and hybrids with hard kernel type (Normal maize type) having good taste and other consumer favouring characteristics in QPM. This innovative work on QPM maize was recognized with Millennium world food prize award for the scientists (Dr. S.K. Vasal and Dr. Villegas in the year 2000) working at CIMMYT, Mexico.

In India under the auspices of the All India Coordinated Research Project on Maize a beginning on QPM was initiated with the introduction of mutant gene opaque-2

and released soft endosperm quality nutritious varieties viz., Rattan, Protina and Shakti during late sixties. Since these varieties had opaque kernel appearance (soft endosperm) with lower yields and highly susceptible to many pests and diseases and stored grain pests could not become popular and not liked by the farmers.

Quality protein maize can help to alleviate human malnutrition and reduce cost of animal feed because it contains the opaque-2 mutant, which results in increased lysine and tryptophan concentrations with higher biological value as a food than normal maize.

QPM's nutritional superiority having higher biological value, increased availability and better utilization of niacin, calcium, carbohydrate and carotene has been amply demonstrated with different experiments on rats, pigs, infants, school children and vulnerable sections of the society (old aged people, women in pregnancy, lactation). Therefore, it is essential to replace with new QPM maize hybrids which are interchangeable in cultivation, grain yield potentiality, tolerance to biotic and abiotic stresses with that of normal maize hybrids under cultivation and also to raise maize crop's contribution to ultimate nutritional security in the country.

Thus, there is every need in present day to evolve new high yielding QPM hybrids, which could exceed the yields of existing best hybrids in terms of quantity and quality. Combining ability analysis through diallel mating system is one such most popular method to select parents and single cross hybrids. The studies on gene effects of various economic traits like grain yield, morphological and physiological growth

parameters would be helpful in formulating suitable breeding methodology for the development of high yielding quality protein maize hybrids. Therefore, in the present investigation efforts were made by selecting ten elite QPM inbreds known for their good agronomic characters from its germplasm developed at Agricultural Research Station (Maize), Amberpet, Hyderabad, India to study the genetic architecture of morphological and physiological parameters in QPM parents and their all possible direct single crosses (45 F_1 's) targeting to develop a high yielding best QPM hybrids with the following objectives.

1. To study the combining ability and gene action for grain yield, protein and physiological growth parameters.
2. To identify parents with high GCA and single crosses with high SCA for grain yield, protein and physiological growth parameters.
3. To study the extent of correlation and path analysis between yield, protein and its physiological growth parameters.
4. To study the stability of yield, protein and its physiological growth parameters.

*REVIEW
OF
LITERATURE*

CHAPTER II

REVIEW OF LITERATURE

Maize is one of the most intensively studied crop and hence, a wealth of information is available on genetics of several morphological, physiological and biochemical parameters. The literature available on genetic analysis of yield and its components in maize (*Zea mays* L.) is reviewed under the following sub heads.

- 2.1 Combining ability and gene action
- 2.2 Physiological and Biochemical parameters
- 2.3 Correlation studies
- 2.4 Path analysis studies
- 2.5 Stability analysis studies for physiological and yield parameters

2.1 COMBINING ABILITY AND GENE ACTION

Combining ability of the inbred lines is the ultimate factor for determining future usefulness of the lines. Combining ability is a general concept of classifying inbred lines relative to their cross performance.

In maize, number of scientists has studied combining ability and gene action controlling the traits. Different breeding methods have been developed for the quantitative estimation of general combining ability and specific combining ability

effects. Among them, popular are (i) top cross, (ii) poly cross, (iii) Line x Tester and (iv) Diallel.

Credit goes to Shull (1909) for the initial suggestion of developing inbred lines through selfing and crossing inbred lines as a practical means of producing a better corn hybrid. However, the main effect of his method was the high cost of single cross seed.

Sprague and Tatum (1942) defined general combining ability (*GCA*) as the "Average performance of a line in hybrid combination" while specific combining ability (*SCA*) as the "Deviation from performance predicted on the basis of *GCA*". The determination of *GCA* and *SCA* gives an index of the parents and crosses, while *GCA* is associated with additive gene action which is fixable component and *SCA* is associated with non-additive gene action, caused by dominance and epistasis which are not fixable in nature.

Griffing (1956) suggested detailed mathematical model for the estimation of *GCA* and *SCA* variances and effects from diallel model involving various combinations of parental lines, direct single crosses and reciprocal crosses.

Hallauer and Russel (1962) revealed that both additive and non-additive type of gene action for days to maturity.

Bhalla and Khehra (1980) from their studies reported that the non-additive effects were important for grain yield per plant and ear height while additive and non-additive effects were equally important for days to 50 per cent silking.

Debnath and Sarkar (1981) analysed data from a half diallel cross of nine inbreds and reported non additive gene effects to be important in the inheritance of grain yield.

Lai *et.al.* (1981) reported predominance of additive gene effects for plant height and ear insertion height.

Murthy *et.al.* (1981) reported the predominance of additive gene effects for days to tasseling, days to silking and non-additive gene effects for grain yield per plant.

Sharma *et.al.* (1982) from their diallel studies revealed that good general combining parents for yield were also generally good combiners for yield contributing characters.

Manmohan (1984) reported that non-additive gene action was predominant for all the characters studied though both *GCA* and *SCA* variances were significant.

Camoussi *et.al.* (1985) while working with maize early inbreds for reported that differences among hybrids for grain yield were always significant and generally due to both *GCA* and *SCA*.

Khallifa and Drolsum (1988) reported the importance of both *GCA* and *SCA* effects for characters like grain yield, days to silking and plant height.

Beck and Vasal (1990) reported that *GCA* was significant for yield, plant height, ear height and days to silking while, *SCA* was significant only for ear height.

Pal and Prodhan (1994) reported that the mean square estimates for both *GCA* and *SCA* were significant for maturity, oil content and grain yield, *SCA* components were higher than *Gca* components for above characters indicating the importance of non-additive gene effects in controlling these traits.

Satyanarayana *et.al.* (1994) based on their combining ability studies revealed that both *GCA* and *SCA* variances were found to be highly significant for all the characters studied indicating both the additive and non additive genetic variances were found to be important in contribution of the character. However, for days to 50 per cent silking, the *GCA* component was higher over *SCA* component while for 50 per cent dry husk, both *GCA* and *SCA* were of equal importance. However, for yield, the *SCA* component was found to be high.

Venkatesh (1994) from his study reported that non-additive gene effects are more important for the characters days to 50 per cent tasseling, days to 50 per cent silking and ear height.

Nagda (1995) in his study revealed that it is high significant *GCA* and *SCA* variances devoting importance of additive gene action for seven traits. *SCA* variances were higher in magnitude for all the traits, except for days to 50 per cent silking indicating the predominance of non-additive gene action.

Giridharan *et.al.* (1996) studied grain yield in diallel, triallel and quadriallel mating designs and reported that grain yield was controlled by both additive and non-additive gene action in diallel crosses and only dominant gene action in triallel and quadriallel crosses.

Singh and Mishra (1996) reported that both general and specific combining ability effects were significant for characters such as days to 50 per cent silking and yield per plant.

Spaner *et.al.* (1996) in their study reported importance of non-additive gene action for days to silking, plant height and grain yield.

Joshi (1998) carried out combining ability analysis in early maize inbred lines for quality and yield attributes. Based on results they concluded that there was a preponderance of non-additive gene action in the expression of all the characters studied.

Singh (1998) reported from a diallel cross that both *GCA* and *SCA* variances were highly significant for days to tasseling, days to silking, ear height and plant height.

Singh and Singh (1998) reported that *SCA* effects were more significant for the characters namely grain yield per plot, days to 50 per cent silking, plant height and ear height.

Tulu and Ramachandrappa (1998) concluded from the data derived from a 7×7 diallel cross that *GCA* effects were significant for days to 50 per cent silking, ear height, plant height and grain yield, whereas, *SCA* effects were significant for days to 50 per cent tasseling and grain yield. General combining ability variances were higher than specific combining ability variances indicating the importance of additive gene effects in controlling all the traits.

Choukan (1999) reported that both additive and non-additive effects found to be important in genetic control of grain yield, plant height and anthesis-silking interval and only additive effects in controlling days to flowering and ear height.

Paul and Debnath (1999) reported that both the *GCA* and *SCA* effects were significant for all the characters studied viz., days to pollen shedding, days to silking, plant height, ear height and biomass weight per plant.

Singh (1998) reported from a diallel cross that both *GCA* and *SCA* variances were highly significant for days to tasseling, days to silking, ear height and plant height.

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Revilla *et.al.* (1999) while studying 90 hybrids from ten inbred lines in a diallel fashion, observed that both *GCA* and *SCA* effects were significant for days to 50 per cent silking, days to 50 per cent tasseling and plant height.

Tallei and Kochaksaraci (1999) reported that *GCA* and *SCA* effects were important for plant height, ear height, days to silking and days to tasseling. Additive genetic variance was found as the main source of variation for days to tasseling.

Venkatesh and Sarma (1999) reported that additive gene action was predominant for most of the yield components, while non-additive gene action was predominant for maturity traits.

Geetha and Jayaraman (2000) found significant additive and dominance components (H1 and H2) in a 10 x 10 diallel analysis in maize, for plant height and grain yield.

Jagan Mohan Reddy (2000) studied ten QPM lines and their 40 crosses and reported that breeding for grain yield, oil and protein content, high yielding hybrids coupled with moderate oil and protein content observed to be more desirable.

Studies were conducted in tropical areas to examine the combining abilities and their interaction with environments in ten selected maize inbred lines in diallel crosses for identifying promising hybrid combinations. The combining ability analysis of diallel data

across environments showed highly significant ($P < 0.01$) effects for environment, GCA, SCA and GCA X environment interactions. The SCA X environment interaction was not significant (Nass *et.al.*, 2000)

Zelleke (2000) made all possible crosses, excluding reciprocals, among six strains to study yield components. The results revealed that both general and specific combining ability effects were significant for all the traits. Cross-x year interaction was highly significant for plant height and days to maturity. GCA x year interaction was highly significant for grain yield, plant height and days to maturity. SCA x year interaction was significant for days to maturity.

Desai and Singh (2001) studied all possible crosses, excluding reciprocals, among 7 strains for yield components. Results revealed that parents, IB 1073, IB 1143 and IB 1155 had negative GCA effects for days to 50 per cent tasseling, days to 50 per cent silking and anthesis silking interval, but positive GCA effects for plant height, ear height and grain yield per plot. The crosses IB 1073 X IB 1143 and IB 1073 X IB 1155 had negative SCA effects for days to 50 per cent tasseling, days to 50 per cent silking and anthesis silking interval, but positive SCA effects for plant height, ear height, LAI and grain yield per plot.

Dubey *et.al.* (2001) conducted a study with 45 hybrids and 18 parental lines along with four controls. Based on SCA effect for oil content, the two-parent single cross

hybrid exhibited the highest magnitude of economic heterosis among the selected conventional and non-conventional two-parent and multiparent hybrids.

Atnafua (2002) studied 6 QPM inbred lines and 4 testers and reported that grain yield per plot was associated significantly and positively with plant height and ear height at genotypic level.

Appunu (2002) in a study of 45 single crosses derived from ten inbreds crossed in diallel fashion reported that, the hybrids in general were early maturing and high yielding, compared to the parents. Combining ability analysis revealed that, non-additive gene action is the predominant component for physiological parameters and yield contributing characters, favoring hybrid-breeding programme.

Venugopal *et al.* (2002) in their study of combining ability analysis revealed the magnitude of specific combining ability (SCA) variances was higher than that of general combining ability (GCA) variances for all the traits studied, except for days to 50% silking and ear girth, indicating the predominance of non-additive gene action governing the respective traits.

Shanti *et.al.* (2002) studied the nature of gene action and combining ability for grain yield, oil and protein contents in maize lines and reported the preponderance on non-additive gene action in governing the inheritance of these attributes.

Katna *et.al.* (2002) studied combining ability for fifteen yield and related traits at Himachal Pradesh, India (1997) in maize involving 12 x 12 half diallel set with three controls (commercial hybrids) and reported preponderance of additive gene effects in the expression of all the traits studied.

Gautam (2003) found that both general combining ability (*gca*) and specific combining ability (*sca*) effects were significant for all the traits. There is a significant crosses x year interaction for plant height and days to maturity, significant *gca* x years interaction for grain yield, plant height and days to maturity.

Suresh (2004) conducted a combining ability analysis and revealed the importance of non-additive gene action for grain yield and most of the yield contributing characters hence suggested recurrent selection for the improvement of these parameters.

2.2 PHYSIOLOGICAL GROWTH PARAMETERS

2.2.1 Leaf area index (LAI)

Leaf area index is an indirect measure of photosynthetic area, directly contributes to biomass accumulation and CGR. It is an important yield contributing parameter that represents source size. To achieve the required biomass production in a variety, optimum leaf area index has to be ensured first. Though higher leaf area index is considered desirable, the efficiency of the leaf area index depends on the plant type with specific reference to the plant height. Maintenance of sufficient LAI is more important for the

plant to perform optimum photosynthesis, after flowering and translocation of the photosynthates towards the development of grain.

Leaf area index attains the maximum value at or shortly after silking in maize. Variation in maximum LAI depends on plant density, genotype and environment.

In another study involving 8 single cross, double and 3-line hybrids and their parental lines, with regard to plant height, rate of photosynthesis, leaf area and dry weight of above ground parts, measured during early growth in the green house, the single hybrids surpassed mid-parental values upto 44% and surpassed the better parent significantly in each of these characters did not exceed 18 per cent in the double hybrids, but in the 3-line hybrids. TC-278, it reached 22 per cent for leaf area and 30 per cent for dry weights (Markowski and Gresiak, 1984)

In another study involving 4 maize inbreds (B 73, Mo 17, MS 71 and VA 22)) and their hybrids (B73 x Mo 17, B 73 x MS71, B73 x VA 22), LAI of hybrids was approximately twice that of the inbreds for most of the growth period. Hybrids sustained a larger LAI during grain filling and lower leaf senescence of hybrids was less than that of inbreds (Djisbar and Gardner, 1989)

2.2.2 Crop growth rate (CGR)

The CGR is a rate of dry matter production on a unit of land in a unit of time. CGR of $20\text{-g m}^{-2}\text{d}^{-1}$ is considered respectable for more crops, particularly C3 types and CGR $30\text{ g m}^{-2}\text{d}^{-1}$ is obtainable from C4 types such as maize and sorghum (Gardener *et.al.*, 1988).

Crop growth rate tends to remain relatively constant over a considerable period following silking (Hanway, 1962). On the other hand decline in crop growth rate at the later part of the grain filling period was also reported (Vietar and Musgrave, 1975) which they attributed to a decline in leaf photosynthetic rate and LAI.

The crop growth rate of hybrids was approximately twice that of parents/inbreds during 40-100 days after planting. Crop growth rate was 17.5,13.2,15.3 and $14.4\text{ g m}^{-2}\text{d}^{-1}$ in inbred B 73,Mo 17,MS 71 and VA 22 and their hybrids B 73 x Mo 17, b73 X ms 71, B73x VA 22 had CGR of 30.5,29.5 and $29.1\text{ g m}^{-2}\text{d}^{-1}$ (Djisbar and Gardner, 1989).

2.2.3 Net assimilation rate (NAR)

Net assimilation rate is the indirect measure of photosynthetic efficiency of a plant. NAR varies depending on leaf photosynthetic capacity and light distribution in the canopy.

Sizeable differences in leaf photosynthetic rate among maize varieties were reported (Duncan and Hesketh, 1968; Heichel and Musgrave, 1969).

Photosynthesis of inbreds should equal to that of hybrids if LAI and light interception are equal, unless photosynthetic efficiency differs. The fact that CGR, indicative of net photosynthesis, of hybrids was significantly greater than that of inbreds at common LAI and light interception strongly suggests that hybrids are photosynthetically more efficient (Djisa and Gardner, 1989).

2.2.4 Relative growth rate (RGR)

Relative growth rate is the rate of increase in plant material per unit dry weight in unit time. According to the compound interest law, the dry matter added over the time is added to itself, hence the higher the dry matter production per unit, so much greater than proportionate would be the further accumulation.

Studies on RGR of inbred parents and hybrids reported no heterosis (Ashby, 1937). Voldeng and Blackman (1973) and Donaldson and Blackman (1973) examined a set of six triplets (two inbreds and their hybrid) in maize for RGR over a period of 150 days. They reported heterosis in RGR in early stages of growth. The mutual shading of leaves might have influenced light penetration more in hybrids than inbreds resulting in reduced RGR of the hybrid at later stages of growth.

Fokorede and Ojo (1981) observed considerable genetic variation for relative growth rate (RGR), but the expression of growth rate was influenced more by the environment than the constitution of seedlings.

2.2.5 Bio mass production

The amount and magnitude of biomass production is an important yield determining criteria.

The total dry weight produced by a maize crop depends on the size and efficiency of its photosynthetic system and the duration of the interval during which this photosynthetic system functions. Differences in total dry weight produced by the plant can be attributed to differences in either crop growth rate or crop growth duration, since total plant dry weight equals crop growth rate integrated over time.

Dry matter per plant was higher in single cross and triple cross hybrids and was determined largely by foliage area and LAI in the study of 2 inbreds, a single cross and triple cross hybrid for silage production (Pasztor, 1984).

The results of the study on photosynthetic rate and other components of photosynthetic efficiency in eight inbred stocks of maize and all their possible one way crosses demonstrated extensive heterosis in respect of photosynthetic rate and other

photosynthetic indices such as leaf area, number of leaves and chlorophyll content which produced higher biomass productivity and yield (Mehta and Sarkar, 1992).

Bolanus (1995) reported that hybrids had greater biomass production, higher harvest index for open pollinated cultivars.

2.2.6 Chlorophyll

Several workers have suggested that chlorophyll content of a hybrid was greater than the mean of that of its parents (Fleming and Palmer, 1975; Mureson *et.al.*, 1975; Yakoulov and Overhinnikova, 1976; Milavev, 1976; Shereverya, 1976; Fattakhova *et.al.*, 1977). They reported that hybrids with marked heterotic effects had a complete chloroplast structure and their rate of photosynthesis (as measured by Hill reaction) was higher than their parents. They felt that heterosis for chlorophyll content resulted the presence in a hybrid of more loci having dominant or partially dominant genes than in either parents.

Heterosis was reported for chlorophyll content in maize hybrids (Khotyleva *et.al.*, 1988). F₁ hybrids showed positive heterosis in the chlorophyll content and chlorophyll/ carotenoid ratio in the study of 3 parental inbred lines CEB 13, CEB 19 and CEB 29 of *Zea mays* and their F₁ hybrids (Kreb *et. al.*, 1966).

2.2.7 Protein

Proteins are catalysts (*enzymes*), regulators (*hormones*) of body processes, antibodies, and are components of body structure itself which are required for growth and maintenance of all tissues. Quality of protein is equally and fully important as quantity of protein. The corn kernel contains several types of proteins of which the major storage protein found in the endosperm, is 'Zein'. Zein is deficient in tryptophan and lysine, which are essential for monogastric animals for their growth and development. The other types of proteins in both endosperm and germ are biologically balanced.

As early as 1896, Illinois University gave the first evidence that protein and oil content in corn could be greatly increased or lowered by breeding. Further, Hayes and Garber (1919) isolated two strains from Minnesota that averages 15 per cent protein compared to 10.2 per cent for the parent variety.

Earle *et.al.* (1946) discussed the composition of the component parts of the corn kernel, about 20 per cent of the protein is in the embryo and 80 per cent in the endosperm.

Woodworth and Jugenheimer (1948) demonstrated that protein content of inbred lines, could be substantially increased by back crossing, selfing and selection.

Jugenheimer (1958) reported that protein content was significantly correlated with maturity, plant and ear heights, grain yield.

Mertz *et.al.* (1964) reported that the substitution of the normal allele opaque-2 (o 2) allele results in an enhancement of the endosperm nutritive value of corn as opaque-2 mutants have twice the lysine and tryptophan amounts than normal maize. Nelson *et al.* (1965) studied the effect of floury 2 (fl 2) gene, which in homozygous condition causes an increase in lysine and tryptophan content of corn protein.

Protein is a scarce, expensive but necessary constituent of food and feed. Lambert *et.al.*(1967) studied the relative performance of normal and modified protein (opaque-2) corn hybrids. They reported that opaque-2 hybrids were lower in grain yield and weight per 100 kernels and high in protein.

Lambert *et.al.* (1969) studied the relative performance of normal and modified protein (opaque-2) corn hybrids and reported that the opaque-2 hybrids were lower in grain yield and weight per 100 kernels, but higher in grain moisture, cracked kernels, total oil content and twice in lysine and tryptophan content.

Dudley and Lambert (1969) reported that coroico corn, a South American race of floury maize contained two to six layers of aleurone cells in which high quality proteins and vitamins are concentrated. The total protein in coroico aleurone was 35 to 38 per cent compared with 22 per cent in yellow dent corn and improvement of protein nutritional

quality using coroico germplasm appears worthwhile. They reported significant genetic variability for both oil and protein contents after 65 generations of selection in Illinois High Oil (IHO), Illinois Low Oil (ILO), Illinois High Protein (IHP) and Illinois Low Protein (ILP) strains.

Geuter and King (1971) investigated the nutritive value of the protein in high-oil selections in corn. They developed inbred lines by continuous selfing and simultaneous selection for high protein and high oil content. Grain of sixth generation-inbred lines was analysed and then composited to represent the four possible combinations of high and low, oil and protein. They found that the protein digestibility of all four composites were lower than that of a field corn which was included as standard.

Palii *et.al.* (1983) reported that appreciable differences in protein yield per hectare were not only due to protein content but also due to the effects of environment and genotype x environment interaction. Hybrid grain yield was concluded to have an increased crude protein content when the material parent had a higher crude protein content. High crude protein in the F₁ could be obtained by crossing high yielding, low crude protein lines.

Ninidze *et.al.* (1987) reported that hybrids Kartuli 52 and Kartuli 9 slightly exceeded their parental lines in total protein content and differed from them in content in individual protein fractions of the endosperm.

Further Proksza and Harmati (1988) reported that hybrids with a relatively short vegetative period had high protein contents. Hybrids with moderate protein content but high yielding capacity produced high protein yield.

Doehlert and Lambert (1991) studied the metabolic characteristics associated with starch, protein and oil deposition in developing kernels. Amino acid concentration in immature kernels were correlated with the activities of phosphoglucosomerase, Phosphoglucosomase, Pyrophosphate fructose-6-phosphate-1-phosphotransferase, aldolase and with mature kernel protein content.

Further, Wilson (1992) studied zein diversity in Reid, Lancaster and Illinois chemical corn strains by isoelectric focusing. They reported many identifiable zein proteins many of which showed variation and segregation in each strain. Corcuera *et al.* (1994) reported that mean endosperm protein content in 19 selfed ears ranged from 5.4% to 13.9%

Deshmukh *et.al.* (1995) reported that protein content ranged from 8.4 to 11.2 per cent in 15 maize cultivars studied. They also reported that Hunis composite, Manjari composite, Ganga safed-2, Deccan-103 were superior to the other cultivars studied for protein content and quality.

Gloverson *et.al.* (1996) reported significant variability for protein content and protein quality among the array of maize genotypes. Protein content (mg/100g flour) ranged from 6.7 to 13.5 for normal and 6.5 to 11.9 for opaque-2 genotypes.

Tagore Varma (1998) had reported protein content in maize hybrids derived from 6 lines and four testers ranged from 8.465 to 12.86%. The highest protein content recorded in the cross TWS-13 x Pozarica 90 27.

Ramagopal (1999) reported high variability for protein per cent, grain yield per plot and also significant correlation between grain yield and protein per cent.

2.2.8 Oil

Corn oil is one of the most valuable products of the corn milling industry and is important by-product of starch manufacturing process. Increasing awareness of nutritional importance of polyunsaturated fatty acids (PUFA) in the diet has resulted in public interest in corn oil, as it possesses a very high proportion of unsaturated fatty acids. Industrial processors of corn have consistently encouraged studies on oil content of maize; an increase in quantity of corn oil could result in increased grain value. In Indian maize varieties oil content is about 4-5 per cent, while in USA the available corn strains possess 18-22 per cent oil and are being cultivated as an important source of very good quality oil. Corn oil contains predominantly (>88%) essential polyunsaturated fatty acids like oleic, linoleic, arachidic acids which make the oil easy to digest and is very fruitful to the patients suffering from cardiological complications. High oil strains of corn were

reported to have higher biological value than low oil corns (Schneider *et al.*, 1952). Corn breeders at Illinois University have been selecting for high oil content continuously, since 1896, which had resulted in the release of several inbred lines with high oil content like R75, R76, R84, R154, R196, R197, R801, R802A, R803, R804 and R805 (Jugenheimer and Williams, 1960 and Henderson, 1972).

In India breeding work has been done, for exploiting the potential of maize as a source of edible oil. There is a strong possibility to develop hybrids, which are nutritionally superior and industrially important with respect to high oil and protein content. If the objective is realized, maize crop in India can attain very high productivity vis-a-vis traditional oil seed crop. Maize oil can impart very high economic importance to this crop, if exploited properly through heterosis breeding.

Studies made in this direction by different workers are reviewed here under.

Hopkins *et. al.* (1903) were the first to report the presence of oil in maize seed in their study on the structure of corn kernel and its chemical composition.

Earle *et.al.* (1946) reported that maize endosperm contained approximately 75 per cent of the total protein and 15 per cent of the total oil kernel, while the germ contained about 22 per cent of the protein and 84 per cent of the oil.

Woodworth and Jugenheimer (1949) successfully attempted the transfer of "high oil trait" to maize inbred lines. Sprague and Brimhall (1949) demonstrated the possibility of modifications in the oil content of corn grain by appropriate selection procedures. Later on Miller and Brimhall (1951) reported factors influencing oil content of corn grain as:

1. Increased oil content in corn grain depended primarily upon
 - a. Increased proportion of germ.
 - b. Increased concentration of oil in the germ.
2. Variation in total oil per cent, however, was positively correlated with per cent protein and relative concentration of tryptophan in the corn kernel.
3. Genotypes of the ear-bearing parent had predominant influence on the oil per cent of the grain produced.

Curtis *et.al.* (1956) studied the effect of pollen parent on oil content of corn kernel and reported that germ portion was markedly influenced in weight, oil content and protein content by both seed and pollen parent. Both seed and pollen parent also influenced the endosperm, but effect of the seed parent was not evident in the germ. Further, a slight tendency was noticed for influence of the pollen parent on oil content of the hull, in a manner similar to metaxenia as described in other plants.

High oil strains with an oil content of 15-17 per cent have been bred in USA, but they do not yield as normal maize. Crowley (1958) crossed nine standard corn belt inbred lines with two testers *viz.*, Illinois High Oil (IHO) (15.0% oil) and Illinois Low Oil (ILO)

(0.76% oil). The high oil top crosses yielded on an average 14 per cent less than the low oil crosses. This may be attributed to the large germ and reduced endosperm noticed in the high oil lines (Jugenheimer, 1961). Leng (1967) also studied the changes in kernel and germ weight, germ per cent and weight of oil in the "Illinois High Oil" strain of corn during 1962-63 growing seasons. Dry weights of both whole kernels and germs increased in a linear manner from the 1st sampling date (19 to 21 days after pollination) to about the end of 7th week of kernel development. The ratio of germ to whole kernel dry weight (germ %) further continued to increase from the 1st sampling date to, until the kernel was near physiological maturity. Germ oil per cent also rose rapidly from around 38 per cent on the 1st sampling date to 54 per cent by the end of 4th week of kernel development. Later on it remained nearly constant. As a result, whole kernel oil per cent increased in about the same manner as germ proportion and did not reach maximum level until about the end of 7th week after pollination.

Alexander and Lambert (1968) studied the possible mutual exclusiveness of high oil content and high yield of grain. They observed that xenia was apparent in the oil contents of the grain of six single crosses. Plants pollinated by low oil males produced significantly lower calories of oil than those pollinated by high oil males.

Curtis *et.al.* (1968) stated that selection for higher or lower oil content resulted in major changes in kernel components affecting oil and kernel development patterns influencing oil content. Illinois high oil (16.45 whole kernel oil) has a larger germ, higher oil percentage of the germ and reduced endosperm size all of which contribute to higher

oil percentage. Illinois low oil has very low oil content because of small germ size, lower oil percentage of the germ and increased endosperm size. However, majority of the oil was located in the germ by 30 days after pollination in the high oil strains and by 36 days in all strains.

Boszormenyiz *et.al.* (1969) studied five sub-species of corn and revealed that sweet corn has the greatest oil content and dent the least. A high or low oil content is a hereditary character. Significant associations were found between the size of the embryo and the contents of oil in the whole grain ($r=0.64$) and that between the contents of oil in the embryo and in the whole grain.

Zozulya (1969) studied five subspecies of corn. The results revealed highest oil content in sweet corn and the least in dent corn. It was reported that high or low oil content was mostly a hereditary character. Significant associations were also found between size of the embryo and oil content in the whole grain ($r=0.64$) and between oil content in the embryo and the whole grain. Further, Zozulya (1971) studied yield and other economically useful characters in oil content. He reported on the possibility of obtaining inbred lines in addition to single and double cross hybrids with high oil yield coupled with other valuable properties.

Dudley *et.al.* (1977) made all possible crosses, excluding reciprocals, among nine strains to study and measure their performance. The results obtained suggest that

- i. Grain yield is negatively correlated with per cent oil and per cent protein.

- ii. Per cent protein in the kernel is primarily determined by per cent protein in the endosperm.
- iii. Caloric content of grain as calories per gram dry matter are largely determined by oil per cent while calories per kernel are largely determined by kernel weight or grain yield.
- iv. Sum of squares due to heterosis accounted for only 5 and 7 per cent respectively, of the entire sum of squares for per cent oil and per cent protein, while for grain yield and protein, they accounted for over 50 per cent of the entire sum of squares.
- v. Evidence was also obtained for dominance of both high and low per cent of oil content.

Funduianu and Moga (1980) in their study on grain yield, oil content and oil yield, conducted during two years of cultivation of 64 half sib families and 256 full sib families, reported significant additive components of genetic variance for oil content and oil yield. Further, for oil yield selection was equally effective, whether based on half-sib families or mass selection.

Miller *et.al.* (1981) studied the response of seven cycles of high intensity selection for oil per cent in the 'Reid Yellow Dent' corn cultivar with in the half sib family and resulted in an increase of oil per cent from 4.0 to 9.1 per cent, while kernel weight and ear height were reduced slightly. However, no significant changes were observed for yield, silking date and plant height.

Cabulea *et al.* (1984) indicated that simultaneous improvement for higher contents of crude protein and oil coupled with earliness would be difficult.

Song *et al.* (1986) determined oil content in maize kernel by NMR spectroscopy and protein content in the cultivars Reid Yellow Dent and Synthetic-Alexho. Significant positive correlation was also established between oil and protein contents indicating that selection for oil content can improve the overall nutritional quality of the grain. Similarly, Kovacs *et al.* (1986) reported a simultaneous increase in protein content upon selection for high oil content ($r=0.69$). This was attributed to the concomitant increase in embryo size. Hence, they proposed combined selection for oil and protein in maize.

Pamin *et al.* (1986) estimated the genetic parameters of oil content and composition and the results revealed that significant genetic variation existed for both fatty acid and per cent oil content. Further, oil quality and quantity was reported to be amenable to change by recurrent selection.

Galeev *et al.* (1986) studied crosses between strains differing in oil content (high x high, low x high and low x low). There is no fall in oil content was noticed in crosses between two high oil strains. However, hybrids between contrasting parents were intermediate between their parents in oil content.

Proksza and Harmati (1988) reported that early hybrids in general tended to have high oil content. The oil yields were usually highest in hybrids with moderate oil content coupled with high yielding capacity.

Misevic and Alexander (1989) reported that selection was effective in increasing oil concentration. The selection for oil concentration resulted in plant height, ear height, 100-kernel weight, ear length and lodging, while grain moisture and ear row number increased. However, no change was observed for days to silking.

Lambert *et.al.* (1997) reported that high oil hybrids having increased oil content were found to be inferior in grain yields than normal hybrids.

Lambert *et.al.* (1998) reported that the increase in oil levels in the Normal Oil (NO) hybrids pollinated by a High Oil Pollinator (HOP) was the result of a small increase in grain weight, an increased concentration of oil in the germ, and a reduction in the percentage of endosperm. The changes in kernel traits do not appear to reduce grain yields of the NO hybrids, but do increase oil levels.

2.3 CORRELATION STUDIES

The grain yield per plant is the net result of interaction of several genetic factors on one hand and their individual or combined interplay with environmental factors on the other. Therefore, the association of characters among themselves or with grain yield

assumes greater significance. The knowledge of relative contribution of characters to yield directly as well as indirectly through other characters, play an important role in plant breeding. Correlation forms the basis for selection index thereby helping the plant breeder for crop improvement.

Strube (1967) analysed correlation between characters and their importance in selection. They found highest phenotypic and genotypic correlation between dry matter content and days to flowering. Environmental effects were less than the corresponding phenotypic and genotypic effects, except for the effect of year upon correlation between yield and dry matter content.

Patil *et. al.* (1969) in their biometrical study on Deccan hybrid maize (double cross) grown at three locations in respect of ear height revealed that yield of grain was positively and significantly correlated with ear height.

Tomasjewaski and Idzkowaska (1972) concluded that correlations were positive and significant for time to tasseling and silking, height of plant, ear height and total grain yield in maize.

Zozulya (1971) reported a significant positive correlation in inbred lines between the oil content and various economically valuable plant, ear and grain characters.

Krivosheya and Zozulya (1974) studied the inter-relation of characters in maize hybrids. They found that significant contribution to grain yield is made by biological yield followed by a significant, but a smaller contribution by plant height and ear height. In two of the three trials, a negative correlation with grain yield was observed. Harvest index, in turn, showed a significant negative correlation with late maturity, plant height, ear height, and above all, with biological yield.

Tomzei *et. al.* (1974) in a study of inbred lines, their F1 and F2 progeny, detected weak positive correlations between yield per plant and dry matter content. A weak negative correlation was found between grain yield per plant and protein content.

Mureson *et. al.* (1975) reported that chlorophyll content and accumulation of dry matter were closely related in hybrids and inbreds.

Lein and Oycherenko (1976) studied the starch and protein content of 4 hybrids in 4 different environments. They reported a negative correlation between yield and protein content but these correlations were not significant in all cases.

Grebnschikov (1977) and Dudley *et.al.*(1977) reported that grain yield per plant was weakly and negatively correlated with protein percentage.

Rupak *et.al.*(1979) found that in eight pop corn varieties and twenty eight crosses, grain yield was significantly associated with an ear height, plant height.

Laptev (1981) and Sharma *et.al.*(1982) reported that yield was positively correlated with plant height and ear height. Bhole and Patil (1984) observed that grain yield had positive and significant correlation with days to tasseling.

Godawat (1982) reported that grain yield per plant had significant positive correlation with ear diameter, plant height.

Raman *et.al.*(1983) in their study of a 27 line x 3 tester experiment revealed that grain oil content was positively correlated with grain yield.

Xhepa *et. al.* (1984) reported that protein content was negatively correlated with oil content and the latter was weakly and negatively correlated with grain yield/ha.

Batnaru (1985) reported that leaf area was closely correlated with biological yield in hybrids in a study involving three hybrids derived from crosses between 7 inbred lines. Yield per leaf area may be suggested as a criterion in the selection of new genotypes.

Pamin *et.al.*(1985) reported that yield was positively correlated with total oil/ha and ear height.

Zelenskii and Khyutin (1985) reported positive correlation between grain yield and plant height and ear height. Parh *et.al.* (1989) revealed significant positive

correlations between days to maturity and grain yield per plant. Zozulya (1986) reported positive correlation between plant height and ear height.

Bianco *et.al.* (1987) reported negative correlation between oil content and both plant and ear heights. They suggested that selection for oil content will result in a reduction in plant and ear heights.

Djisbar and Brewbaker (1987) reported that grain yield was highly correlated with plant and ear height in both normal maize and hybrids.

Sharma and Kumar (1987) also reported that grain yield per plant was positively associated with plant height, leaf area and tassel height.

Chmeleva *et.al.* (1988) reported that protein and oil contents were correlated ($r=0.59$). They also reported that 6 high protein lines had high oil content.

Tyagi and Pokhiryal (1988) observed that the ear height and plant height were positively correlated with grain yield.

Annapurna ((1989) observed significant positive correlation for grain yield with plant height and days to 75 per cent tasseling and 75 per cent silking had a negative correlation.

Bullock *et.al.* (1989) conducted field experiments in Georgia, USA on 11 short, 13 mid and 4 full season commercial maize hybrids. They reported that protein yield was positively correlated with grain yield. Oil yield was positively correlated with grain and protein yield and oil concentration, but not correlated with protein concentration.

Farhatullah (1990) reported significant and positive correlation between grain yield and ear height.

Ramesh (1990) reported from a study of hybrids involving 100 parental inbred lines that plant height has strong negative correlation with yield and yield components

Spaner and Mather (1992) in an evaluation of top cross hybrids reported significant correlation of grain yield with days to 50 per cent silking and anthesis.

Genetic correlation analysis of nine characters related to photosynthesis and grain yield revealed significant positive correlation between leaf area per plant, area of the three leaves near the cob and leaf area of seedlings at the grain filling stage in 15 hybrids from a diallel cross involving six inbred lines of maize (Zhang and Wang, 1992).

Rao (1993) reported a high positive correlation between plant height and ear height.

Correlation studies made by Umakanth (1993) indicated a negative correlation between yield and both oil and protein contents.

Robin and Subramanian (1994) reported a significant positive correlation was observed between yield and plant height.

Venkatesh (1994) reported that the characters days to 50 per cent silking and days to 50 per cent tasseling exhibited negative correlation with grain yield.

Krishnan and Natarajan (1995) reported significant and positive association of grain yield with plant height, dry matter production and harvest index.

Rahman (1995) observed that grain yield was significantly and positively correlated with plant height.

Naresh Kumar and Singh (1996) studied six cultivars of maize viz., Ganga-5, Hi-starch, Deccan 103, Manjara, Aruna and Diara and reported that total chlorophyll was correlated positively with leaf area per plant, leaf area duration and grain yield and negatively with NAR and crop growth duration. Chlorophyll content was correlated with yield (Adhikari, 1989 and Allurwar and Deotale, 1991).

Spaner *et.al.* (1996) reported that both phenotypic and genotypic correlations between time to silk, plant height and grain yield were positively significant.

Tusuz and Balbanti (1997) observed that yield was significantly correlated with 50 per cent silking ($r=0.67$), plant height ($r=0.50$) and ear height ($r=0.42$).

Annapurna *et.al.* (1998) reported that seed yield was positively significantly correlated with plant height, number of seed rows per ear and test weight.

Netaji (1998) reported grain yield per plot was significantly and positively correlated with all characters barring days to 50 per cent tasseling, silking and maturity where it was negatively correlated, both phenotypically and genotypically.

Reddy (1998) reported grain yield per plot was found to be significantly and positively correlated with yield component characters, namely, plant height and ear height. However, negative and significant association of grain yield was noticed with days to 50 per cent silking and days to maturity.

Gautam *et.al.* (1999) studied 50 indigenous genotypes of maize collected from different agroclimatic situations and reported that grain yield was positively correlated with plant height and ear height.

Mani (1999) reported from their studies that grain yield was positively significant with plant height and ear insertion height.

Rathore *et.al.*(1999) studied 19 cultivars. Results revealed that estimates of genotypic correlation coefficients were generally higher than their corresponding phenotypic correlation coefficient. Strong genotype environment interactions were observed. Days to 50 per cent silking were positively correlated with ear height and grain yield. Plant height had no association with grain yield.

Umakanth *et.al.* (2000) reported that grain yield was negatively correlated with days to 50 per cent silk and yield correlation was highest (0.588) with plant height. Plant height and ear height as positively correlated with grain yield.

Kumar and Kumar (2000) identified that the balanced selection in the form of high yielding hybrids with moderate oil contents needs to be emphasized while breeding for both grain yield and oil content.

According to Venu Gopal (2000), there was negative and non significant correlation between grain yield and oil content of maize kernels. Existence of positive correlation between oil and protein contents and negative correlation with grain yield indicates the possibility of simultaneous improvement of protein and oil, but leading to reduction in grain yield (Krishna Raju, 2001).

Ravindra Babu (2002) reported in his studies that oil and protein contents had significant positive correlation with each other and negative correlation with yield.

Satyanarayana *et al.* (2003) recorded that the grain yield had a significant positive correlation with all the traits except with oil and protein content. Oil content was positively correlated with protein content and vice versa. Thus, selection for grain yield in addition to oil and protein content should involve high-yielding lines with average oil and protein contents.

Kabdal *et al.* (2003) revealed the results based on the data recorded on eight yield related traits; the values of genotypic correlation were slightly higher than the corresponding phenotypic values. Phenotypic and genotypic correlations between grain yield on one hand and plant height, ear height and ear length on the other were positive and significant.

Suresh (2004) obtained a significant and positive correlation between grain yield, plant height and ear height at two locations in two seasons.

2.4 PATH COEFFICIENT STUDIES

Direct effect of a character on yield may be found through the study of genetic correlation. But, path coefficient analysis allows separating the direct effect and their indirect effects through other attributes by portioning the correlation coefficients (Wright, 1921).

Panchanatham (1978) reported that a direct effect of the plant height on grain yield was positive.

Path coefficient studies of Rupak *et.al.*(1979) revealed maximum direct effects of plant height on yield.

Malhotra and Khetra (1986) reported that the direct effect of plant height and ear height was small as that of days to silking.

Parh and Hussain (1986) reported that direct effects of maturity and height on yield were negatively indicating possibility of selecting early short high yielding plants.

Sharma and Kumar (1987) in a study involving 24 genotypes of popcorn showed that the grain yield of maize was directly influenced by plant height and leaf area.

Tyagi and Pokhriyal (1988) studied correlation and path analysis and indicating that the components that affected grain yield were ear weight, ear length, plant height, kernels per row and 100-kernel weight in that order of importance. The effect of days to 50 per cent pollen shedding and silking however revealed that the early matured plants had relatively lower yield.

Chandramohan (1999) reported that oil content and protein content had direct negative effects on yield.

Krishnam Raju (2001) studied the path coefficient analysis and revealed that protein yield had direct influence on grain yield.

2.5 STABILITY

Importance of Genotype X Environment interaction was recognized almost since the breeding programme was started. The occurrence of genotype environment interaction has long provided a major challenge in obtaining complete understanding of the genetic control of variability. The genetic effects are not independent of the non-genetic environmental effects. Yates and Cochran (1938) sub-divided Genotype Environment interaction into linear and non-linear components. Allard and Bradshaw (1964) and Allard and Hanmsche (1964) quoted the term stability as “well buffered “ capacity of genotypes. Thus stability is universally related with genotype x environment interactions.

Allard and Bradshaw (1964) stated that the nature of genotype x environment interaction were extremely complex. It was proved that G X E interaction usually exist irrespective of the fact whether the varieties are of pure lines, single cross/double cross hybrids, test crosses and segregating populations or any other material with which breeder may be working (Eberhart and Rusell 1969).

Sprague and Federer (1951), in a reanalysis of maize data obtained over many environments presented evidence that double crosses interact with environments less than single crosses. Eberhart *et.al.* (1966) also reported that when

the two types of crosses were compared in the same experiment hybrid X year interaction were significantly greater for single than for many crosses. Though different stability models are available for G X E studies, regression analysis of Eberhart and Russell (1966) has been widely used by many workers.

Eberhart and Russell (1966) emphasized the need of considering both linear (β_i) and non linear (S^2_{di}) components. In order to be practical use, the variety should have desirable mean.

Genotype x Environment (G X E) interactions which commonly occur in plant material are of considerable importance in developing improved varieties and rationalization of policy and procedure in breeding programmes aimed at further genetic improvement in crop plants. Hence, in recent years much emphasis has been laid on the nature of G X E interactions. Earlier Finlay and Wilkinson (1963) considered linear regression as a measure of stability.

Creech *et.al.* (1968) conducted a multi-location test with fourteen corn hybrids at five locations and for three years. They observed the plant height showed significant location x hybrid and year x hybrid interactions, while the characters, viz., number of days to 50 per cent silking days to harvest and the length of the blank tip showed non-significant location x hybrid interaction.

Eberhart and Russell (1969) in their study to find out stability between single crosses and double cross hybrids derived from ten inbred lines of maize and a balanced set of forty five double cross hybrids from the same inbred lines plus ten commercial hybrids, grown at two locations in 1965-66, observed, two of the single crosses were as stable as any other double cross. Although the single crosses differed in their ability to respond to more favourable environments, the most important stability parameter appeared to be the deviation mean square. Since all types of gene action appeared to be involved in this stability, they suggested that evaluations of potential single crosses must be done over a range of environmental conditions to identify stable, high yielding single crosses for commercial release.

Ramamurthy *et.al.* (1970) measured the regression of yield of each maize hybrid on the mean yield of all varieties in each environment with thirteen F_1 hybrids, a local variety and a control in five locations. Few of the hybrids were found to be superior to all other as regards to yielding capacity and wide adaptation and one of them out-yielded all varieties in all the locations.

Olivieri and Parrini (1974) while evaluating the yield stability in maize genotypes observed the hybrids to be more variable in yield than open pollinated varieties but higher yielding on the average. This was explained as a greater capacity to favourable environmental conditions.

Das *et.al.* (1987) recorded the presence of significant differences among genotypes of maize and environments for all the traits studied. The G X E interaction mean squares was significant for grain yield, plant height and days to 75 per cent husk browning (maturity) showing the variable response of varieties to a range of environments. The highly significant variation due to linear response of varieties was observed for all these traits.

Parh *et.al.* (1989) studied the genotype location interaction for silk emergence and yield of 11 exotic maize lines over four locations of Bangladesh. Estimated stability parameters (b_i and $S^2d_i = 0$) for silk emergence indicated that all the lines, both early and late, were average in response ($b=1.0$) and stable ($S^2d_i = 0$) over the locations. However, for yield, in high yielding lines ponta Grossa 8342, Rat. Arnold (1) 8244 ND Across 4244 showed high sensitivity with changes of locations. Except Rat. Arnold (1) 8244, the remaining two lines had minimum deviations from regression ($S^2d_i = 0$) indicating good stability. Cultivar Barnali was found to be suitable for overall cultivation for its average response ($b = 1$), minimum from regression deviation and very close mean yield to the grand mean.

Gentinetta *et.al.* (1988) evaluated 7 opaque- 2 maize hybrids for agronomic viz., grain yield, plant height, ear height, 100 seed weight and protein content at 11 locations. Two hybrids maintained high yields and stability for the traits in different locations.

Vega and Vega (1992) evaluated 24 maize hybrids at 7 locations to obtain estimates of parameters describing yield stability over environments. The estimates were used for empirical comparison and association study. The methods based on the effects or sum of squares of G X E interaction were useful and their stability parameters showed the highest coefficient of correlation.

Information on stability is also derived (Mahajan and Khehra, 1992) from data on 6 yield components in 28 F1 hybrids from a diallel cross of 8 maize inbred lines growing at 2 locations in Punjab during winter. Deviation from regression appeared to be more important parameter than regression for measuring stability.

For evaluating maize top crosses for their potential use in breeding programme, Gomes -e- Gama *et.al.* (1993) conducted experiments at three locations in Brazil. Both single cross hybrids and populations had longer environmental interactions than the top crosses.

Singh and Haque (1993) reported no appreciable gain in information on stability from evaluating more than 3 locations.

Information on stability was derived based on grain yield of 11 genotypes when grown in temperate wet areas of Himachal Pradesh. Gautam *et. al.* (1998) reported that the local check performed well by recording highest average yield.

The effect of additive, dominant and epistatic gene action on grain oil content was investigated by Rosulj and Saratlic (1998) in two maize inbred lines differing in oil content. The additive gene effects were highly significant at two locations. Epitasis did not contribute significantly to the inheritance of oil content. A comparison of gene effects in the different environments did not show significant Genotype x Environment interaction.

The methods to be used to estimate stability of corn hybrids for grain yield depend on the characteristics of the experiment. Luquez and Jura (2000) used three methods to estimate stability, among which the test of relative yield (RY) that uses standard deviation as the measure of stability found to be the best in corn improvement programmes, as there is possibility to classify some materials as high yielding and stable, avoiding the bias that high yielding environments given to the general average.

Scapion *et. al.* (2000) evaluated twenty maize cultivars at eight locations for two years using three procedures to analyze cultivar stability and adaptability. The level of associations among the three parameters was assessed using Spearman's rank correlation. The results revealed that the most responsive cultivars tended to have smaller π_i and did not correlate with Huehn's non parametric measurements $Si(2)$ and $Si(3)$ but correlated positively with $Si(1)$ indicating that superior genotypes with lower π_i could also be stable.

Aguiar *et.al.* (2003) studied adaptability and stability of twenty five entries in seven environments and reported significant differences for entries and environments for all the traits studies i.e., grain yield, plant height, ear height, ear placement and prolificacy. The genotype environment interaction was significant for all traits.

Dodiya and Joshi (2003) studied eighty-six genotypes of maize (*Zea mays*) for Genotype x Environment (G x E) interaction and stability parameters with respect to yield and maturity over three locations (Udaipur, Banswara and Pratapgarh) in Rajasthan, India. The results showed significant G x E interaction for both characters studied (days to 50% brown husk and grain yield per plant) and more number of genotypes was found to be stable for maturity compared to grain yield across the environment as indicated by the non-significant deviation from regression in stability analysis.

Narasimha Reddy (2003) conducted a stability analysis experiment involving 45 diallel crosses, ten parents and two checks at three locations during *kharif* 2001. The results revealed that the stability of grain yield was due to stability of shelling per cent, ear length, number of seed rows and number of seeds per ear.

MATERIALS
AND
METHODS

CHAPTER III

MATERIALS AND METHODS

The present investigation was undertaken with an objective of identifying the most suitable QPM single cross hybrids, which could surpass the yield of existing normal hybrids based on study of the genetic parameters such as combining ability, correlation and stability using diallel-mating design. The studies were conducted during *Rabi* and *Kharif* 2002-03 at two locations viz., College farm, College of Agriculture, Rajendranagar, Hyderabad (Location 1) and Regional Agricultural Research Station, Palem, Mahaboobnagar (Location 2). The college farm is situated at an altitude of 542.6 m above Mean Sea Level. Geographically, it lies at latitude of 18.5 °N and a longitude of 77.53 °E. the Regional Agricultural Research Station, Palem is situated at an altitude of 532.7 m above Mean Sea Level. Geographically, it lies at latitude of 16.8 °N and a longitude of 70.43 °E.

The materials used in the present investigation, methods, characters studied and statistical procedures followed for analysing the data were described under the following heads:

- 3.1 Experimental material
- 3.2 Methods
- 3.3 Characters studied
- 3.4 Statistical analysis

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3.1 EXPERIMENTAL MATERIAL

The experiment material for the present investigation comprised ten promising elite genotypes *viz.*, P₁, P₂, P₅, P₇, P₈ and P₁₀ were of flint grain type and the remaining four lines were of dent grain type (P₃, P₄, P₆, P₉). These parental lines were mated in diallel fashion to obtain single crosses. Standard checks *viz.*, Madhuri and Shaktiman-2 were involved.

3.2 METHODS

3.2.1 Generating breeding material (crossing)

Based on top cross data and combining ability studies ten elite parents were selected. These parents were mated in diallel fashion excluding reciprocals to produce 45 F₁'s during *Kharif* 2002 at A.R.S, Amberpet, Hyderabad. The 45 F₁'s along with parents and checks will be evaluated for two seasons in two locations (Rajendranagar and Palem), each during *Rabi* and *Kharif* seasons of 2002-2003. The details of parental lines are given below:

S . No	Parents	Pedigree	Source (line developed at)	Grain colour/ texture	Quality Charact
1.	P ₁	TQPM 178-1-1-1-⊗	A.R.S. Amberpet	GYSF	High protein+high oil
2.	P ₂	PK (C103ae x B 73ae B-3-6-1-1-1-1-⊗	A.R.S. Amberpet	Deep Rose F	High protein
3.	P ₃	QPM 46-3-1-2-1-1-1-⊗	A.R.S. Amberpet	OD	High protein
4.	P ₄	TQPM 34-1-2-1-⊗-2-1-1-⊗	A.R.S. Amberpet	GYD	High protein+high oil
5.	P ₅	QPM 10-2-1-1-1-1-⊗	A.R.S. Amberpet	OSF	High protein
6.	P ₆	TQPM 42-1-2-1-⊗-2-1-1-⊗	A.R.S. Amberpet	YD	High protein+high oil
7.	P ₇	TQPM 80-1-2-1-⊗-1-1-1-⊗	A.R.S. Amberpet	OYF	High protein+high oil
8.	P ₈	DMR 274-1-1-2-1-1-1-1-⊗	DMR	RF	Medium protein+high yield
9.	P ₉	QPM 35-1-1-1-1-⊗-1-1-⊗	A.R.S. Amberpet	OD	Medium protein+high yield
10.	P ₁₀	QPM 89E-1-1-1-⊗-5-1-1-⊗	A.R.S. Amberpet	OF	High protein

G: Golden; Y: Yellow; S: Semi; F: Flint; O: Orange; D: Dent;

R: Rose

3.2.2 Evaluation of crosses

The single crosses developed through diallel mating design were evaluated during *Rabi* 2002-03 and *Kharif* 2003 at Rajendranagar and Palem for studying the magnitude of

gene action, combining ability effects, correlations and stability for yield and physiological growth parameters.

3.2.3 Design

Randomized Complete Block Design (RCBD) was followed for conducting the experiment with three replications. Each replication consisted of 57 entries, which included ten parents, 45 crosses and two standard checks.

3.2.4 Sowing

The plot size for each entry was a single row of five-meter length, with a spacing of 75 cm and 20 cm between rows and plants respectively. Initially two to three seeds per hill were sown and after germination, the population was thinned out to a single seedling per hill. Border rows were planted to eliminate the border effect.

3.2.5 Crop Husbandry

The field was uniformly fertilized with the recommended dose of 120 kg Nitrogen, 40 kg Phosphorous and 20 kg Potassium per hectare. The entire P and K and half dose of nitrogen was applied as basal, the remaining nitrogen was applied in two equal split doses at knee height and tasseling stages. Usual recommended cultural practices were adopted to maintain a good crop.

3.3.1 CHARACTERS STUDIED

In the present investigation data on the following characters were recorded.

Morphological parameters:

1. Days to 50 per cent tasselling
2. Days to 50 per cent silking
3. Anthesis -silking interval (days)
4. Days to maturity
5. Plant height at maturity (cm)
6. Ear height (cm)

Physiological parameters:

7. Leaf area index (at 50% silking)
8. Leaf weight (at 50% silking)
9. Crop growth rate ($\text{g m}^{-2} \text{ day}^{-1}$)
10. Relative growth rate ($\text{g g}^{-1} \text{ day}^{-1}$)
11. Net assimilation rate ($\text{g m}^{-2} \text{ day}^{-1}$)
12. Specific leaf weight (mg cm^{-2})
13. Total biomass at maturity (kg/plot)
14. Total chlorophyll content (mg/g) (at 50% silking)
15. Harvest index

II Biochemical traits

16. Total seed protein (%)
17. Seed protein yield/ha
18. Oil per cent
19. Oil yield/ha
20. Tryptophan content (g/16g N)

III Grain yield per plot per entry (Kg)

3.3.2 Observational procedure

Five competitive plants were selected at random in each plot for recording data except for days to 50 per cent tasseling, days to 50 per cent silking, ASI, days to maturity and grain yield which were recorded on plot basis.

Growth analysis

The destructive sampling was taken at an interval of 15 days interval. One square meter plot was demarcated with pegs at the center of the plot eliminating the border rows. Five plants were selected randomly and dugout along with the root system. The roots were washed thoroughly to remove the soil particles. The plants separated into leaves, branches, flower, stem and root. The separated plant parts were dried in hot air oven at 75 to 80°C for 48 hours to constant weight. Each dried component of plant weighed separately on an electronic balance.

The particulars of characters studied are as follows:

1. Days to 50 per cent tasseling:

Number of days from the date of sowing to the date of 50 per cent plants shedding pollen was recorded.

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2. Days to 50 per cent silking:

Number of days from the date of sowing to the date of 50 per cent plants with silk emergence was recorded.

3. Anthesis silking interval (days):

Number of days taken from days to 50 per cent tasseling to days to 50 per cent silking.

4. Days to maturity

Number of days from the date of sowing to the date of 50 per cent plants turned to brown husk was recorded.

5. Plant height at maturity (cm):

The measurement was recorded from the base of the plant to tip of the tassel.

6. Ear height (cm):

Measurement was taken from the base of the plant to the mode of attachment of the upper most ear.

7. Leaf area index (LAI):

The leaf area index (cm²) was measured by using LI-3100 Area meter (LICOR-Lincoln, Nebraska, USA).

$$\text{Leaf area index (LAI)} = \frac{\text{Leaf area (cm}^2\text{)}}{\text{Ground area (cm}^2\text{)}}$$

8. Leaf dry weight (at 50% silking) :

The leaves were kept in paper bags and dried in a hot air oven at a temperature of 80 °C till constant weight was attained. The dry weights were recorded.

$$9. \text{ Crop growth rate (CGR)} = \frac{W_2 - W_1}{t_2 - t_1} \times \frac{1}{p} \text{ (g m}^{-2} \text{ day}^{-1}\text{)}$$

$$10. \text{ Relative growth rate (RGR)} = \frac{\text{Log}_e W_2 - \text{Log}_e W_1}{t_2 - t_1} \text{ (g g}^{-1} \text{ day}^{-1}\text{)}$$

$$11. \text{ Net assimilation rate (NAR)} = \frac{W_2 - W_1}{t_2 - t_1} \times \frac{\text{Log}_e A_2 - \text{Log}_e A_1}{A_2 - A_1} \text{ (g m}^{-2} \text{ day}^{-1}\text{)}$$

$$12. \text{ Specific leaf weight (SLW)} = \frac{LW}{LA} \text{ (mg cm}^{-2}\text{)}$$

The following symbols were used

A_1 : total leaf area at initial time

A_2 : Total leaf area at final time

LA : Leaf area

LW : Leaf weight

t_1 : Initial time

t_2	:	Final time
W_1	:	Initial dry weight
W_2	:	Final dry weight
P	:	Land area

13.Total biomass at maturity (kg/plot):

The plants were kept in paper bags and dried in a hot air oven at a temperature of 80°C till constant weight was attained. The dry weights were recorded and expressed in kg.

14. Total chlorophyll content (mg/g) (at 50% silking):

The 8th leaf of the maize was collected and used for chlorophyll estimation. The chlorophyll content in the leaves was estimated colorimetrically by dimethyl sulfoxide method of Hiscox and Stam (1979)

The leaf samples were cleaned and sliced into small pieces. Samples of 300 mg was immersed in 10 ml of pure dimethyl sulfoxide for 2-3 h in a water bath at 65 °C and the OD were taken at 645 nm and 663 nm in a spectronic-20 and chlorophyll content was calculated according to the following formula (Arnon, 1949).

$$\text{Chlorophyll a} = (12.7 \times D_{663}) - (2.69 \times D_{645}) \times \frac{V}{1000 \times W}$$

$$\text{Chlorophyll b} = (22.9 \times D_{645}) - (4.68 \times D_{663}) \times \frac{V}{1000 \times W}$$

$$\text{Total chlorophyll} = \text{Chl a} + \text{Chl b}$$

Where V = Volume of dimethyl sulfoxide

W = Fresh weight of sample taken

$$\text{15. Harvest Index (HI)} = \frac{\text{Grain dry weight}}{\text{Total plant dry weight}} \times 100$$

16. Protein content (%):

The protein content in kernels was estimated by Kjeldahl procedure as given in AOAC (1980). The protein per cent was estimated by multiplying the nitrogen percentage with the factor, 6.25.

17. Seed protein yield(kg / ha)

Based on protein per cent and grain yield / plot, protein yield was calculated and recorded in kg / ha.

18. Oil estimation :

Oil content in grain was assessed using Nuclear magnetic Resonance (NMR) spectroscopy. Grains from each entry in each replication were dried in hot air to get moisture content of 4.5%. 15 grams of seed sample was then used for assessing oil content, using NMR spectroscopy against a standard reference sample.

19. Oil yield / ha

Based on oil per cent and grain yield / plot, oil yield was calculated and recorded in kg / ha.

20. Tryptophan content (g/16g N)

Tryptophan was estimated by Papain hydrolysis method given by Hernandez and Bates (1969).

21. Grain yield per plot (kg):

All ears in a row (entry) were harvested and their weight was recorded after thorough drying and shelling. Yield was adjusted to 15 per cent moisture and 25 plants per row.

3.4 STATISTICAL ANALYSIS

The recorded data were analysed through the following statistical procedure.

3.4.1 Analysis of variance

Since the design adopted for the trial was Randomized Complete Block Design (RCBD), the analysis of variance for RCBD was carried out by following the method given by Snedecor and Cochran (1967) and it is given below:

ANOVA

Source of variation	d.f.	M.S.S.	Calculated F
Replications (r)	(r-1)	R.M.S.	R.M.S./E.M.S
Treatments (t)	(t-1)	Tr.M.S.	Tr.M.S./E.M.S
Error (r x t)	(r-1) (t-1)	E.M.S.	
Total	(rt-1)		

Where,

r = number of replications

t = number of treatments

The sum of squares of each character were treated against the corresponding error degrees of freedom using 't' test.

3.4.2 Combining ability analysis

Ten diversified maize genotypes were crossed in all possible combinations in diallel fashion (without reciprocal). The parents with their 45 F_1 s were evaluated in Randomized block design. Data recorded on parents and their F_1 s were subjected to combining ability analysis following the procedure proposed by Griffing (1956a,b)- Experimental Method -II (Single crosses + Parents, total experimental material would be $p(p+1)/2$) and Model-I (Fixed effects) with assumption that there were no reciprocal differences.

Model-I assumes that the variety and block effects are constant, but environmental effects are variable and the experimental material is the population, about which inferences are to be drawn.

The linear mathematical model through combining ability analysis in Method-II and Model-I for an observation made on ij^{th} genotype could be assumed to be

$$Y_{ij} = \mu + g_i + g_j + S_{ij} + \frac{1}{Be} \sum_{k=1}^B \sum_{l=1}^C e_{ijkl}$$

p = Number of parents

B = Number of blocks

C = Number of observations on $(I,j)^{\text{th}}$ genotypes in k^{th} block

μ = Population mean

g_i = General combining ability effect (*gca*) of i^{th} parent

g_j = General combining ability effect (*gca*) of j^{th} parent

S_{ij} = Specific combining ability effect (*sca*) of the cross between the i^{th} and j^{th} parents such that $S_{ij}=S_{ji}$ and

e_{ijkl} = Environmental effect pertaining to the $ijkl^{\text{th}}$ observation on ij^{th} individual in k^{th} block with i^{th} as female and j^{th} as male parent

Restrictions imposed on this model are:

$$\sum_i g_i = 0 \text{ and}$$

i

$$\sum_j S_{ij} + S_{ii} = 0 \text{ (for each } i\text{)}$$

j

The skeleton ANOVA for each combining ability analysis with expectation of mean square generated was as follows:

Source	Degrees of Freedom	Sum of square	Mean square	Expectation of mean square (Model-I, fixed effect)
<i>GCA</i>	$(p-1)$	S_G	M_G	$\sigma_e^2 + (p+2) \left[\frac{1}{p-1} \sum_i g_i^2 \right]$
<i>SCA</i>	$\frac{p(p-1)}{2}$	S_S	M_S	$\sigma_e^2 + \frac{2}{p(p-1)} \sum_{i \leq j} s_{ij}^2$
Error	m	M_E	M_E'	σ_e^2

Where,

GCA = General combining ability

SCA = Specific combining ability

S_G = Sum of squares for general combining ability

$$= \frac{1}{p+2} \left[\sum_i (X_i + X_{ii})^2 - \frac{4}{p} X_{..}^2 \right]$$

S_S = sum of square for specific combining ability

$$= \sum_{i \leq j} \sum X_{ij}^2 - \frac{1}{p+2} \sum \left[(X_i + X_{ii})^2 \right] + \frac{2}{(p+1)(p+2)} X_{..}^2$$

Where,

X_i = total of the array involving i^{th} parent

X_{ii} = Mean value of i^{th} parent

$X_{..}$ = Grand mean total of $P(P+1)/2$ progenies (i.e., Total of means of F_1 's + parents)

X_{ij} = Mean value of progenies in the diallel table

M = Error degree of freedom from the RBD ANOVA table

M_E' = (Error mean square from RBD ANOVA)/r

$\sum \sum = i$ is equal to and less than j not greater than j (as reciprocals excluded)

$i \leq j$

GCA to SCA ratio was calculated to know the type of gene action involving whether additive or non-additive type.

Additive variance = $D=2 \times$ Expected variance due to *GCA*

Dominance variance = $H=$ Expected variance due to *SCA*

$$\text{Degree of dominance} = \frac{H}{D}$$

3.4.2.1 Estimation of general combining ability (*gca*) and specific combining ability (*sca*) effects and their standard errors

Estimates of the general combining ability effects (*g*) of i^{th} inbred parent:

$$g_i = \left[\frac{1}{p+2} (X_{i.} + X_{.i}) - \frac{2}{p} X_{..} \right]$$

Estimates of the specific combining ability effects (S_{ij}) of ij^{th} cross:

$$S_{ij} = X_{ij} - \frac{1}{p+2} \left[X_{i.} + X_{.i} + X_{.j} + X_{j.} \right] + \frac{2}{(p+1)(p+2)} X_{..}$$

where,

p , X_{ij} , $X_{i.}$, $X_{.i}$ and $X_{..}$ are the denotes of the same terms as mentioned above.

3.4.2.2 Estimation of standard error

Standard error were estimated to test significance of gca effects and difference between gca effects as:

$$S.E.g_i = \left[\frac{p-1}{p(p+2)} \sigma_e^2 \right]$$

$$S.E.(g_i - g_j) = \left[\frac{p-1}{p+2} \sigma_e^2 \right]$$

Standard errors to test significance of sca effects and differences between sca effects were estimated as:

$$S.E.S_{ij} = \left[\frac{p^2 + p + 2}{(p+1)(p+2)} \sigma_e^2 \right]$$

$$S.E.(S_{ij} - S_{kl}) = \left[\frac{2(p+1)}{p+2} \sigma_e^2 \right]$$

$$S.E.(S_{ij} - S_{kl}) = \frac{2p}{p+2} \sigma_e^2$$

3.4.2.3 Test of significance

The significance of gca and sca effects were tested against zero by calculating 't' value using following formula, which were then computed with tabulated 't' value at 5 per cent and 1 per cent level of significance.

$$t_{g_i} = \frac{g_i - 0}{S.E.g_i}$$

$$t_{s_{ij}} = \frac{s_{ij} - 0}{S.E.s_{ij}}$$

3.4.3 Correlations

The data was utilised for the computation of correlation coefficients between yield and its components for all the 55 genotypes. The following formula suggested by Snedecor and Cochran (1967) was followed

$$r(X_i . X_j) = \frac{\text{Cov}(X_i . X_j)}{(\text{Var } X_i) (\text{Var } X_j)}$$

where,

$r(X_i . X_j)$	=	Correlation coefficients between i^{th} and j^{th} characters
$\text{Cov}(X_i . X_j)$	=	Covariance between i^{th} and j^{th} characters
$\text{Var } X_i \text{ and } \text{Var } X_j$	=	variance of i^{th} and j^{th} characters

3.4.3.1 Phenotypic and genotypic correlations

Phenotypic and genotypic correlation coefficients were calculated for all the twelve characters by working out the variance components for each character and the covariance components for each pair of characters using the formula suggested by Al-Jibouri et.al. (1958).

$$\text{Phenotypic correlation coefficient, } (r_p) = \frac{\text{Cov XY (phenotype)}}{\sqrt{\text{Var(X) Var(Y) (phenotype)}}}$$

$$\text{Genotypic correlation coefficient, } (r_p) = \frac{\text{Cov XY (genotype)}}{\sqrt{\text{Var(X) Var(Y) (genotype)}}}$$

$$\text{Genotypic variance was calculated as follows} = \frac{\text{Treatment MS} - \text{Error MS}}{\text{Number of replications}}$$

Similarly,

$$\text{Genotypic Cov.} = \frac{\text{Treatment Cov} - \text{Error Cov}}{\text{Number of replications}}$$

The values of genotypic correlations exceeding unity should be considered as unit only (of same sign). To test the significance of correlation coefficients at phenotypic level,

the estimated values were compared with the table values of correlation coefficients (Fisher and Yates, 1967) at 5 per cent and 1 per cent levels of significance with (n-2) d.f where 'n' is the number of genotypes used in the present investigation.

3.4.4 Path coefficient analysis

The use of path coefficient analysis explains cause and effect relationship among the variables. It is a standardized partial regression coefficient and as such measures the direct influence of one variable upon another permits the separation of the correlation coefficients into components of direct and indirect effects (Dewey and Lu, 1959).

The direct and indirect effects, both at phenotypic and genotypic levels were estimated taking dry grain yield per plot as dependent variables, using path coefficient analysis as suggested by Wright (1921) and elaborated by Dewey and Lu (1959). The following equations were formed and solved simultaneously for estimating the various direct and indirect effects.

$$r_{1y} = P_{1y} r_{11} + P_{2y} r_{12} + P_{3y} r_{13} + \dots + P_{ny} r_{1n}$$

$$r_{2y} = P_{2y} r_{21} + P_{2y} r_{22} + P_{3y} r_{23} + \dots + P_{ny} r_{2n}$$

$$r_{ny} = P_{1y} r_{n1} + P_{2y} r_{n2} + P_{3y} r_{n3} + \dots + P_{ny} r_{nn}$$

where,

1,2,3,.....n, independent variables

Y = dependent variable (grain yield per plot)

$r_{1y}, r_{2y}, r_{3y}, \dots, r_{ny}$ = Coefficient of correlation between independent variables and dependent variable

The equation of matrix rotation is as under:

$$\begin{pmatrix} 1 & r_{12} & r_{13} \\ r_{21} & 1 & r_{23} \\ r_{n1} & r_{n2} & 1 \end{pmatrix} \begin{pmatrix} P_{1y} \\ P_{1y} \\ P_{1y} \end{pmatrix} = \begin{pmatrix} r_{1y} \\ r_{2y} \\ r_{3y} \end{pmatrix}$$

$$(R) \ n \times n = P_{iy} = r_{iy}$$

$$\text{So, the } P_{iy} = R_{n \times n} \times r_{ixy}$$

Where,

(R) = Correlation matrix

P_{iy} = Column vector of coefficient

r_{iy} = Correlation coefficient of individual trait with dependent variable

If $(R-1) = (C) n \times n$, their path coefficient s are calculated as under:

Direct effects

$$P_1 = C_{11} r_{1Y} + C_{12} r_{2Y} + C_{13} r_{3Y} + \dots$$

$$P_2 = C_{21} r_{1Y} + C_{22} r_{2Y} + C_{23} r_{3Y} + \dots$$

$$P_n = C_{n1} r_{1Y} + C_{n2} r_{2Y} + C_{n3} r_{3Y} + \dots$$

Indirect effects

Indirect effects of n^{th} variable (X_n) via i^{th} variable (X_i) are given below:

$$X_1 = P_{iy} r_{in}$$

$$P_{1y} r_{12} = \text{is the indirect effect of } X_1 \text{ on 'Y' via } X_2$$

$$P_{2y} r_{23} = \text{is the indirect effect of } X_2 \text{ on 'Y' via } X_1 \text{ and so on}$$

3.4.5 Stability Analysis

Data obtained from the three environments were subjected to pooled analysis of variance (Panse and Sukhatme, 1985). The genotypes x environment interactions were significant for most of the characters and hence the data were further analyzed to determine the phenotypic stability of different hybrids.

3.4.5.1 Phenotypic stability analysis

Following the methodology of Eberhart and Russell's model (1966) three parameters namely (i) overall mean of each genotype over a range of environments, (ii) the regression of each genotype on the environmental index and (iii) a function of the squared deviation from the regression were estimated. Eberhart and Russell (1966) used to study the stability of genotypes under different environments.

$$Y_{ij} = \mu + b_i I_j + \delta_{ij}$$

Where,

Y_{ij} = Mean value of i^{th} parent in j^{th} environment.

μ = Mean of i^{th} genotype over all the environments

b_i = Regression coefficient of the i^{th} genotype on the environmental index which measures the response of this genotype to varying environments

I_j = Environmental index which is defined as the deviation of the mean of all the genotypes at a given location from overall mean with $E_j - I_j = 0$

δ_{ij} = The deviations from regression of the i^{th} genotype at j^{th} environment

3.4.5.2 Analysis of variance for stability

The analysis of variance proposed by Eberhart and Russell (1966) is given below

ANOVA to estimate stability parameters (Eberhart and Russell, 1966)

Source	d.f	S.S	M.S.S
1.Total	(ge-1)	$\sum_i \sum_j Y_{ij}^2 - C.F.$	
2.Genotype	(g-1)	$1 \sum_e Y_{ij}^2 - C.F.$	MS 1
3.Environment	g(e-1)	$\sum_i \sum_j (Y_{ij}^2 - \sum_I Y_{ij}^2 / e)$	
4.Environment (linear)	1	$1 \sum_g (Y_{ij})^2 - \sum I_j^2$	
5.Genotype X Environment	(g-1)	$\sum_i (\sum_j Y_{ij} I_j)^2 - \sum I_j^2 - \text{Environment (linear) S.S}$	MS 2
6.Pooled deviation	g(e-2)	$\sum_i \sum_j \sigma_{ij}^2$	MS 3
7.Deviation due to genotype 1	(e-2)	$\sum_i Y_{ij}^2 - (Y_i)^2 - (\sum_j Y_{ij} I_j)^2 / \sum_j I_j^2 = \sum_j \sigma_{ij}^2$	
Genotype g	(e-2)	$\sum_j Y_{gj}^2 - (Y_g)^2 - (\sum_i Y_{gj} I_j)^2 / \sum_i I_j^2 = \sum_i \sigma_{gj}^2$	
8.Pooled error	e(r-1)(g-1)		

g= genotype; e= environment; r= replications

3.4.5.3 Computation of regression coefficient (b_i) for each genotype

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

Where,

b_i = regression coefficient of i^{th} genotype

$\sum I_j^2$ = the sum of squares of environmental indices which are common to each value of b_i .

$\sum Y_{ij}^2$ = (for each genotype) = the sum of products of environmental index and the corresponding means (X) of that variety at each location. These values may be obtained in the following manner.

$$(X)(I_j) = \sum_j Y_{ij}^2 I_j = (S)$$

(I_j) = vector for environmental index, and

(S) = Vector for sum of products i.e., $\sum Y_{ij} I_j$

3.4.5.4 Computation of $S^2 d_i$:

In a regression analysis, it is possible to partition the variance of dependent variable (Y) into two parts, the one which explains the linearity between dependent and independent variables (variance due to regression) and the other which explains the variance due to deviations from linearity symbolically.

$$\sigma_Y^2 = \sigma^2_{\text{regression}} + \sigma^2_{\text{deviation from regressions}}$$

The variance of means over different locations with regard to individual genotypes may be obtained in the following way.

$$\sigma^2_{gi} = Y_{ij} (Y^2 / g)$$

The variance due to deviations from regression ($\sum_i \delta_{ij}^2$) for a genotype being:

$$\sum_i \delta_{ij}^2 = (\sum (Y^2_{ij} - Y_i^2/g) - \frac{(\sum Y_{ij} I_j)^2}{\sum I_j^2})$$

Where

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

$\frac{(\sum Y_{ij} I_j)^2}{\sum I_j^2} =$ The variance due to regression

Because

$$\frac{(\sum_i Y_{ij} I_j)^2}{\sum I_j^2} = \frac{(\sum_i Y_{ij} I_j) (\sum_i Y_{ij} I_j)}{\sum I_j^2} = b_i \sum Y_{ij} I_j$$

From

$\sum_i \delta_{ij}^2 =$ values, the stability parameter,

S^2_{di} for each genotype is computed as follows:

$$S^2_{di} = \sum_i \delta_{ij}^2 / (e-2) - (S^2/r)$$

Mean square = $\frac{\text{Deviation fro regression}}{\text{d.f. for environment}} - \frac{\text{Pooled error deviation}}{\text{Number of replications}}$

The variance due to genotypes, environments and the pooled error were the same as those calculated in the pooled analysis of the data, except that the total sum of squares was mainly partitioned into three main components.

- i. Sum of squares due to genotypes
- ii. Sum of squares due to environments +m (G X E) and
- iii. Pooled error

Again sum of squares due to G X E was further partitioned into two parts namely

- i. S.S due to G X E(linear) which is in fact S.S due to regression and
- ii. S.S due to deviation from linearity of response (i.e., due to pooled deviation).

The different computational steps involved were as follows .

$$a) \text{ S.S due to environment + (GxE) } = \sum \sum Y_{ij}^2 - (\sum Y_{ij}^2 / e)$$

$$b) \text{ S.S due to environment + (linear) } = \frac{1}{G} \sum Y_i I_j^2 / \sum I_j^2$$

$$c) \text{ S.S due to (GxE) (linear) } = S(S \cdot Y_j I_j^2 / S I_j^2) - \text{environment(linear)S.S}$$

Where,

$$\sum Y_i I_j^2 / \sum I_j^2 = b_i \sum Y_i I_j^2 \text{ for each variety}$$

Test of significance

The following tests of significance were carried out:

1. To test the significance of the difference among genotype means namely:

$$H_0 = \mu_1 = \mu_2 = \mu_3 = \dots \dots \mu_n$$

$$F = \frac{\text{Mean square due to genotype}}{\text{Mean square due to pooled Deviation}} = \frac{MS_1}{MS_3}$$

2. To test that the genotypes did not differ for their regression on environmental index
i.e.,

$$H_0 = b_1 = b_2 = b_3 = \dots \dots b_n$$

$$F = \frac{\text{Mean square due to G X E (linear)}}{\text{Mean square due to pooled deviation}} = \frac{MS_2}{MS_3}$$

$$F = \text{M.S. due to G X E (linear)} \quad MS^2$$

3. Individual deviations from linear regression was tested as follows:

$$F = [\sum \delta^2_{ij} / (S-2)] / \text{pooled error}$$

Against F table value at (e-2)(g-2), at 5% or 1% probability level

The hypothesis that any regression coefficient did not differ from unity or zero was tested by appropriate 't' test i.e.,

$$F \text{ or } (b-0), t = \frac{|b - 0|}{SE(b_i)} \text{ for } (g - 2) \text{ df at 5\% level of probability}$$

$$F \text{ or } (1-b), t = \frac{|b - 1|}{SE(b_i)} \text{ for } (g - 2) \text{ df at 5\% level of probability}$$

Where,

$$SE(b_i) = \sqrt{\sum \delta^2_{ij} / (e-2) / \sum I_j^2}$$

3.4.5.5 Stable genotypes

A genotype with unit regression coefficient ($b_i = 1$) and deviation not significantly different from zero ($Sd^2 = 0$) was taken to be a stable genotype with unit response.

Mean and standard error of 'b'

$$\text{Mean of } b = \bar{b} = \sum b_i / g$$

$$S.E(b) = \frac{\text{M.S due to pooled deviation}}{\sum I_j^2}$$

Population mean (μ) and standard error was calculated as

$$\text{Population mean } (\mu) = \text{Grand total} / \text{No. of observations}$$

$$S.E(b) = \frac{\text{M.S due to pooled deviation}}{\text{Number of environments} - 1}$$

RESULTS

CHAPTER IV

RESULTS

In the present investigation, ten elite QPM inbred lines known for their good combining ability and agronomic characters developed at ARS (Maize), Amberpet, Hyderabad, India were utilized as parents in diallel mating design with an objective to get high yielding best QPM hybrids.

The experimental material consisted of 57 genotypes comprising ten parents, 45 hybrids and two standard checks *Viz.*, Madhuri and Shaktiman-2 were raised in Randomized Complete Block Design, replicated thrice. The experiments were conducted during Rabi and Kharif 2002-03 at two locations *Viz.*, Rajendranagar and Palem. The data were recorded on 21 morphological, physiological and Biochemical parameters and grain yield.

The results obtained have been presented under the following heads

- 4.1 Analysis of variance
- 4.2 Mean performance of parents, hybrids and checks
- 4.3 Combining ability studies
- 4.4 Correlation coefficients
- 4.5 Path coefficient studies
- 4.6 Stability analysis

4.1 ANALYSIS OF VARIANCE

The analysis of variance of RCBD with respect to twenty-one characters studied during *Kharif* and *Rabi* seasons at Rajendranagar and Palem is presented in Table 1. The mean sum of squares due to genotypes at two locations *viz.*, Rajendranagar and Palem and in two seasons (*Kharif* and *Rabi*) were found to be significant for morphological, physiological parameters and grain yield except

Table 1: Analysis of variance (Mean Squares) for 21 characters in QPM

Source of variation	df	Days to 50 % tasseling				Days to 50% silking			
		Rajendranagar		Palem		Rajendranagar		Palem	
		Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
Replications	2	1.05	3.57	8.02	0.87	1.75	0.88	9.61	0.7
Genotypes	54	34.58**	49.36**	31.72**	47.63**	34.12**	49.83**	30.96**	47.3**
Error	108	0.46	3.16	3.13	4.37	0.67	3.71	3.39	3.6

Source of variation	df	ASI				Days to maturity			
		Rajendranagar		Palem		Rajendranagar		Palem	
		Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
Replications	2	0.77	8.02	0.02	0.01	3.71	0.32	2.19	4.72
Genotypes	54	0.26NS	1.17NS	1.05NS	0.88NS	31.86**	43.92**	37.50**	44.61**
Error	108	0.25	0.91	0.94	0.54	1.96	4.54	5.31	8.72

Contd...

Source of variation	df	Plant height				Ear height			
		Rajendranagar		Palem		Rajendranagar		Palem	
		Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
Replications	2	48.43	137.46	36.90	43.87	5.06	23.1	8.51	36.89
Genotypes	54	1764**	1714**	1582**	1646**	597**	622**	459**	430**
Error	108	20.16	92.05	17.37	20.15	1.81	10.45	18.38	13.05

Contd.....

Source of variation	df	LAI				LDW			
		Rajendranagar		Palem		Rajendranagar		Palem	
		Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
Replications	2	0.01	0.01	0.00	0.00	7.77	54.69	14.23	0.76
Genotypes	54	2.86**	3.05**	2.87**	3.12**	2190**	5086**	3855**	2610**
Error	108	0.01	0.01	0.01	0.00	76.97	55.29	79.05	72.68

Contd....

Source of variation	df	CGR				RGR			
		Rajendranagar		Palem		Rajendranagar		Palem	
		Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
Replications	2	0.01	0.33	1.19	0.62	0.00	0.00	0.00	0.00
Genotypes	54	77.99**	74.37**	71.25**	68.40**	0.00**	0.00**	0.00**	0.00**
Error	108	0.86	0.88	0.95	0.79	0.00	0.00	0.00	0.00

Source of variation	df	NAR				SLW			
		Rajendranagar		Palem		Rajendranagar		Palem	
		Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
Replications	2	0.36	0.14	0.16	0.03	0.18	0.43	0.09	0.37
Genotypes	54	3.19**	3.71**	3.21**	2.94**	6.87**	4.51**	4.50**	4.87**
Error	108	0.12	0.14	0.11	0.12	0.20	0.17	0.13	0.17

Contd....

Source of variation	df	Total biomass				Total chlorophyll content			
		Rajendranagar		Palem		Rajendranagar		Palem	
		Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
Replications	2	0.08	0.05	0.14	0.35	0.00	0.00	0.01	0.00
Genotypes	54	1.89**	2.00**	1.30**	1.54**	0.04**	0.04**	0.04**	0.04**
Error	108	0.11	0.06	0.05	0.15	0.05	0.00	0.00	0.00

Contd.....

Source of variation	df	Harvest index				Protein content			
		Rajendranagar		Palem		Rajendranagar		Palem	
		Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
Replications	2	1.35	2.66	6.69	0.48	0.03	0.01	0.09	0.08
Genotypes	54	53.77**	62.67**	51.55**	49.6**	1.64**	1.63**	1.71**	1.62**
Error	108	0.70	1.31	3.34	2.95	0.12	0.04	0.04	0.03

Contd.....

Source of variation	df	Seed protein yield				Oil per cent			
		Rajendranagar		Palem		Rajendranagar		Palem	
		Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
Replications	2	35.89	2288.87	3356.00	79.20	0.21	0.04	0.34	0.13
Genotypes	54	94210**	96496**	85580**	77529**	0.66**	0.62**	0.79**	0.61
Error	108	103.14	2265.93	5534.25	191.35	0.19	0.02	0.14	0.09

Contd.....

Source of variation	df	Oil yield				Tryptophan content			
		Rajendranagar		Palem		Rajendranagar		Palem	
		Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
Replication	2	660.33	18.42	193.91	188.69	0.00	0.00	0.00	0.00
Genotypes	54	39431**	49652**	38641**	40550**	0.03**	0.03**	0.03**	0.03*
Error	108	419.38	309.07	355.33	396.48	0.00	0.00	0.00	0.00

Source of variation	df	Grain yield/plot			
		Rajendranagar		Palem	
		Kharif	Rabi	Kharif	Rabi
Replications	2	0.24	0.20	0.11	0.01
Genotypes	54	2.14**	2.18**	1.70**	1.69**
Error	108	0.13	0.08	0.06	0.09

grain yield except Anthesis-Silking interval under study. The mean sum of squares for replication were non significant.

4.2 MEAN PERFORMANCE OF PARENTS, HYBRIDS AND CHECKS

The mean performance of parents, hybrids along with Standard checks for 21 characters studied are presented in Table 2. The character wise results are given in detail hereunder.

4.2.1 Days to 50 per cent tasseling

At Rajendranagar during *Kharif*, the mean values for days to 50 per cent tasseling ranged from 51.33 to 62.67 days. The mean value of parents was 59.90. The parental line P4 was the earliest (54.67 days), while the parental line P9 took a maximum of 62.67 days after sowing for reaching 50 per cent tasseling. The mean value for crosses was 57.05 days. Among all the cross combinations, the cross P2 X P3 (51.33 days) was earliest while P2 X P10 was found to be late (62.60 days) to reach 50 per cent tasseling stage. The checks Madhuri recorded 59.67 days and Shaktiman-2 recorded 56.33 days.

Whereas at Palem during *Kharif* the mean values for days to 50 per cent tasseling ranged from 50 to 63 days. The mean value of parents was 58.60 days. The parental line P4 (52.00) was the earliest line while P10 and P1 took a maximum of 61.00 days to reach 50 per cent tasseling. The mean value for crosses was 57.53 days. Among the 45 cross combinations, the cross P2 X P5 (52.00 days) was early to 50 per cent tasseling while P2 X P10 was found to be late (63.00 days) for 50 per cent tasseling. The checks Madhuri recorded 61 days and Shaktiman-2 recorded 58 days.

During *Rabi* at Rajendranagar, the mean values for days to 50 per cent tasseling ranged from 57 to 71 days. The mean value of parents was 66.70 and for

Table 2: Mean performance of parents, crosses and checks for 21 characters										
at four locations in QPM										
Parents	Days to 50% tasseling					Days to 50% silking				
	Rajendranagar		Palem		Mean	Rajendranagar		Palem		Mean
	Kharif	Rabi	Kharif	Rabi		Kharif	Rabi	Kharif	Rabi	
P1	61.00	68.00	61.00	68.00	64.50	64.00	71.00	63.00	70.00	67.00
P2	60.67	67.00	58.00	66.00	62.92	63.00	69.00	61.00	69.00	65.50
P3	55.67	62.00	56.00	64.00	59.42	58.33	65.00	59.00	66.00	62.08
P4	54.67	60.00	55.00	62.00	57.92	57.33	62.00	57.00	64.00	60.08
P5	60.67	68.00	58.00	65.00	62.92	63.00	70.00	60.00	67.00	65.00
P6	61.67	69.00	59.00	64.00	63.42	63.67	71.00	61.00	67.00	65.67
P7	60.33	68.00	58.00	68.00	63.58	62.67	70.00	61.00	70.00	65.92
P8	59.33	65.00	60.00	69.00	63.33	61.67	69.00	64.00	72.00	66.67
P9	62.67	70.00	60.00	70.00	65.67	64.67	72.00	62.00	72.00	67.67
P10	62.33	70.00	61.00	70.00	65.83	64.33	73.00	64.00	73.00	68.58
Mean	59.90	66.70	58.60	66.60	62.95	62.27	69.20	61.20	69.00	65.42
Crosses										
P1 X P2	55.67	62.00	56.00	65.00	59.67	58.33	65.00	59.00	68.00	62.58
P1 X P3	55.67	62.00	57.00	63.00	59.42	58.00	64.00	59.00	65.00	61.50
P1 X P4	57.67	65.00	59.00	65.00	61.67	60.00	66.00	61.00	67.00	63.50
P1 X P5	56.33	63.00	54.00	60.00	58.33	58.67	65.00	57.00	63.00	60.92
P1 X P6	57.67	69.00	58.00	66.00	62.67	60.33	71.00	60.00	70.00	65.33
P1 X P7	56.33	59.00	58.00	65.00	59.58	58.67	62.00	61.00	67.00	62.17
P1 X P8	61.00	60.00	60.00	69.00	62.50	63.00	63.00	62.00	71.00	64.75
P1 X P9	52.33	58.00	53.00	60.00	55.83	54.67	60.00	55.00	62.00	57.92
P1 X P10	54.67	60.00	54.00	61.00	57.42	57.00	62.00	57.00	64.00	60.00
P2 X P3	51.33	57.00	52.00	58.00	54.58	53.67	59.00	55.00	60.00	56.92
P2 X P4	52.33	59.00	54.00	60.00	56.33	55.00	61.00	56.00	63.00	58.75
P2 X P5	53.00	60.00	52.00	57.00	55.50	55.00	62.00	54.00	60.00	57.75
P2 X P6	60.67	67.00	61.00	70.00	64.67	62.33	70.00	63.00	73.00	67.08
P2 X P7	59.33	66.00	60.00	69.00	63.58	62.00	69.00	62.00	71.00	66.00
P2 X P8	53.33	60.00	55.00	62.00	57.58	55.33	62.00	58.00	64.00	59.83
P2 X P9	60.67	68.00	59.00	65.00	63.17	63.67	70.00	61.00	67.00	65.42
P2 X P10	62.00	70.00	63.00	71.00	66.50	64.67	72.00	65.00	74.00	68.92
P3 X P4	60.00	68.00	61.00	70.00	64.75	62.00	70.00	62.00	72.00	66.50
P3 X P5	60.00	68.00	61.00	70.00	64.75	63.00	71.00	63.00	73.00	67.50
P3 X P6	57.00	65.00	58.00	65.00	61.25	59.00	69.00	60.00	67.00	63.75
P3 X P7	54.67	60.00	55.00	62.00	57.92	57.00	63.00	57.00	64.00	60.25
P3 X P8	60.67	68.00	62.00	70.00	65.17	63.00	70.00	64.00	72.00	67.25
P3 X P9	61.67	67.00	60.00	65.00	63.42	64.00	69.00	63.00	67.00	65.75
P3 X P10	54.67	60.00	55.00	62.00	57.92	57.00	63.00	57.00	65.00	60.50
P4 X P5	56.33	62.00	57.00	65.00	60.08	58.67	64.00	60.00	67.00	62.42
P4 X P6	54.33	60.00	55.00	63.00	58.08	56.67	62.00	59.00	65.00	60.67
P4 X P7	55.00	63.00	54.00	60.00	58.00	57.33	65.00	56.00	62.00	60.08
P4 X P8	54.33	60.00	55.00	62.00	57.83	56.67	63.00	57.00	64.00	60.17
P4 X P9	51.67	59.00	50.00	61.00	55.42	54.33	61.00	52.00	64.00	57.83
P4 X P10	53.67	60.00	55.00	56.00	56.17	56.00	62.00	58.00	59.00	58.75
P5 X P6	60.67	68.00	62.00	61.00	62.92	62.67	70.00	64.00	64.00	65.17
P5 X P7	52.33	59.00	54.00	70.00	58.83	54.33	62.00	56.00	72.00	61.08
P5 X P8	61.00	69.00	60.00	60.00	62.50	63.00	71.00	62.00	62.00	64.50
P5 X P9	61.00	70.00	62.00	67.00	65.00	63.33	72.00	64.00	69.00	67.08
P5 X P10	60.33	68.00	59.00	71.00	64.58	62.33	70.00	61.00	74.00	66.83
P6 X P7	55.00	64.00	56.00	66.00	60.25	57.67	67.00	59.00	69.00	63.17
P6 X P8	60.67	68.00	61.00	61.00	62.67	63.00	70.00	64.00	64.00	65.25
P6 X P9	61.00	71.00	62.00	68.00	65.50	63.00	74.00	65.00	70.00	68.00
P6 X P10	55.67	64.00	56.00	62.00	59.42	57.67	65.00	59.00	65.00	61.67
P7 X P8	60.67	68.00	62.00	68.00	64.67	63.00	70.00	64.00	70.00	66.75
P7 X P9	61.00	68.00	63.00	69.00	65.25	63.00	71.00	65.00	71.00	67.50
P7 X P10	56.00	62.00	58.00	65.00	60.25	58.00	65.00	61.00	68.00	63.00
P8 X P9	60.67	67.00	62.00	70.00	64.92	62.67	70.00	64.00	72.00	67.17
P8 X P10	53.67	60.00	55.00	62.00	57.67	56.00	62.00	57.00	65.00	60.00
P9 X P10	53.67	61.00	54.00	60.00	57.17	55.67	64.00	56.00	61.67	59.33
Mean	57.05	63.82	57.53	64.38	60.70	59.34	66.18	59.87	66.81	63.05
G M	57.57	64.35	57.73	64.78		59.87	66.73	60.11	67.21	
SE d	0.55	1.45	1.44	1.71		0.67	1.57	1.50	1.55	
CD(0.05)	1.08	2.84	2.83	3.35		1.31	3.08	2.95	3.05	
CV(%)	1.17	2.76	3.06	3.23		1.37	2.89	3.07	2.83	
Madhuri	59.67	65.00	61.00	68.00		62.33	68.00	64.00	70.00	
Shaktiman-2	56.33	62.01	54.02	64.03		58.67	64.01	61.04	67.33	

Table contd.....										
Parents	Anthesis silking interval					Days to maturity				
	Rajendranagar		Palem		Mean	Rajendranagar		Palem		Mean
	Kharif	Rabi	Kharif	Rabi		Kharif	Rabi	Kharif	Rabi	
P1	3.00	3.00	2.00	2.00	2.50	95.00	103.00	95.00	101.00	98.50
P2	2.33	2.00	3.00	3.00	2.58	95.33	101.00	94.00	100.00	97.58
P3	2.67	3.00	3.00	2.00	2.67	91.00	97.00	92.00	98.00	94.50
P4	2.67	2.00	2.00	2.00	2.17	88.00	95.00	89.00	96.00	92.00
P5	2.33	2.00	2.00	2.00	2.08	96.00	102.00	92.00	99.00	97.25
P6	2.00	2.00	2.00	3.00	2.25	96.33	103.00	93.00	100.00	98.08
P7	2.33	2.00	3.00	2.00	2.33	91.00	105.00	94.00	102.00	98.00
P8	2.33	4.00	4.00	3.00	3.33	94.67	101.00	96.00	104.00	98.92
P9	2.00	2.00	2.00	2.00	2.00	97.00	104.00	95.00	105.00	100.25
P10	2.00	3.00	3.00	3.00	2.75	95.67	105.00	97.00	106.00	100.92
Mean	2.37	2.50	2.60	2.40	2.47	94.00	101.60	93.70	101.10	97.60
Crosses										
P1 X P2	2.67	3.00	3.00	3.00	2.92	90.00	98.00	91.00	100.00	94.75
P1 X P3	2.33	2.00	2.00	2.00	2.08	91.67	96.00	90.00	97.00	93.67
P1 X P4	2.33	1.00	2.00	2.00	1.83	92.67	98.00	94.00	99.00	95.92
P1 X P5	2.33	2.00	3.00	3.00	2.58	91.67	97.00	90.00	95.00	93.42
P1 X P6	2.67	2.00	2.00	4.00	2.67	92.33	103.00	94.00	100.00	97.33
P1 X P7	2.33	3.00	3.00	2.00	2.58	92.00	95.00	95.00	98.00	95.00
P1 X P8	2.00	3.00	2.00	2.00	2.25	96.00	96.00	95.00	102.00	97.25
P1 X P9	2.33	2.00	2.00	2.00	2.08	86.33	93.00	88.00	94.00	90.33
P1 X P10	2.33	2.00	3.00	3.00	2.58	87.00	95.00	90.00	95.00	91.75
P2 X P3	2.33	2.00	3.00	2.00	2.33	86.00	92.00	86.00	93.00	89.25
P2 X P4	2.67	2.00	2.00	3.00	2.42	88.00	93.00	89.00	95.00	91.25
P2 X P5	2.00	2.00	2.00	3.00	2.25	86.00	95.00	85.00	92.00	89.50
P2 X P6	1.67	3.00	2.00	3.00	2.42	94.00	102.00	96.00	105.00	99.25
P2 X P7	2.67	3.00	2.00	2.00	2.42	94.33	101.00	94.00	102.00	97.83
P2 X P8	2.00	2.00	3.00	2.00	2.25	87.67	95.00	90.00	96.00	92.17
P2 X P9	3.00	2.00	2.00	2.00	2.25	95.00	102.00	94.00	98.00	97.25
P2 X P10	2.67	2.00	2.00	3.00	2.42	97.00	105.00	97.00	105.00	101.00
P3 X P4	2.00	2.00	1.00	2.00	1.75	92.00	102.00	94.00	103.00	97.75
P3 X P5	3.00	3.00	2.00	3.00	2.75	94.00	104.00	95.00	105.00	99.50
P3 X P6	2.00	4.00	2.00	2.00	2.50	90.00	100.00	92.00	99.00	95.25
P3 X P7	2.33	3.00	2.00	2.00	2.33	89.67	95.00	90.00	96.00	92.67
P3 X P8	2.33	2.00	2.00	2.00	2.08	94.00	102.00	99.00	104.00	99.75
P3 X P9	2.33	2.00	3.00	2.00	2.33	96.00	101.00	96.00	99.00	98.00
P3 X P10	2.33	3.00	2.00	3.00	2.58	89.33	96.00	89.00	96.00	92.58
P4 X P5	2.33	2.00	3.00	2.00	2.33	90.67	97.00	92.00	98.00	94.42
P4 X P6	2.33	2.00	4.00	2.00	2.58	92.00	95.00	91.00	96.00	93.50
P4 X P7	2.33	2.00	2.00	2.00	2.08	88.00	98.00	88.00	95.00	92.25
P4 X P8	2.33	3.00	2.00	2.00	2.33	89.67	95.00	89.00	97.00	92.67
P4 X P9	2.67	2.00	2.00	3.00	2.42	86.67	94.00	85.00	96.00	90.42
P4 X P10	2.33	2.00	3.00	3.00	2.58	90.67	96.00	90.00	91.00	91.92
P5 X P6	2.00	2.00	2.00	3.00	2.25	95.33	102.00	97.00	96.00	97.58
P5 X P7	2.00	3.00	2.00	2.00	2.25	89.00	95.00	90.00	103.00	94.25
P5 X P8	2.00	2.00	2.00	2.00	2.00	97.33	103.00	95.00	94.00	97.33
P5 X P9	2.33	2.00	2.00	2.00	2.08	95.00	105.00	98.00	101.00	99.75
P5 X P10	2.00	2.00	2.00	3.00	2.25	94.33	102.00	93.00	106.00	98.83
P6 X P7	2.67	3.00	3.00	3.00	2.92	89.00	99.00	92.00	101.00	95.25
P6 X P8	2.33	2.00	3.00	3.00	2.58	95.00	101.00	97.00	96.00	97.25
P6 X P9	2.00	3.00	3.00	2.00	2.50	93.00	106.00	98.00	102.00	99.75
P6 X P10	2.00	1.00	3.00	3.00	2.25	91.00	97.00	91.00	97.00	94.00
P7 X P8	2.33	2.00	2.00	2.00	2.08	95.00	101.00	98.00	102.00	99.00
P7 X P9	2.00	3.00	2.00	2.00	2.25	94.00	102.00	97.00	103.00	99.00
P7 X P10	2.00	3.00	3.00	3.00	2.75	89.33	97.00	93.00	100.00	94.83
P8 X P9	2.00	3.00	2.00	2.00	2.25	94.00	102.00	98.00	103.00	99.25
P8 X P10	2.33	2.00	2.00	3.00	2.33	87.67	94.00	90.00	96.00	91.92
P9 X P10	2.00	3.00	2.00	1.67	2.17	89.33	97.00	88.00	94.00	92.08
Mean	2.29	2.36	2.33	2.44	2.35	91.53	98.53	92.51	98.56	95.28
G M	2.30	2.38	2.38	2.43		91.98	99.09	92.73	99.02	
SE d	0.41	0.78	0.79	0.60		1.14	1.74	1.88	2.41	
CD(0.05)	0.80	1.52	1.56	1.18		2.24	3.41	3.69	4.73	
CV(%)	21.70	22.30	19.70	20.14		1.52	2.15	2.48	2.98	
Madhuri	2.67	3.00	3.00	2.00		94.33	102.00	97.00	104.00	
Shaktiman-	2.33	2.01	3.03	3.33		93.33	98.01	95.04	100.02	

Table contd.....										
Parents	Plant height (cm)					Ear height (cm)				
	Rajendranagar		Palem		Mean	Rajendranagar		Palem		Mean
	Kharif	Rabi	Kharif	Rabi		Kharif	Rabi	Kharif	Rabi	
P1	154.00	156.00	116.77	120.60	136.84	63.33	62.33	55.13	57.10	59.47
P2	135.00	104.00	146.20	152.30	134.38	60.20	54.33	60.13	62.30	59.24
P3	147.67	197.67	145.87	148.40	159.90	76.00	80.00	60.20	61.60	69.45
P4	153.33	128.00	169.50	171.20	155.51	62.00	65.33	61.37	64.50	63.30
P5	148.00	122.00	147.77	151.30	142.27	61.20	63.40	69.53	60.20	63.58
P6	127.67	127.67	142.23	145.40	135.74	61.67	62.67	68.53	60.20	63.27
P7	143.33	131.00	125.00	128.60	131.98	67.00	62.00	57.70	59.20	61.48
P8	163.33	144.33	183.47	185.40	169.13	68.33	62.67	68.40	70.40	67.45
P9	173.33	168.67	168.33	172.30	170.66	78.00	81.33	69.40	72.60	75.33
P10	133.00	159.00	177.60	181.40	162.75	81.00	83.33	84.73	85.40	83.62
Mean	147.87	143.83	152.27	155.69	149.92	67.87	67.74	65.51	65.35	66.62
Crosses										
P1 X P2	175.33	171.00	192.57	195.60	183.63	88.00	82.67	88.10	90.20	87.24
P1 X P3	165.00	172.67	178.60	180.30	174.14	90.00	86.33	85.43	87.20	87.24
P1 X P4	149.33	107.67	182.93	185.40	156.33	70.20	74.33	77.60	76.40	74.63
P1 X P5	152.67	101.00	176.30	180.30	152.57	83.33	80.00	81.57	83.40	82.08
P1 X P6	164.00	139.00	177.20	175.60	163.95	77.33	82.33	79.07	82.30	80.26
P1 X P7	164.67	151.00	186.47	189.40	172.88	81.00	87.67	84.03	86.60	84.83
P1 X P8	134.00	171.33	188.53	185.30	169.79	89.33	82.67	88.03	89.20	87.31
P1 X P9	183.33	181.67	146.47	150.10	165.39	82.00	83.00	82.63	84.40	83.01
P1 X P10	163.67	185.00	190.87	187.60	181.78	79.00	83.33	90.23	91.30	85.97
P2 X P3	223.33	177.33	183.50	185.40	192.39	83.67	82.67	79.97	82.30	82.15
P2 X P4	153.67	175.33	201.03	205.60	183.91	78.67	75.67	87.20	89.40	82.74
P2 X P5	153.00	149.00	176.30	198.40	169.18	69.00	65.00	81.03	83.40	74.61
P2 X P6	133.67	129.33	138.50	142.30	135.95	67.00	63.00	58.27	60.20	62.12
P2 X P7	163.33	129.00	178.33	182.10	163.19	78.67	81.33	79.33	82.40	80.43
P2 X P8	149.00	169.00	175.80	178.60	168.10	82.00	80.33	75.00	78.60	78.98
P2 X P9	170.00	172.00	115.97	120.30	144.57	79.33	71.33	68.03	62.40	70.27
P2 X P10	172.33	145.33	201.93	205.40	181.25	83.00	70.67	93.23	95.60	85.63
P3 X P4	183.00	141.00	189.17	191.20	176.09	84.67	77.33	76.30	77.40	78.93
P3 X P5	174.00	176.00	196.63	198.40	186.26	69.00	64.00	76.00	79.30	72.08
P3 X P6	163.00	142.67	223.93	225.60	188.80	78.33	70.00	97.17	99.20	86.18
P3 X P7	172.33	171.00	174.27	178.90	174.13	89.00	84.67	67.30	71.40	78.09
P3 X P8	183.33	139.33	195.87	197.40	178.98	78.67	74.33	92.30	95.60	85.23
P3 X P9	193.67	161.00	182.10	185.40	180.54	88.00	85.33	89.27	92.30	88.73
P3 X P10	182.67	176.33	186.07	182.30	181.84	83.00	75.33	83.30	85.60	81.81
P4 X P5	201.67	179.00	131.93	128.60	160.30	84.67	77.00	62.13	65.40	72.30
P4 X P6	136.33	202.33	170.43	172.30	170.35	94.00	94.33	54.73	65.60	77.17
P4 X P7	180.00	172.67	167.40	170.40	172.62	68.67	64.00	62.43	64.80	64.98
P4 X P8	184.00	179.00	164.37	171.20	174.64	88.33	88.33	62.03	65.60	76.07
P4 X P9	151.00	145.00	167.53	172.50	159.01	83.00	82.67	68.57	71.20	76.36
P4 X P10	173.33	133.00	188.10	191.30	171.43	68.67	83.67	75.17	77.30	76.20
P5 X P6	157.67	164.00	170.90	207.20	174.94	81.00	68.33	68.20	70.40	71.98
P5 X P7	132.00	195.33	174.87	176.80	169.75	74.67	78.00	76.20	80.20	77.27
P5 X P8	138.00	170.67	177.37	181.40	166.86	64.00	73.33	63.27	66.40	66.75
P5 X P9	106.67	171.67	172.60	175.60	156.63	63.67	62.00	77.60	80.80	71.02
P5 X P10	113.67	160.00	172.27	170.20	154.03	58.00	78.67	82.13	84.50	75.83
P6 X P7	153.00	142.33	190.40	192.30	169.51	73.00	64.33	70.90	72.60	70.21
P6 X P8	121.67	142.33	159.93	155.60	144.88	68.67	65.00	76.00	79.40	72.27
P6 X P9	104.67	141.67	110.63	115.70	118.17	53.00	50.33	53.60	59.30	54.06
P6 X P10	128.00	141.00	188.10	192.30	162.35	68.67	67.33	75.73	78.40	72.53
P7 X P8	129.33	112.00	161.77	160.40	140.88	68.33	65.00	56.93	60.60	62.72
P7 X P9	144.00	131.00	175.60	179.30	157.48	63.00	60.67	71.30	72.90	66.97
P7 X P10	134.67	149.67	166.47	172.40	155.80	64.67	64.33	63.60	66.40	64.75
P8 X P9	127.67	159.33	186.23	191.40	166.16	63.67	77.67	72.00	75.60	72.24
P8 X P10	118.33	182.00	195.20	201.30	174.21	84.00	84.67	87.87	91.20	86.94
P9 X P10	170.00	160.67	178.17	182.40	172.81	78.67	76.67	75.77	78.40	77.38
Mean	156.18	157.08	175.77	179.28	167.08	76.59	75.33	75.92	78.51	76.59
G M	154.67	154.67	171.49	174.98		68.38	66.20	72.58	75.21	
SE d	3.67	7.83	3.40	3.66		1.09	2.64	3.00	2.95	
CD(0.05)	7.19	15.35	6.67	7.18		2.15	5.17	6.87	5.78	
CV(%)	2.90	6.20	2.43	2.57		1.97	4.88	5.91	5.80	
Madhuri	152.67	113.00	141.80	145.00		81.00	79.67	51.10	53.00	
Shaktiman-	162.33	107.01	177.03	180.01		78.02	76.03	78.01	80.03	

Table contd...										
Parents	Leaf area index at 60 DAS					Leaf dry weight at 90 DAS (g/m ²)				
	Rajendranagar		Palem		Mean	Rajendranagar		Palem		Mean
	Kharif	Rabi	Kharif	Rabi		Kharif	Rabi	Kharif	Rabi	
P1	1.45	1.52	1.40	1.42	1.45	190.83	191.80	193.80	195.20	192.91
P2	1.81	1.64	2.12	2.14	1.93	194.30	196.30	195.30	198.20	196.03
P3	1.64	1.72	1.04	1.05	1.36	190.40	205.40	197.40	204.90	199.53
P4	2.80	2.85	1.12	1.11	1.97	251.10	245.60	255.10	245.80	249.40
P5	1.66	1.65	1.23	1.25	1.45	201.60	120.60	238.60	205.20	191.50
P6	1.34	1.42	1.39	1.40	1.39	226.60	223.60	228.60	228.60	226.85
P7	1.21	1.34	1.23	1.25	1.26	213.20	140.20	315.20	214.30	220.72
P8	3.10	3.20	2.34	2.31	2.74	251.20	265.20	260.20	263.70	260.08
P9	1.11	1.21	1.12	1.35	1.20	228.80	226.50	300.80	210.80	241.72
P10	3.81	3.81	2.23	2.24	3.02	256.60	248.60	252.60	255.20	253.25
Mean	1.99	2.04	1.52	1.55	1.78	220.46	206.38	243.76	222.19	223.20
Crosses										
P1 X P2	2.25	2.28	1.30	1.21	1.76	250.20	165.20	250.20	246.20	227.95
P1 X P3	3.11	3.21	2.36	2.38	2.77	227.30	225.30	304.30	320.80	269.43
P1 X P4	2.23	2.39	2.21	2.20	2.26	313.60	320.10	320.60	310.00	316.08
P1 X P5	2.98	3.01	1.21	1.23	2.11	222.30	314.10	225.30	228.80	247.63
P1 X P6	3.57	3.12	1.23	1.25	2.29	225.60	210.50	206.30	207.60	212.50
P1 X P7	2.21	1.60	1.36	1.34	1.63	236.30	242.30	250.30	258.30	246.80
P1 X P8	1.56	1.76	2.21	2.20	1.93	248.10	275.60	244.20	250.40	254.57
P1 X P9	3.28	3.56	2.37	3.36	3.14	265.40	270.90	250.40	260.40	261.77
P1 X P10	3.31	3.48	3.76	3.75	3.58	248.80	260.80	245.80	250.80	251.55
P2 X P3	1.22	1.41	1.09	1.30	1.26	225.80	310.80	210.80	210.80	239.55
P2 X P4	3.16	3.12	3.16	3.36	3.20	258.20	250.20	250.80	251.20	252.60
P2 X P5	3.92	4.10	4.00	3.90	3.98	263.10	210.60	260.30	272.30	251.58
P2 X P6	2.11	2.12	1.12	1.11	1.62	226.80	318.60	210.80	200.80	239.25
P2 X P7	3.63	3.79	3.35	3.34	3.53	258.20	252.20	246.20	250.80	251.85
P2 X P8	3.57	3.59	2.81	2.82	3.20	247.90	250.90	250.90	248.90	249.65
P2 X P9	1.62	1.74	1.34	1.45	1.54	320.10	232.60	325.10	237.90	278.93
P2 X P10	3.02	3.10	2.82	2.80	2.94	274.40	270.60	265.10	265.10	268.80
P3 X P4	2.46	2.50	2.41	2.32	2.42	235.20	235.20	225.20	225.70	230.32
P3 X P5	3.74	3.79	3.10	3.16	3.45	224.30	225.20	245.30	292.30	246.78
P3 X P6	2.34	2.42	2.56	2.54	2.47	205.50	194.40	200.50	200.60	200.25
P3 X P7	1.86	1.62	1.22	1.21	1.48	206.80	300.80	200.80	193.80	225.55
P3 X P8	2.24	2.61	2.54	2.51	2.48	246.10	242.40	250.60	245.30	246.10
P3 X P9	2.31	2.42	2.54	2.56	2.46	248.80	253.80	245.80	250.80	249.80
P3 X P10	1.40	1.43	1.55	1.53	1.48	210.60	200.60	200.60	198.60	202.60
P4 X P5	3.28	3.58	3.21	3.19	3.32	251.40	260.60	260.10	260.90	258.25
P4 X P6	4.19	4.24	2.96	3.72	3.78	280.40	276.50	265.30	267.20	272.35
P4 X P7	2.62	1.69	1.25	1.17	1.68	265.80	250.30	250.80	265.20	258.03
P4 X P8	2.42	2.68	1.62	1.63	2.09	243.30	268.80	253.30	255.70	255.28
P4 X P9	3.11	3.20	2.20	3.22	2.93	245.20	244.20	250.20	250.00	247.40
P4 X P10	3.22	3.34	3.56	3.58	3.43	202.80	200.80	205.80	195.80	201.30
P5 X P6	4.02	4.20	4.02	3.74	4.00	240.20	245.20	242.20	240.70	242.08
P5 X P7	1.77	1.56	1.63	3.65	2.15	200.40	200.90	206.40	205.00	203.18
P5 X P8	3.96	4.11	3.70	2.73	3.63	270.10	264.40	260.80	265.40	265.18
P5 X P9	2.56	2.68	2.70	1.65	2.40	215.80	205.80	205.80	202.20	207.40
P5 X P10	1.62	1.54	1.22	1.24	1.41	238.80	245.30	350.80	236.80	267.93
P6 X P7	1.41	1.46	1.18	1.52	1.39	228.80	145.80	308.80	210.30	223.43
P6 X P8	1.47	1.62	1.56	1.80	1.61	249.60	248.60	250.60	245.60	248.60
P6 X P9	1.18	1.21	1.61	1.62	1.41	245.80	240.50	238.80	230.80	238.97
P6 X P10	1.54	1.53	1.21	1.62	1.48	206.60	202.60	300.60	200.60	227.60
P7 X P8	1.39	1.41	1.38	1.18	1.34	211.30	213.30	200.30	205.30	207.55
P7 X P9	3.86	2.35	3.92	3.74	3.47	257.70	241.70	250.70	250.70	250.20
P7 X P10	1.60	1.92	1.72	1.60	1.71	240.10	240.60	243.10	248.10	242.98
P8 X P9	2.98	3.05	2.86	2.88	2.94	225.30	226.10	225.30	224.30	225.25
P8 X P10	1.12	1.06	1.12	1.13	1.11	234.20	235.40	247.30	245.10	240.50
P9 X P10	2.28	2.62	2.21	2.41	2.38	253.10	250.10	257.10	262.80	255.78
Mean	2.55	2.56	2.23	2.31	2.41	242.14	243.14	248.01	241.04	243.58
G M	2.41	2.47	2.04	2.07		238.19	230.45	247.23	237.61	
SE d	0.07	0.08	0.05	0.06		7.16	6.07	7.26	6.96	
CD(0.05)	0.13	0.15	0.09	0.11		14.04	11.89	14.23	13.64	
CV(%)	3.45	3.84	2.76	3.32		3.68	3.14	3.59	3.59	
Madhuri	2.64	2.68	0.78	0.79		234.20	252.20	245.20	248.60	
Shaktiman-	2.05	2.1	3.1	3.15		243.6	248.61	240.62	250.21	

Table contd.....										
Parents	Crop growth rate at 60-75 DAS (g m ⁻² d ⁻¹)					Relative growth rate at 60-75 DAS (gg-l d ⁻¹)				
	Rajendranagar		Palem		Mean	Rajendranagar		Palem		Mean
	Kharif	Rabi	Kharif	Rabi		Kharif	Rabi	Kharif	Rabi	
P1	22.10	22.00	21.80	20.80	21.68	0.04	0.04	0.04	0.04	0.04
P2	21.60	21.80	21.20	21.60	21.55	0.05	0.05	0.05	0.05	0.05
P3	22.40	22.10	22.00	21.40	21.97	0.06	0.06	0.05	0.05	0.06
P4	21.40	21.10	21.00	20.60	21.02	0.05	0.05	0.05	0.05	0.05
P5	22.40	22.00	22.00	22.10	22.13	0.06	0.06	0.06	0.05	0.06
P6	22.20	22.00	21.80	21.20	21.80	0.05	0.05	0.05	0.05	0.05
P7	21.00	20.60	20.30	20.20	20.52	0.04	0.04	0.04	0.04	0.04
P8	21.50	21.40	21.00	21.00	21.23	0.06	0.05	0.05	0.04	0.05
P9	21.20	21.00	20.60	21.40	21.05	0.05	0.04	0.04	0.06	0.05
P10	21.70	21.40	21.20	20.80	21.27	0.04	0.04	0.04	0.04	0.04
Mean	21.75	21.54	21.29	21.11	21.42	0.05	0.05	0.05	0.05	0.05
Crosses										
P1 X P2	30.60	30.20	30.40	29.40	30.15	0.04	0.04	0.04	0.05	0.04
P1 X P3	30.10	29.60	29.60	29.10	29.60	0.04	0.04	0.04	0.04	0.04
P1 X P4	27.40	27.10	27.10	26.40	27.00	0.04	0.04	0.04	0.04	0.04
P1 X P5	27.20	27.20	26.40	26.80	26.90	0.04	0.04	0.04	0.04	0.04
P1 X P6	27.10	27.00	26.80	26.20	26.78	0.04	0.04	0.04	0.04	0.04
P1 X P7	30.60	30.40	29.80	29.20	30.00	0.05	0.05	0.04	0.04	0.04
P1 X P8	27.50	27.10	27.10	26.40	27.02	0.04	0.04	0.04	0.04	0.04
P1 X P9	29.80	29.60	29.10	28.40	29.22	0.06	0.06	0.06	0.06	0.06
P1 X P10	34.60	33.40	33.40	32.30	33.43	0.06	0.06	0.06	0.06	0.06
P2 X P3	28.20	28.00	27.40	26.40	27.50	0.04	0.04	0.04	0.04	0.04
P2 X P4	27.30	27.20	26.80	26.80	27.03	0.05	0.06	0.05	0.05	0.05
P2 X P5	27.70	27.40	27.20	26.60	27.22	0.05	0.05	0.04	0.04	0.05
P2 X P6	26.80	26.40	26.20	25.80	26.30	0.05	0.05	0.04	0.04	0.04
P2 X P7	26.70	26.30	26.10	25.40	26.13	0.04	0.06	0.05	0.05	0.05
P2 X P8	35.20	34.80	34.40	33.60	34.50	0.06	0.05	0.05	0.05	0.05
P2 X P9	27.80	27.10	26.80	26.80	27.13	0.06	0.05	0.05	0.05	0.05
P2 X P10	38.60	38.40	37.40	37.20	37.90	0.05	0.06	0.06	0.05	0.05
P3 X P4	26.90	26.60	26.10	26.20	26.45	0.05	0.05	0.05	0.04	0.05
P3 X P5	26.60	26.10	25.40	25.40	25.88	0.06	0.05	0.05	0.05	0.05
P3 X P6	27.30	26.40	26.20	25.80	26.42	0.05	0.05	0.05	0.05	0.05
P3 X P7	27.40	27.40	26.80	26.80	27.10	0.04	0.04	0.04	0.04	0.04
P3 X P8	27.10	26.40	26.40	26.10	26.50	0.05	0.05	0.04	0.04	0.04
P3 X P9	27.20	27.20	26.10	26.40	26.73	0.04	0.04	0.04	0.04	0.04
P3 X P10	34.80	33.60	33.40	32.40	33.55	0.04	0.04	0.05	0.05	0.05
P4 X P5	34.90	34.10	33.10	33.40	33.87	0.06	0.05	0.05	0.05	0.05
P4 X P6	38.70	38.20	37.80	37.40	38.02	0.07	0.05	0.07	0.07	0.06
P4 X P7	22.80	22.60	22.10	21.40	22.23	0.04	0.04	0.04	0.04	0.04
P4 X P8	23.40	23.10	23.20	22.30	23.00	0.05	0.05	0.05	0.04	0.05
P4 X P9	22.60	22.40	21.40	21.60	22.00	0.04	0.04	0.04	0.04	0.04
P4 X P10	34.60	33.40	33.00	32.40	33.35	0.04	0.04	0.04	0.04	0.04
P5 X P6	36.80	30.10	35.40	35.40	34.42	0.05	0.04	0.05	0.05	0.05
P5 X P7	34.20	33.20	33.60	31.40	33.10	0.05	0.05	0.05	0.05	0.05
P5 X P8	34.80	31.90	33.60	33.60	33.47	0.05	0.05	0.05	0.05	0.05
P5 X P9	32.10	34.10	31.80	30.80	32.20	0.04	0.04	0.04	0.04	0.04
P5 X P10	31.10	36.60	30.20	29.60	31.88	0.05	0.05	0.05	0.05	0.05
P6 X P7	30.60	30.60	25.80	29.40	29.10	0.05	0.05	0.05	0.05	0.05
P6 X P8	22.10	33.40	21.00	21.00	24.38	0.04	0.04	0.04	0.04	0.04
P6 X P9	23.60	23.10	22.40	22.80	22.98	0.06	0.06	0.06	0.05	0.06
P6 X P10	22.10	22.10	21.80	21.80	21.95	0.05	0.05	0.05	0.05	0.05
P7 X P8	22.40	22.00	21.90	21.60	21.97	0.06	0.06	0.06	0.06	0.06
P7 X P9	34.30	21.60	32.20	32.60	30.18	0.06	0.06	0.06	0.06	0.06
P7 X P10	22.60	21.80	22.00	21.20	21.90	0.05	0.05	0.05	0.04	0.05
P8 X P9	22.80	22.00	22.20	21.40	22.10	0.04	0.04	0.04	0.04	0.04
P8 X P10	23.10	22.40	22.40	22.00	22.48	0.04	0.04	0.04	0.04	0.04
P9 X P10	23.40	23.00	22.60	22.60	22.90	0.05	0.05	0.05	0.05	0.05
Mean	28.74	28.28	27.82	27.50	28.09	0.05	0.05	0.05	0.05	0.05
G M	27.47	27.05	26.63	26.34		0.05	0.05	0.05	0.05	
SE d	0.76	0.76	0.79	0.72		0.00	0.00	0.00	0.00	
CD(0.05)	1.48	1.50	1.56	1.42		0.00	0.00	0.00	0.00	
CV(%)	3.37	3.48	3.65	3.37		4.70	5.22	4.78	4.98	
Madhuri	30.80	29.67	29.82	28.63		0.04	0.04	0.04	0.04	
Shaktiman-	31.21	30.6	30.62	29.42		0.05	0.05	0.05	0.05	

Table contd.....										
Parents	Net assimilation rate at 60-75 DAS (gm-2d-1)					Specific leaf weight at 90 DAS (mgcm-2)				
	Rajendranagar		Palem		Mean	Rajendranagar		Palem		Mean
	Kharif	Rabi	Kharif	Rabi		Kharif	Rabi	Kharif	Rabi	
P1	8.39	8.45	8.72	8.56	8.53	10.10	10.19	10.14	10.14	10.14
P2	8.64	8.70	8.48	8.42	8.56	8.12	8.42	8.79	8.24	8.39
P3	7.34	7.50	8.58	8.52	7.99	9.50	8.91	8.93	8.53	8.97
P4	8.96	8.44	8.82	8.79	8.75	10.10	9.99	9.92	10.15	10.04
P5	8.05	9.11	7.62	7.75	8.13	10.12	10.92	12.45	11.82	11.33
P6	9.62	9.65	9.32	9.72	9.58	10.35	9.31	9.91	9.81	9.85
P7	7.56	8.05	7.81	7.94	7.84	10.10	10.45	8.99	9.42	9.74
P8	7.95	7.61	8.61	8.92	8.27	9.92	11.13	10.74	9.72	10.38
P9	8.28	8.01	8.58	8.94	8.45	10.13	9.19	11.08	9.98	10.10
P10	8.46	8.32	8.69	9.52	8.75	12.50	11.81	11.85	12.73	12.22
Mean	8.33	8.38	8.52	8.71	8.49	10.09	10.03	10.28	10.05	10.12
Crosses										
P1 X P2	8.32	8.50	7.77	7.92	8.13	12.20	11.48	10.99	12.81	11.87
P1 X P3	9.64	10.43	9.72	9.25	9.76	10.81	12.17	11.99	10.73	11.42
P1 X P4	9.23	9.11	9.11	10.59	9.51	12.52	10.73	12.85	11.85	11.99
P1 X P5	9.69	9.31	9.29	9.23	9.38	12.10	11.81	11.75	12.13	11.95
P1 X P6	10.11	9.72	9.72	10.72	10.07	12.13	12.42	10.42	11.75	11.68
P1 X P7	11.24	9.20	10.78	10.85	10.52	13.50	10.49	11.91	12.48	12.10
P1 X P8	9.82	10.30	10.38	10.84	10.34	11.19	12.13	12.02	12.85	12.05
P1 X P9	10.51	10.84	9.93	10.52	10.45	13.10	12.73	13.55	13.52	13.23
P1 X P10	12.19	11.69	11.36	9.75	11.25	12.90	11.92	11.01	12.48	12.08
P2 X P3	9.50	9.42	9.13	9.49	9.38	14.10	13.18	12.53	11.98	12.95
P2 X P4	10.37	10.72	10.13	10.25	10.37	13.80	12.42	11.95	12.89	12.76
P2 X P5	9.63	8.41	10.60	9.12	9.44	12.91	12.95	13.81	12.82	13.12
P2 X P6	9.98	9.70	9.74	10.42	9.96	10.13	10.13	12.01	10.52	10.70
P2 X P7	10.15	10.25	9.44	10.75	10.15	13.90	12.41	12.91	11.63	12.71
P2 X P8	9.38	9.65	8.56	8.79	9.10	13.80	12.81	12.05	12.82	12.87
P2 X P9	9.39	9.50	8.18	9.83	9.23	12.30	11.89	11.41	12.82	12.11
P2 X P10	10.02	10.64	10.18	10.75	10.40	12.20	11.51	12.55	11.42	11.92
P3 X P4	8.49	9.05	11.08	11.52	10.03	11.30	10.92	10.51	10.57	10.83
P3 X P5	11.09	12.12	10.16	10.42	10.95	13.40	13.50	12.01	10.91	12.46
P3 X P6	10.10	10.70	11.12	11.50	10.85	11.80	11.98	10.15	11.42	11.34
P3 X P7	9.50	8.96	9.52	10.92	9.73	10.20	8.99	10.01	9.81	9.75
P3 X P8	10.64	10.60	12.02	10.52	10.94	12.50	11.71	11.82	11.37	11.85
P3 X P9	9.79	9.81	9.22	8.56	9.35	12.10	10.99	12.01	12.51	11.90
P3 X P10	10.68	10.18	11.02	10.45	10.58	12.80	11.92	11.91	13.11	12.44
P4 X P5	9.97	9.15	10.90	10.93	10.24	13.20	13.13	12.72	12.98	13.01
P4 X P6	11.33	10.99	10.48	11.73	11.13	13.80	12.14	12.05	12.14	12.53
P4 X P7	9.12	9.12	8.28	9.83	9.09	12.20	11.13	13.15	13.95	12.61
P4 X P8	9.59	9.00	9.74	9.99	9.58	12.10	11.98	12.51	11.90	12.12
P4 X P9	8.81	8.65	8.34	8.73	8.63	13.70	11.83	11.58	12.82	12.48
P4 X P10	10.45	9.21	10.26	9.83	9.94	10.20	9.99	9.82	10.01	10.01
P5 X P6	11.19	12.34	11.47	11.42	11.60	13.80	12.81	11.72	11.92	12.56
P5 X P7	9.28	7.61	9.44	9.83	9.04	10.70	10.12	9.81	9.82	10.11
P5 X P8	10.19	10.44	10.72	10.73	10.52	13.60	13.12	12.14	12.12	12.74
P5 X P9	8.31	8.98	9.10	9.82	9.05	10.30	9.84	9.98	11.82	10.48
P5 X P10	8.61	7.92	9.80	8.82	8.79	11.40	11.12	11.83	11.52	11.47
P6 X P7	7.99	8.12	8.72	8.92	8.44	11.10	11.52	11.91	11.45	11.49
P6 X P8	9.75	9.42	9.88	9.72	9.69	12.91	11.52	11.71	11.82	11.99
P6 X P9	8.96	9.00	8.96	8.97	8.97	11.73	10.92	10.34	10.87	10.97
P6 X P10	8.73	9.05	8.50	9.53	8.95	10.72	9.45	10.01	10.93	10.28
P7 X P8	8.28	9.25	8.32	9.72	8.89	11.23	10.98	10.13	11.73	11.02
P7 X P9	9.95	10.66	10.76	10.84	10.55	12.72	12.10	12.14	11.75	12.18
P7 X P10	10.36	10.50	9.58	9.72	10.04	12.80	11.92	13.51	11.38	12.40
P8 X P9	9.12	9.56	8.88	8.99	9.14	8.12	9.81	9.52	9.63	9.27
P8 X P10	8.31	8.51	9.12	9.49	8.86	10.10	10.23	11.23	9.84	10.35
P9 X P10	9.12	8.23	9.49	10.92	9.44	13.40	11.72	10.99	12.23	12.09
Mean	9.71	9.66	9.75	10.03	9.79	12.17	11.57	11.62	11.77	11.78
G M	9.46	9.42	9.53	9.79		11.79	11.29	11.38	11.46	
SE d	0.29	0.31	0.27	0.28		0.36	0.33	0.29	0.34	
CD(0.05)	0.56	0.61	0.54	0.55		0.71	0.65	0.58	0.66	
CV(%)	3.71	4.03	3.52	3.49		3.75	0.62	3.19	3.59	
Madhuri	8.89	8.57	8.82	8.23		13.40	12.14	11.45	13.01	
Shaktiman-	9.23	8.35	9.56	9.39		12.1	11.41	13.05	12.44	

Table contd....										
Parents	Total Biomass (kg/plot)					Total Chlorophyll content (mg/g)				
	Rajendranagar		Palem		Mean	Rajendranagar		Palem		Mean
	Kharif	Rabi	Kharif	Rabi		Kharif	Rabi	Kharif	Rabi	
P1	1.99	1.92	1.69	1.50	1.77	1.36	1.31	1.40	1.32	1.35
P2	1.75	1.73	1.93	1.78	1.80	1.15	1.11	1.22	1.12	1.15
P3	2.43	2.43	1.97	2.20	2.26	1.11	1.09	1.14	1.07	1.10
P4	2.01	1.98	2.48	2.51	2.24	1.39	1.36	1.43	1.37	1.39
P5	2.50	2.52	2.84	1.94	2.45	1.37	1.31	1.41	1.36	1.36
P6	2.43	2.19	2.74	1.93	2.32	1.32	1.24	1.28	1.30	1.28
P7	2.33	2.30	2.52	2.47	2.40	1.30	1.22	1.25	1.28	1.26
P8	2.83	2.49	2.47	2.49	2.57	1.23	1.20	1.28	1.21	1.23
P9	1.96	2.00	2.40	2.42	2.19	1.26	1.28	1.31	1.27	1.28
P10	2.29	2.60	2.03	2.32	2.31	1.40	1.40	1.46	1.33	1.40
Mean	2.25	2.22	2.31	2.16	2.23	1.29	1.25	1.32	1.26	1.28
Crosses										
P1 X P2	1.98	2.07	3.72	3.99	2.94	1.21	1.23	1.38	1.22	1.26
P1 X P3	2.50	3.50	3.50	3.42	3.23	1.40	1.38	1.42	1.36	1.39
P1 X P4	3.25	3.75	4.04	3.73	3.69	1.25	1.21	1.28	1.27	1.25
P1 X P5	2.02	2.72	3.26	3.87	2.96	1.38	1.33	1.41	1.38	1.38
P1 X P6	3.15	3.68	4.07	3.73	3.66	1.45	1.42	1.46	1.45	1.45
P1 X P7	3.11	3.58	3.73	4.15	3.64	1.48	1.45	1.35	1.31	1.40
P1 X P8	3.98	3.95	3.53	3.87	3.83	1.28	1.26	1.33	1.28	1.29
P1 X P9	3.75	4.10	3.30	3.67	3.71	1.49	1.50	1.52	1.50	1.50
P1 X P10	4.28	4.50	3.97	4.27	4.25	1.58	1.60	1.68	1.58	1.61
P2 X P3	2.25	3.03	3.43	3.74	3.11	1.20	1.21	1.35	1.22	1.25
P2 X P4	3.97	4.00	4.04	2.84	3.71	1.55	1.52	1.60	1.46	1.53
P2 X P5	3.82	4.03	3.78	3.55	3.80	1.51	1.45	1.55	1.43	1.49
P2 X P6	3.75	3.78	4.03	3.94	3.88	1.45	1.42	1.48	1.38	1.43
P2 X P7	4.30	4.47	3.96	3.77	4.13	1.42	1.40	1.45	1.40	1.42
P2 X P8	4.12	4.50	4.04	3.88	4.13	1.38	1.36	1.41	1.37	1.38
P2 X P9	3.68	3.81	4.02	4.06	3.89	1.31	1.30	1.35	1.25	1.30
P2 X P10	4.40	4.47	3.70	3.97	4.13	1.40	1.38	1.42	1.36	1.39
P3 X P4	4.13	3.73	3.95	3.23	3.76	1.42	1.41	1.45	1.36	1.41
P3 X P5	2.30	3.06	3.90	4.14	3.35	1.54	1.42	1.61	1.57	1.53
P3 X P6	3.72	3.79	3.65	3.96	3.78	1.30	1.40	1.36	1.25	1.33
P3 X P7	4.18	4.02	3.57	3.81	3.90	1.56	1.54	1.33	1.22	1.41
P3 X P8	3.30	3.77	3.74	3.91	3.68	1.45	1.42	1.26	1.45	1.39
P3 X P9	4.27	4.20	3.82	3.56	3.96	1.48	1.46	1.52	1.41	1.47
P3 X P10	2.75	3.25	3.45	4.04	3.38	1.28	1.30	1.57	1.45	1.40
P4 X P5	4.43	4.43	3.95	4.18	4.25	1.58	1.55	1.48	1.45	1.51
P4 X P6	4.48	4.53	3.73	3.75	4.12	1.62	1.64	1.62	1.49	1.59
P4 X P7	3.75	3.98	4.10	3.27	3.78	1.30	1.28	1.35	1.22	1.29
P4 X P8	3.39	3.38	3.50	3.17	3.36	1.26	1.22	1.31	1.24	1.26
P4 X P9	3.45	3.74	3.89	4.11	3.80	1.38	1.35	1.42	1.35	1.38
P4 X P10	3.27	3.52	3.65	3.55	3.50	1.40	1.37	1.45	1.36	1.39
P5 X P6	3.97	3.98	3.83	3.29	3.77	1.54	1.50	1.62	1.56	1.55
P5 X P7	2.48	2.81	3.50	3.25	3.01	1.42	1.39	1.46	1.38	1.41
P5 X P8	4.27	4.35	3.91	4.28	4.20	1.50	1.48	1.54	1.45	1.49
P5 X P9	3.98	4.15	3.43	3.65	3.80	1.24	1.22	1.60	1.25	1.33
P5 X P10	3.79	4.07	4.05	3.94	3.96	1.35	1.33	1.36	1.22	1.31
P6 X P7	3.43	3.75	3.42	3.85	3.61	1.26	1.22	1.31	1.21	1.25
P6 X P8	3.65	3.83	3.35	4.07	3.72	1.35	1.32	1.38	1.32	1.34
P6 X P9	3.16	3.36	3.00	2.78	3.07	1.33	1.31	1.39	1.28	1.33
P6 X P10	2.74	2.32	3.73	3.48	3.07	1.30	1.31	1.55	1.45	1.40
P7 X P8	3.17	2.48	3.45	3.22	3.08	1.36	1.33	1.41	1.32	1.36
P7 X P9	4.30	4.39	3.95	2.83	3.87	1.42	1.43	1.60	1.51	1.49
P7 X P10	3.16	3.17	2.64	2.66	2.91	1.28	1.30	1.49	1.40	1.37
P8 X P9	3.16	4.48	3.49	3.69	3.71	1.19	1.15	1.25	1.15	1.19
P8 X P10	3.17	4.02	4.20	4.07	3.87	1.22	1.20	1.28	1.20	1.23
P9 X P10	3.93	4.01	3.75	3.56	3.81	1.38	1.36	1.42	1.32	1.37
Mean	3.51	3.74	3.70	3.68	3.66	1.39	1.37	1.44	1.36	1.39
GM	3.28	3.47	3.45	3.41		1.36	1.35	1.42	1.34	
SE d	0.27	6.20	0.18	0.31		0.05	0.06	0.05	0.05	
CD(0.05)	0.53	0.39	0.36	0.61		0.10	0.11	0.09	0.10	
CV(%)	10.11	12.07	6.48	11.19		4.64	5.08	4.29	4.87	
Madhuri	2.96	3.18	3.65	3.44		1.45	1.42	1.49	1.42	
Shaktiman-	4.04	3.85	4.51	4.26		1.57	1.51	1.61	1.51	

Table contd.....										
Parents	Harvest index (%)					Protein content (%)				
	Rajendranagar		Palem		Mean	Rajendranagar		Palem		Mean
	Kharif	Rabi	Kharif	Rabi		Kharif	Rabi	Kharif	Rabi	
P1	46.25	48.23	51.41	54.54	50.11	10.50	10.60	11.18	10.55	10.71
P2	44.51	46.40	49.04	50.82	47.69	11.10	11.20	10.82	11.14	11.06
P3	51.37	50.25	51.04	53.13	51.45	10.60	10.57	10.60	10.55	10.58
P4	41.03	41.03	35.50	36.67	38.56	11.10	11.20	11.20	11.25	11.19
P5	52.33	53.48	56.10	45.52	51.86	10.30	10.20	10.10	10.20	10.20
P6	46.52	51.37	52.80	45.72	49.10	10.60	10.60	10.50	10.40	10.53
P7	46.31	47.73	48.49	52.65	48.79	10.60	10.70	10.62	10.63	10.64
P8	50.53	49.15	50.56	50.43	50.17	9.10	9.30	9.20	9.22	9.21
P9	39.37	41.54	38.13	51.06	42.53	11.10	11.00	11.20	11.20	11.13
P10	49.44	48.13	48.19	52.35	49.53	10.00	10.01	10.03	10.06	10.02
Mean	46.77	47.73	48.13	49.29	47.98	10.50	10.54	10.55	10.52	10.53
Crosses										
P1 X P2	47.52	48.52	46.98	48.48	47.88	9.50	9.70	9.62	9.63	9.61
P1 X P3	44.45	37.05	43.35	43.83	42.17	9.70	9.90	9.80	9.82	9.81
P1 X P4	48.17	46.23	46.47	44.34	46.31	11.30	11.50	11.41	11.42	11.41
P1 X P5	43.59	38.42	48.43	51.38	45.46	11.00	11.03	11.03	11.03	11.02
P1 X P6	46.57	44.77	50.29	48.49	47.53	10.70	10.91	10.80	10.82	10.81
P1 X P7	47.60	46.10	47.63	51.59	48.23	10.00	10.20	10.12	10.09	10.10
P1 X P8	44.38	44.90	47.66	48.58	46.38	9.10	9.30	9.21	9.24	9.21
P1 X P9	48.49	47.06	50.90	53.34	49.95	9.60	9.70	9.62	9.62	9.63
P1 X P10	49.51	48.37	48.53	50.44	49.21	9.80	9.92	9.83	9.91	9.86
P2 X P3	41.37	37.51	47.58	48.62	43.77	10.00	10.10	10.04	10.11	10.06
P2 X P4	48.50	49.83	51.12	51.44	50.22	10.10	10.20	10.14	10.15	10.15
P2 X P5	47.77	48.25	51.34	52.00	49.84	10.20	10.31	10.22	10.23	10.24
P2 X P6	46.35	46.74	45.38	45.41	45.97	10.40	10.52	10.42	10.50	10.46
P2 X P7	48.50	47.66	46.37	50.45	48.25	10.20	10.31	10.22	10.23	10.24
P2 X P8	49.29	48.58	52.30	51.55	50.43	10.00	10.15	10.04	10.12	10.08
P2 X P9	47.41	46.79	44.57	44.28	45.76	11.00	11.04	11.02	11.07	11.03
P2 X P10	48.46	48.78	50.43	51.18	49.72	9.30	9.50	9.42	9.51	9.43
P3 X P4	41.56	43.56	51.18	48.54	46.21	11.40	11.51	11.42	11.50	11.46
P3 X P5	28.46	28.39	49.43	50.48	39.19	11.20	11.32	11.30	11.31	11.28
P3 X P6	42.78	43.65	48.27	48.53	45.81	9.70	9.91	9.80	9.82	9.81
P3 X P7	45.31	46.70	48.47	48.72	47.30	9.30	9.40	9.32	9.33	9.34
P3 X P8	48.38	45.27	49.34	48.75	47.93	9.10	9.13	9.02	9.68	9.23
P3 X P9	45.50	47.15	47.46	50.21	47.58	11.60	11.72	11.63	11.70	11.66
P3 X P10	38.71	36.63	45.11	48.74	42.30	10.00	10.11	10.04	10.12	10.07
P4 X P5	47.79	50.65	48.46	50.35	49.31	10.20	10.31	10.23	10.30	10.26
P4 X P6	48.56	49.11	53.53	53.50	51.18	10.30	10.50	10.40	10.41	10.40
P4 X P7	46.46	46.44	51.33	42.07	46.57	9.80	9.90	9.82	9.91	9.86
P4 X P8	42.50	40.35	40.17	44.50	41.88	12.00	12.50	12.30	12.31	12.28
P4 X P9	44.23	42.00	49.14	41.20	44.14	10.56	10.63	10.60	10.62	10.60
P4 X P10	42.50	41.26	49.42	48.16	45.34	9.60	9.70	9.63	9.71	9.66
P5 X P6	47.52	48.49	51.39	48.82	49.05	11.30	10.83	11.40	11.41	11.24
P5 X P7	41.47	40.40	43.47	40.46	41.45	9.15	9.30	9.20	9.23	9.22
P5 X P8	47.56	47.39	48.51	48.85	48.08	11.40	11.51	11.42	11.51	11.46
P5 X P9	47.13	46.51	42.30	42.68	44.66	10.00	10.07	10.04	10.04	10.04
P5 X P10	45.84	46.45	44.47	47.55	46.08	11.80	12.01	11.91	11.93	11.91
P6 X P7	42.59	41.05	45.00	46.61	43.81	10.30	10.50	10.40	10.42	10.40
P6 X P8	45.87	45.24	46.29	49.36	46.69	10.10	10.33	10.20	10.21	10.21
P6 X P9	41.86	41.85	39.21	37.63	40.14	10.70	10.94	10.80	10.82	10.81
P6 X P10	36.59	44.17	47.37	44.44	43.14	9.50	9.70	9.60	9.62	9.60
P7 X P8	36.33	43.76	44.55	40.80	41.36	9.80	9.90	9.82	9.91	9.86
P7 X P9	45.52	46.52	55.27	48.97	49.07	11.60	11.70	11.62	11.71	11.66
P7 X P10	41.72	43.35	39.26	41.53	41.47	10.20	10.30	10.22	10.41	10.28
P8 X P9	45.65	39.50	43.51	44.80	43.36	10.40	10.50	10.40	10.51	10.45
P8 X P10	38.57	35.68	47.51	47.25	42.25	10.50	10.70	10.60	10.70	10.63
P9 X P10	43.30	44.49	46.22	48.36	45.59	10.00	10.13	10.05	10.13	10.08
Mean	44.63	44.26	47.44	47.49	45.96	10.30	10.43	10.36	10.42	10.38
G M	45.02	44.89	47.57	47.82		10.33	10.45	10.39	10.44	
SE d	0.68	0.93	1.49	1.40		0.28	0.15	0.16	0.14	
CD(0.05)	1.34	1.83	2.92	2.74		0.55	0.30	0.31	0.28	
CV(%)	1.86	2.54	3.84	3.59		3.31	1.81	1.85	1.66	
Madhuri	46.09	38.09	42.41	39.25		12.10	12.20	12.31	12.32	
Shaktiman-	42.73	45.5	48.78	47.23		11.7	12.01	11.82	11.91	

Table contd.....										
Parents	Seed Protein yield / ha					Oil per cent				
	Rajendranagar		Palem		Mean	Rajendranagar		Palem		Mean
	Kharif	Rabi	Kharif	Rabi		Kharif	Rabi	Kharif	Rabi	
P1	357.00	381.40	379.40	380.52	374.58	6.82	6.75	6.49	6.82	6.72
P2	310.80	336.00	390.33	380.12	354.31	6.51	6.75	6.68	6.92	6.71
P3	477.00	504.00	477.00	485.30	485.82	6.28	6.46	6.55	6.75	6.51
P4	310.80	313.60	324.80	315.00	316.05	7.10	7.00	7.14	7.23	7.12
P5	566.50	591.60	555.50	571.20	571.20	6.09	6.20	6.29	6.49	6.27
P6	445.20	487.60	493.50	478.40	476.18	6.04	6.60	6.06	6.34	6.26
P7	402.80	449.27	479.47	512.60	461.03	6.22	6.49	6.32	6.62	6.41
P8	464.10	455.47	469.74	491.33	470.16	6.72	6.61	6.56	6.64	6.63
P9	277.50	308.00	333.00	336.00	313.63	6.80	6.91	7.05	7.08	6.96
P10	450.00	484.53	431.70	433.58	449.95	6.40	6.53	6.38	6.69	6.50
Mean	406.17	431.15	433.44	438.41	427.29	6.50	6.63	6.55	6.76	6.61
Crosses										
P1 X P2	342.00	368.40	676.20	677.60	516.05	7.13	7.40	7.49	7.70	7.43
P1 X P3	388.00	415.53	529.70	551.60	471.21	7.27	7.31	7.26	7.50	7.34
P1 X P4	678.00	736.00	742.30	742.30	724.65	6.31	6.42	6.54	6.67	6.49
P1 X P5	330.00	377.27	771.40	797.51	569.04	7.19	7.09	7.16	7.26	7.17
P1 X P6	588.50	632.13	567.75	847.05	658.86	6.46	6.62	6.65	6.88	6.65
P1 X P7	552.00	591.40	808.80	762.47	678.67	6.52	6.71	6.62	7.03	6.72
P1 X P8	573.70	613.53	617.74	650.00	613.74	7.50	7.94	7.94	8.14	7.88
P1 X P9	672.00	717.53	723.75	715.58	707.22	5.98	6.03	6.22	6.42	6.16
P1 X P10	793.80	831.40	791.20	813.44	807.46	7.18	7.52	7.50	7.75	7.49
P2 X P3	320.00	363.40	653.25	688.11	506.19	5.20	5.07	5.22	5.60	5.27
P2 X P4	750.40	795.40	853.44	814.23	803.37	6.17	6.09	6.25	6.51	6.26
P2 X P5	714.00	764.27	789.23	792.33	764.96	6.59	6.96	7.10	7.16	6.95
P2 X P6	667.68	696.40	770.55	700.17	708.70	6.27	6.62	6.54	7.08	6.63
P2 X P7	836.40	827.13	821.60	668.32	788.36	6.45	6.81	6.93	7.04	6.81
P2 X P8	800.00	852.40	866.02	869.46	846.97	6.47	6.83	6.70	7.02	6.75
P2 X P9	726.00	776.20	717.60	730.62	737.61	6.52	6.96	7.06	7.17	6.93
P2 X P10	766.30	798.00	746.55	761.53	768.10	7.21	7.42	7.31	7.64	7.39
P3 X P4	627.00	668.11	859.50	851.00	751.40	6.79	7.03	7.04	7.31	7.04
P3 X P5	766.08	681.33	904.00	928.16	819.89	7.16	7.27	7.43	7.61	7.37
P3 X P6	543.20	594.00	686.70	690.60	628.63	6.46	6.32	6.22	6.53	6.38
P3 X P7	626.80	658.00	635.80	656.60	644.30	6.48	6.83	6.75	7.16	6.80
P3 X P8	546.00	577.43	648.00	687.03	614.61	6.82	6.83	7.45	7.34	7.11
P3 X P9	812.00	856.08	887.60	749.29	826.24	6.45	6.81	6.77	7.08	6.78
P3 X P10	350.00	383.19	465.28	657.53	464.00	6.65	6.94	7.03	7.20	6.96
P4 X P5	816.00	850.24	822.40	824.53	828.29	7.07	7.13	7.18	7.62	7.25
P4 X P6	875.33	915.40	905.67	897.84	898.56	7.22	7.11	7.18	7.35	7.21
P4 X P7	637.00	660.88	591.00	743.25	658.03	6.48	6.83	7.01	7.08	6.85
P4 X P8	508.53	565.00	683.88	714.37	617.95	5.43	6.72	6.84	6.98	6.49
P4 X P9	580.53	600.51	599.97	596.40	594.35	7.16	7.22	7.18	7.55	7.28
P4 X P10	455.03	473.24	654.30	680.27	565.71	6.98	7.01	7.19	7.28	7.11
P5 X P6	813.60	853.20	827.64	822.24	829.17	6.25	6.42	6.48	6.64	6.45
P5 X P7	329.27	357.07	438.39	464.33	397.26	6.38	6.63	6.28	6.74	6.51
P5 X P8	855.00	898.37	859.50	944.43	889.32	6.65	6.96	7.15	7.28	7.01
P5 X P9	700.00	731.16	512.55	540.29	621.00	6.25	6.50	6.45	6.73	6.48
P5 X P10	767.00	818.27	868.70	763.35	804.33	6.40	6.63	6.53	6.69	6.56
P6 X P7	515.00	552.20	624.00	647.60	584.70	6.22	6.50	5.48	6.93	6.28
P6 X P8	626.13	663.20	780.00	695.43	691.19	6.21	6.31	6.35	6.62	6.37
P6 X P9	481.33	523.13	388.80	412.53	451.45	5.82	5.94	5.90	6.24	5.97
P6 X P10	304.00	349.13	576.00	598.61	456.94	6.10	6.32	6.41	6.57	6.35
P7 X P8	343.00	376.13	557.50	495.43	443.02	7.23	7.30	7.17	7.48	7.30
P7 X P9	835.13	889.64	893.16	891.48	877.35	6.65	6.94	6.82	7.23	6.91
P7 X P10	459.00	494.27	375.10	396.70	431.27	6.58	6.81	6.64	6.97	6.75
P8 X P9	572.00	609.00	593.25	631.20	601.36	6.52	6.79	6.64	6.84	6.70
P8 X P10	420.00	449.27	795.00	803.25	616.88	7.07	7.23	7.08	7.46	7.21
P9 X P10	600.00	649.40	756.00	588.70	648.53	7.17	7.22	7.47	7.55	7.35
Mean	605.84	641.18	703.04	710.11	665.04	6.60	6.81	6.81	7.08	6.83
G M	569.53	602.99	654.02	660.10		6.58	6.78	6.77	7.02	
SE d	8.29	38.87	60.74	11.29		0.36	0.10	0.31	0.24	
CD(0.05)	16.25	76.18	119.04	22.14		0.71	0.21	0.60	0.47	
CV(%)	1.78	7.89	11.37	2.09		6.65	1.89	5.58	4.18	
Madhuri	435.40	475.00	578.07	617.50		7.20	7.12	7.25	7.02	
Shaktinan-	702	768.03	944.04	831.27		6.92	6.71	6.72	6.89	

Table contd.....										
Parents	Oil yield / ha					Tryptophan content (g/16gN)				
	Rajendranagar		Palem		Mean	Rajendranagar		Palem		Mean
	Kharif	Rabi	Kharif	Rabi		Kharif	Rabi	Kharif	Rabi	
P1	231.88	243.00	251.28	250.20	244.09	0.75	0.75	0.76	0.76	0.75
P2	182.00	182.50	233.80	232.90	207.80	0.78	0.78	0.78	0.78	0.78
P3	280.80	311.52	294.75	310.50	299.39	0.65	0.65	0.65	0.65	0.65
P4	198.80	196.00	205.90	252.00	213.17	0.82	0.82	0.83	0.83	0.83
P5	330.00	360.18	342.65	364.00	349.21	0.53	0.54	0.54	0.54	0.54
P6	249.90	303.60	282.00	289.90	281.35	0.56	0.56	0.57	0.57	0.56
P7	233.70	272.16	281.25	319.20	276.58	0.60	0.61	0.61	0.61	0.60
P8	341.70	324.87	357.00	337.92	340.37	0.52	0.53	0.53	0.52	0.52
P9	170.00	193.76	208.50	211.50	195.94	0.86	0.87	0.87	0.87	0.87
P10	285.75	316.32	273.05	263.16	284.57	0.62	0.62	0.64	0.64	0.63
Mean	250.45	270.39	273.02	283.13	269.25	0.67	0.67	0.68	0.68	0.67
Crosses										
P1 X P2	257.40	281.58	522.20	535.50	399.17	0.77	0.77	0.78	0.77	0.77
P1 X P3	288.00	308.28	392.00	420.00	352.07	0.79	0.80	0.78	0.80	0.79
P1 X P4	369.60	413.44	425.10	593.12	450.31	0.80	0.81	0.81	0.81	0.81
P1 X P5	211.50	243.44	493.50	522.00	367.61	0.58	0.59	0.59	0.58	0.59
P1 X P6	355.30	386.86	498.75	531.96	443.22	0.60	0.61	0.61	0.60	0.60
P1 X P7	358.80	458.32	436.00	521.25	443.59	0.65	0.66	0.66	0.65	0.65
P1 X P8	472.50	522.72	532.65	565.11	523.24	0.57	0.58	0.58	0.57	0.57
P1 X P9	414.40	449.92	461.25	469.90	448.87	0.85	0.86	0.86	0.85	0.85
P1 X P10	578.34	635.04	600.00	637.96	612.84	0.76	0.77	0.77	0.77	0.77
P2 X P3	163.20	183.60	347.75	344.08	259.66	0.79	0.80	0.81	0.80	0.80
P2 X P4	444.00	482.04	525.00	518.40	492.36	0.78	0.79	0.79	0.79	0.79
P2 X P5	459.20	515.78	539.00	550.55	516.13	0.65	0.66	0.66	0.65	0.66
P2 X P6	400.60	439.56	438.18	464.41	435.69	0.68	0.69	0.69	0.69	0.69
P2 X P7	519.80	545.64	553.60	455.65	518.67	0.66	0.67	0.67	0.67	0.67
P2 X P8	512.00	578.76	580.50	597.70	567.24	0.59	0.60	0.61	0.59	0.60
P2 X P9	429.00	488.60	455.00	471.90	461.12	0.82	0.83	0.83	0.83	0.83
P2 X P10	586.68	627.48	573.30	612.00	599.86	0.67	0.68	0.68	0.68	0.68
P3 X P4	376.75	406.00	528.75	536.50	462.00	0.80	0.81	0.81	0.81	0.81
P3 X P5	489.10	577.98	592.00	622.30	570.35	0.60	0.61	0.61	0.61	0.61
P3 X P6	336.00	381.00	430.50	455.00	400.63	0.62	0.63	0.63	0.63	0.63
P3 X P7	434.73	481.60	459.00	490.00	466.33	0.65	0.66	0.66	0.66	0.66
P3 X P8	405.00	435.44	504.00	551.00	473.86	0.59	0.59	0.60	0.59	0.59
P3 X P9	451.50	496.44	513.00	448.00	477.24	0.83	0.83	0.84	0.83	0.83
P3 X P10	231.70	261.95	462.00	464.75	355.10	0.69	0.68	0.69	0.69	0.69
P4 X P5	560.00	593.28	572.00	596.00	580.32	0.72	0.72	0.73	0.72	0.72
P4 X P6	599.25	620.86	629.44	629.52	619.77	0.73	0.73	0.74	0.74	0.73
P4 X P7	419.25	659.58	417.00	423.00	479.71	0.69	0.69	0.70	0.69	0.69
P4 X P8	269.66	305.55	376.96	403.10	338.82	0.62	0.62	0.63	0.63	0.62
P4 X P9	394.90	408.01	404.12	418.88	406.48	0.83	0.83	0.83	0.83	0.83
P4 X P10	329.43	342.57	473.20	507.50	413.18	0.70	0.70	0.70	0.70	0.70
P5 X P6	442.80	479.33	468.27	478.08	467.12	0.56	0.55	0.56	0.56	0.56
P5 X P7	230.40	256.51	297.50	337.50	280.48	0.55	0.55	0.56	0.56	0.56
P5 X P8	498.75	545.22	531.00	594.50	542.37	0.52	0.52	0.53	0.52	0.52
P5 X P9	437.50	470.60	328.95	364.50	400.39	0.69	0.69	0.70	0.69	0.69
P5 X P10	412.75	456.25	474.50	435.20	444.67	0.57	0.57	0.58	0.58	0.58
P6 X P7	310.50	342.42	388.80	424.70	366.61	0.58	0.58	0.59	0.59	0.59
P6 X P8	378.20	407.00	412.75	452.20	412.54	0.54	0.54	0.55	0.54	0.54
P6 X P9	258.75	285.60	215.28	233.70	248.33	0.65	0.65	0.66	0.66	0.65
P6 X P10	192.00	229.32	382.50	405.48	302.32	0.55	0.55	0.56	0.55	0.55
P7 X P8	250.25	277.78	334.58	372.50	308.78	0.54	0.54	0.55	0.55	0.54
P7 X P9	478.80	526.68	524.71	535.80	516.50	0.74	0.74	0.75	0.75	0.74
P7 X P10	294.75	327.84	243.39	265.24	282.80	0.61	0.61	0.62	0.62	0.61
P8 X P9	354.75	392.66	377.34	411.00	383.94	0.70	0.70	0.70	0.70	0.70
P8 X P10	280.00	306.18	535.50	555.00	419.17	0.53	0.53	0.54	0.53	0.53
P9 X P10	427.20	465.28	508.20	435.00	458.92	0.76	0.76	0.76	0.76	0.76
Mean	385.89	428.89	461.31	481.28	439.34	0.67	0.67	0.68	0.68	0.67
G M	361.26	400.07	427.08	445.25		0.67	0.67	0.68	0.68	
SE d	16.72	14.31	15.39	16.26		0.03	0.03	0.03	0.04	
CD(0.05)	32.77	28.04	30.17	31.87		0.06	0.06	0.06	0.07	
CV(%)	5.67	4.38	4.42	4.47		5.32	5.47	5.48	6.42	
Madhuri	288.04	310.40	376.02	412.51		0.70	0.70	0.71	0.71	
Shaktiman-	390.02	430.72	537.62	575.41		0.81	0.83	0.84	0.86	

Table contd...					
Parents	Grain Yield (kg / plot)				
	Rajendranagar		Palem		Mean
	Kharif	Rabi	Kharif	Rabi	
P1	1.65	1.72	1.83	1.80	1.75
P2	1.45	1.31	1.85	1.71	1.58
P3	1.93	2.35	2.27	2.30	2.21
P4	1.42	1.43	1.45	1.40	1.43
P5	2.65	2.89	2.75	2.80	2.77
P6	2.14	2.33	2.45	2.30	2.31
P7	1.98	2.14	2.27	2.40	2.20
P8	2.53	2.52	2.52	2.56	2.53
P9	1.32	1.49	1.84	1.50	1.54
P10	2.54	2.42	2.23	2.15	2.34
Mean	1.96	2.06	2.15	2.09	2.07
Crosses					
P1 X P2	1.94	1.95	3.50	3.55	2.73
P1 X P3	2.22	2.19	2.71	2.80	2.48
P1 X P4	3.12	3.28	3.25	3.32	3.24
P1 X P5	1.57	1.66	3.48	3.60	2.58
P1 X P6	3.08	2.88	3.75	3.84	3.39
P1 X P7	2.76	3.06	4.02	3.73	3.39
P1 X P8	3.21	3.37	3.33	3.51	3.35
P1 X P9	3.50	3.72	3.73	3.70	3.66
P1 X P10	4.04	4.27	4.03	4.12	4.12
P2 X P3	1.62	1.81	3.26	3.43	2.53
P2 X P4	3.16	3.98	4.22	4.07	3.85
P2 X P5	3.77	3.64	3.85	3.85	3.78
P2 X P6	3.60	3.34	3.33	3.35	3.40
P2 X P7	4.18	4.01	4.10	3.33	3.90
P2 X P8	4.11	4.22	4.32	4.30	4.24
P2 X P9	3.37	3.31	3.54	3.30	3.38
P2 X P10	4.16	4.29	3.90	4.00	4.09
P3 X P4	2.78	2.97	3.74	3.70	3.30
P3 X P5	3.43	3.82	4.09	4.10	3.86
P3 X P6	2.83	3.09	3.53	3.75	3.30
P3 X P7	3.40	3.52	3.40	3.49	3.45
P3 X P8	3.05	3.22	3.63	3.75	3.41
P3 X P9	3.52	3.64	3.85	3.27	3.57
P3 X P10	1.73	1.84	3.28	3.25	2.52
P4 X P5	4.14	4.17	4.06	4.11	4.12
P4 X P6	4.27	4.39	4.35	4.32	4.33
P4 X P7	3.34	3.34	3.09	3.00	3.19
P4 X P8	2.15	2.31	2.75	2.84	2.51
P4 X P9	2.74	2.80	2.80	2.80	2.78
P4 X P10	2.40	2.51	3.41	3.50	2.96
P5 X P6	3.65	3.71	3.63	3.60	3.65
P5 X P7	1.78	1.96	2.41	2.48	2.16
P5 X P8	3.72	4.02	3.77	4.19	3.92
P5 X P9	3.51	3.62	2.53	2.66	3.08
P5 X P10	3.35	3.41	3.67	3.30	3.43
P6 X P7	2.52	2.70	3.04	3.20	2.86
P6 X P8	3.18	2.92	3.29	3.46	3.21
P6 X P9	2.28	2.40	1.83	1.80	2.08
P6 X P10	1.64	1.68	3.13	3.14	2.40
P7 X P8	1.74	2.00	2.34	2.50	2.14
P7 X P9	3.80	3.88	3.80	3.80	3.82
P7 X P10	2.38	2.47	1.83	2.08	2.19
P8 X P9	2.75	2.97	2.82	3.09	2.91
P8 X P10	2.08	2.13	3.74	3.75	2.93
P9 X P10	3.12	3.26	3.52	2.88	3.19
Mean	2.99	3.11	3.41	3.41	3.23
G M	2.81	2.92	3.18	3.17	
SE d	0.29	0.23	0.19	0.24	
CD(0.05)	0.57	0.48	0.38	0.47	
CV(%)	12.72	9.63	7.51	9.36	
Madhuri	1.99	1.90	2.34	2.52	
Shaktiman-	3.06	3.61	4.01	4.25	

crosses it was 63.82 days. The parental line P4 was the earliest (60.00 days), while the parental line P9 took a maximum of 70 days after sowing for reaching 50 per cent tasseling. Among all the cross combinations, the cross P2 X P3 (57 days) was earliest while P6 X P9 was found to be late (78 days) to reach 50 per cent tasseling stage. The checks Madhuri recorded 65 days and Shaktiman-2 recorded 62 days.

At Palem, the mean values for this character ranged from 56 to 71 days. The mean value of parents was 66.60 days while for crosses it was 64.38 days. The parental line P4 (62.00) was the earliest while, P10 took a maximum of 70 days to reach 50 per cent tasseling. Among the 45 cross combinations, the cross P4 X P10 (56 days) was early to 50 per cent tasseling while P2 X P10 was found to be late (71 days) for 50 per cent tasseling. The checks Madhuri reached to tasseling at 68 days and Shaktiman-2 at 64 days.

4.2.2 Days to 50 per cent silking

During *Kharif* at Rajendranagar the mean values ranged from 53.67 days to 64.67 days. The mean value of parents was 62.27. The parental line P4 came early to silking with 57.33 days and that of P9 was late for silking 64.67 days. The mean value of crosses was 59.34 days, among the crosses P2 X P3 was earlier to silk i.e. 53.67 days and that of P2 X P10 came to silking very late (64.67 days), while the Standard checks Madhuri recorded 62.33 days and Shaktiman-2 recorded 58.66 days to silking.

At Palem during *Kharif* the mean values ranged from 50 days to 65 days. The mean value of parents was 61.20 days. The parental line P5 came to silking early (57 days) and that of P8 and P10 recorded (64 days) late for silking. The mean value of crosses was 59.87 days. The cross involving P4 X P9 recorded early to silking (52 days) whereas P2 X P10 recorded late to silking (65 days). Checks recorded 64 and 61 days for silking.

The mean values ranged from 59 days to 74 days during *Rabi* at Rajendranagar. The mean value of parents was 69.20 and that of crosses was 66.18 days. The parent P4 came early to silking with 62.00 days and that of P10 was late for silking (73 days). The cross-involving the parent P2 X P3 was earlier to silk i.e. 59 days and that of P6 X P9 came to silking very late (74 days) while the Standard checks came to silking at 68 and 64 days respectively

At Palem during *Rabi* the mean values ranged from 59 to 74 days. The mean value of parents was 69 days. The parent P4 came early to silking with 64 days and that of P10 was very late for silking (73 days). The mean value of crosses was 66.81 days. The cross involving P2 X P5 came to silking early (60 days) whereas P2 X P10 and P5 X P10 were late (74 days). While the Standard checks used, came to silking at 70 and 67 days respectively

4.2.3 Anthesis silking interval

The mean values ranged from 1.67 to 3 days during *Kharif* at Rajendranagar. The parental mean value was 2.37 days. The parents P6, P9 and P10 have low ASI (2 days) and that of P1 has high ASI (3 days). The mean value of crosses was 2.29 days with a cross combination of P2 X P6 having less ASI of 1.67 days and that of P2 X P9 and P3 X P5 have a maximum of 3 days ASI. The Standard check Madhuri has ASI of 2.7 days and that of Shaktiman-2 has 2.3 days.

At Palem during *Kharif*, the mean values ranged from 1 to 4 days. The mean value of parents was 2.60 days. The parents P1, P5 and P9 have less ASI (2 days) and that of P8 has 4 days. The mean value of crosses was 2.33 days. Among the crosses P3 X P4 has 1.0 days ASI and that of P4 X P6 has an ASI of 4 days. Both the checks have 3 days ASI.

The mean values ranged from 1 to 4 days during *Rabi* at Rajendranagar. The mean value of parents was 2.5 days. The parent P6 (2 days) has low ASI and P8 has

high ASI (4 days). The mean value of crosses was 2.36 days. The crosses P1 X P4 and P6 X P10 have less ASI (1 day) and that of P3 X P6 has ASI of 4 days, while the Standard checks Madhuri had an ASI of 3 and Shaktiman-2 had an ASI of 2 days.

During *Rabi* at Palem, the mean values ranged from 1.67 to 4 days. The mean value of parents was 2.40 days. The parents P1 and P4 have less ASI (2 days). The mean value of crosses was 2.44 days. The cross P9 X P10 has 1.57 days ASI and that of P1 X P6 has an ASI of 4 days, while the Standard checks Madhuri had an ASI of 2 days and that of Shaktiman-2 has 3 days.

4.2.4 Days to maturity

At Rajendranagar during *Kharif*, the mean values ranged from 86 to 97.33 days the parental mean values was 94 days .P4 recorded 88 days to maturity whereas P9 recorded 97 days to maturity. The mean value for crosses was 91.53 days .The cross involving parents P2XP3 and P2 X P5 recorded 86 days to maturity and that of parents involving P2 X P10 and P5 X P8 recorded 97.33 days to maturity. The check Madhuri recorded 94.3 days whereas Shaktiman-2 recorded 93.3 days.

During *Kharif* at Palem, the mean values ranged from 85 to 99 days. The mean value for parents was 93.70 days. The parent P10 recorded 85 days to maturity whereas P3 recorded 92.51 days to maturity. The mean value for crosses was 94.11 days .The cross involving the parent P2 X P5 and P4 X P9 recorded 85 days to maturity and the hybrids P6XP9, P7XP8 and P8 X P9 recorded 98.00 days to maturity. The checks Madhuri and Shaktiman-2 recorded 97 and 95 days to maturity respectively.

At Rajendranagar during *Rabi*, the mean values ranged from 92 to 106 days for parents and 102 to 113 days for crosses. For days to maturity the mean values of parents (101.60 days) and hybrids (98.53 days) indicated that hybrids were relatively early maturing than parents. The parent P4 recorded 95 days to maturity whereas P7

and P10 recorded 105 days to maturity. The cross involving the parents P2 X P3 reached early to maturity (90 days) and the cross involving the parent P6 X P9 recorded late (106 days) to maturity while the check Madhuri matured in 102 days whereas Shaktiman-2 recorded 98 days.

During *Rabi* at Palem, the mean values ranged from 91 to 106 days. The mean value for parents was 101.10 days. The parent P4 recorded 96 days to maturity whereas P10 recorded 106.00 days to maturity. The mean value for crosses was 98.56 days .the cross involving the parent P4 X P10 recorded 90 days to maturity and the hybrid P5 X P10 recorded 106 days to maturity. The check Madhuri matured in 104 days whereas Shaktiman-2 recorded 100 days to maturity.

4.2.5 Plant height (cm)

The mean values for plant height ranged from 104.67 cm to 223.33 cm during *Kharif* at Rajendranagar. The range of plant height of parents was from 116.77 cm to 183.47 cm with an average of 153.27 cm while the mean values of hybrids ranged from 110.63 cm to 223.93 cm. Maximum plant height was recorded in cross combination P2 X P3 with 223.3 cm while the checks recorded 152.6 cm and 162.3 cm respectively.

The range of mean values for plant height was from 110.63 to 223.93 cm during *Kharif* at Palem. The mean plant height for parents was 116.77-183.47 cm with an average of 152.27 cm the mean value for crosses was 110.63 cm to 223.93 cm with an average of 175.77 cm. Among the crosses P3 X P6 recorded 223.9cm. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 141.8 and 177.0 cm, respectively.

The range of mean values for plant height was from 101.00 to 202.33 cm during *Rabi* at Rajendranagar. The mean plant height for parents was 143.80 cm, while for crosses, it was 157.08 cm. The parent P3 recorded highest plant height of

197.6 cm. among the crosses P5 X P6 recorded 202.3cm. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 113 and 107 cm, respectively.

During *Rabi* at Palem, the mean plant height ranged from 115.70 to 225.60 cm. The mean value for parents was 155.69 cm, while for crosses it was 179.28 cm. The parent P1 recorded minimum plant height (120.60 cm) while the P8 recorded maximum plant height (185.40 cm). Among the crosses P6 X P9 recorded a minimum of 115.70 and a maximum plant height of 225.60cm (P3XP6). Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 145 and 180 cm, respectively.

4.2.6 Ear height (cm)

The mean values for ear height ranged from 53.00 cm to 94.00 cm during *Kharif* at Rajendranagar. The range of ear height of parents was from 60.20 cm to 81.00 cm with an average of 66.75 cm while the mean values of hybrids ranged from 53.00 cm to 94.00 cm with an average of 76.57cm. Among the parents P10 recorded maximum ear height of 81cm Maximum ear height was observed in cross combination P4 X P6 with 94 cm while the checks recorded 81 cm and 78 cm respectively.

The range of mean values for ear height was from 53.60 to 97.17 cm during *Kharif* at Palem. The mean ear height for parents was 55.13 to 84.73 cm with an average of 65.51 cm. the mean value for crosses was 53.60 cm to 97.17 cm with an average of 75.92 cm. Among the parents P10 recorded maximum ear height of 84.73cm. Among the crosses P3 X P6 recorded maximum ear height (97.17cm). Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 51 and 78 cm, respectively.

The range of mean values for ear height was from 50.33 to 94.33 cm during *Rabi* at Rajendranagar. The mean value for parents was 66.73 cm while for crosses, it is 75.32 cm . Among the parents P10 recorded maximum ear height of 83.33cm. The cross P4 X P6 recorded maximum ear height 94.33cm. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 79.6 and 76.0 cm respectively.

During *Rabi* at Palem, the mean ear height ranged from 57.10 to 99.20 cm. The mean value for parents was 65.35 cm, while for crosses it was 78.51 cm. Among the parents P1 recorded a minimum of 57.10cm and a maximum ear height of 85.40cm by P10. Among the crosses P6XP9 showed a minimum of 59.30cm whereas P3X P6 recorded a maximum ear height of 99.20 cm. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 53.0 and 80cm of ear height respectively.

4.2.7 Leaf Area Index (LAI)

For the character the differences among genotypes were significant during *Kharif* at Rajendranagar (Table 3a). Single cross P4 X P6 recorded the highest (3.56) and the least (0.93) by P9 parent. Highest LAI (2.41) was recorded at 60 DAS and the least (1.26) at 45 DAS. In all the genotypes, LAI increased upto 60DAS and decreased towards maturity. The range in LAI at flowering was 1.11 (P9) to 3.81(P10) in parents and 1.12 (P8 X P10) to 4.19 (P4 X P6) single crosses have higher LAI compared to parents. The check Madhuri recorded 2.64 whereas Shaktiman-2 recorded 2.05 LAI (Fig.1a)

Significant differences were observed among genotypes during *Kharif* at Palem.(Table3c). Single cross P5 X P6 recorded the highest (3.42) and the least (0.90) by P8 X P10. Highest LAI (2.04) was recorded at 70 DAS and the least (1.60) at 45 DAS. In all the genotypes, LAI increased upto 60DAS and decreased towards maturity. The range in LAI at flowering was 1.04 (P3) to 2.34 (P8) in parents and 1.12 (P8 X P10) to 4.02 (P5 X P6). Single crosses have higher LAI compared to parents. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 0.78 and 3.10 respectively. (Fig.1c)

For this character the differences among genotypes were significant during *Rabi* at Rajendranagar.(Table 3b). Single cross P4 X P6 recorded the highest (3.65) and the least (1.10) by P7 parent. Highest LAI (2.46) was recorded at 75 DAS and the

Table 3a: Leaf Area Index (LAI) in QPM (Kharif 2003, Rajendranagar)

100

Genotypes	45DAS	60DAS	75DAS	90DAS	Row mean
Parents					
P1	0.75	1.45	1.28	1.05	1.13
P2	0.78	1.81	1.62	1.41	1.41
P3	0.86	1.64	1.56	1.42	1.20
P4	1.40	2.80	2.71	--	2.30
P5	0.81	1.66	1.54	1.51	1.38
P6	0.74	1.41	1.26	1.12	1.13
P7	0.68	1.21	1.11	0.98	0.99
P8	1.94	3.10	3.01	2.86	2.73
P9	0.58	1.11	1.05	0.96	0.93
P10	2.00	3.81	3.72	3.56	3.27
Crosses					
P1 X P2	1.11	2.25	2.15	--	1.84
P1 X P3	1.72	3.11	3.01	2.89	2.68
P1 X P4	1.18	2.23	2.18	2.06	1.91
P1 X P5	1.54	2.98	2.74	2.58	2.46
P1 X P6	1.81	3.57	3.31	3.28	2.99
P1 X P7	1.16	2.21	2.11	2.00	1.87
P1 X P8	0.88	1.56	1.34	1.22	1.25
P1 X P9	1.78	3.28	3.11	--	2.72
P1 X P10	1.73	3.31	3.14	--	2.73
P2 X P3	0.68	1.22	1.18	--	1.03
P2 X P4	1.80	3.16	2.91	--	2.63
P2 X P5	2.10	3.92	3.74	--	3.25
P2 X P6	1.03	2.11	1.96	1.78	1.72
P2 X P7	1.89	3.63	3.52	3.46	3.13
P2 X P8	1.75	3.57	3.39	--	2.90
P2 X P9	0.87	1.62	1.49	1.27	1.31
P2 X P10	1.58	3.02	2.86	2.68	2.54
P3 X P4	1.27	2.46	2.32	2.16	2.05
P3 X P5	1.89	3.74	3.56	3.45	3.16
P3 X P6	1.19	2.34	2.22	--	1.92
P3 X P7	0.83	1.86	1.72	--	1.47
P2 X P8	1.31	2.24	2.11	1.98	1.91
P3 X P9	1.18	2.31	2.24	2.11	1.96
P3 X P10	0.71	1.40	1.28	--	1.13
P4 X P5	1.80	3.28	3.16	--	2.75
P4 X P6	2.15	4.19	4.02	3.86	3.56
P4 X P7	1.40	2.62	2.45	--	2.16
P4 X P8	1.33	2.42	2.22	--	1.99
P4 X P9	1.68	3.11	2.98	--	2.59
P4 X P10	1.75	3.22	3.11	--	2.69
P5 X P6	2.14	4.02	3.86	3.59	3.40
P5 X P7	0.80	1.77	1.59	--	1.38
P5 X P8	2.04	3.96	3.78	3.59	3.34
P5 X P9	1.30	2.56	2.39	2.21	2.12
P5 X P10	0.84	1.62	1.47	1.29	1.31
P6 X P7	0.71	1.34	1.22	--	1.09
P6 X P8	0.78	1.47	1.29	1.11	1.16
P6 X P9	0.60	1.18	1.07	0.89	0.94
P6 X P10	0.86	1.54	1.32	1.24	1.24
P7 X P8	0.72	1.39	1.18	1.01	1.08
P7 X P9	1.97	3.86	3.65	3.54	3.26
P7 X P10	0.81	1.60	1.45	--	1.26
P8 X P9	1.50	2.98	2.79	2.58	2.46
P8 X P10	0.54	1.12	1.01	--	0.89
P9 X P10	1.28	2.28	2.12	--	1.89
COL.MEAN	1.28	2.45	2.30	2.13	2.03
Group mean					
Parents	1.05	2.00	1.89	1.65	
Crosses	1.33	2.55	2.40	2.31	
Checks					
Madhuri	1.38	2.64	2.48	2.29	
Shaktiman-2	1.03	2.05	1.89	1.71	
Mean	1.34	2.35	2.19	2.00	

CD (A) at 0.05 level = 0.0501
 CD (B) at 0.05 level = 0.0135
 Interaction CD (0.05) = 0.1003

A = Genotypes
 B = Growth stages
 A X B = Interaction

Table3b: Leaf Area Index (LAI) in QPM (Rabi 2002-03, Rajendranagar)

Genotypes	45DAS	60DAS	75DAS	90DAS	Row mean
Parents					
P1	0.77	1.52	1.35	1.19	1.21
P2	0.80	1.64	1.51	1.42	1.34
P3	0.85	1.72	1.59	1.41	1.38
P4	1.41	2.85	2.76	--	1.76
P5	0.82	1.65	1.48	1.38	1.33
P6	0.78	1.46	1.28	1.09	1.15
P7	0.66	1.34	1.26	1.15	1.10
P8	1.95	3.20	3.01	2.89	2.76
P9	0.60	1.21	1.09	0.96	0.97
P10	1.96	3.81	3.69	3.52	3.25
Crosses					
P1 X P2	1.25	2.28	2.15	--	1.42
P1 X P3	1.74	3.21	3.09	2.98	2.76
P1 X P4	1.20	2.39	2.23	2.07	1.97
P1 X P5	1.55	3.01	2.90	2.78	2.56
P1 X P6	1.82	3.12	2.91	2.76	2.65
P1 X P7	0.83	1.60	1.45	1.29	1.29
P1 X P8	0.90	1.76	1.58	1.42	1.42
P1 X P9	1.80	3.56	3.38	--	2.19
P1 X P10	1.75	3.48	3.29	--	2.13
P2 X P3	0.70	1.41	1.23	--	0.84
P2 X P4	1.80	3.12	2.89	--	1.95
P2 X P5	2.12	4.10	4.00	--	2.56
P2 X P6	1.05	2.12	2.02	2.91	2.03
P2 X P7	1.91	3.79	3.65	3.49	3.21
P2 X P8	1.76	3.59	3.48	--	2.21
P2 X P9	0.89	1.74	1.56	1.49	1.42
P2 X P10	1.60	3.10	2.98	2.76	2.61
P3 X P4	1.29	2.50	2.41	2.23	2.11
P3 X P5	1.90	3.79	3.61	3.46	3.19
P3 X P6	1.20	2.42	2.25	--	1.47
P3 X P7	0.84	1.62	1.46	--	0.98
P3 X P8	1.32	2.61	2.48	2.29	2.18
P3 X P9	1.20	2.42	2.23	2.08	1.98
P3 X P10	0.75	1.43	1.29	--	0.87
P4 X P5	1.79	3.58	3.39	--	2.19
P4 X P6	2.17	4.24	4.12	4.06	3.65
P4 X P7	1.38	1.69	1.50	--	1.14
P4 X P8	1.35	2.68	2.46	--	1.62
P4 X P9	1.70	3.20	3.02	--	1.98
P4 X P10	1.77	3.34	3.16	--	2.07
P5 X P6	2.15	4.20	4.11	3.91	3.59
P5 X P7	0.82	1.56	1.38	--	0.94
P5 X P8	2.06	4.11	3.91	3.74	3.46
P5 X P9	1.30	2.68	2.50	2.31	2.20
P5 X P10	0.86	1.54	1.38	1.17	1.24
P6 X P7	0.72	1.42	1.31	--	0.86
P6 X P8	0.82	1.62	1.41	1.23	1.27
P6 X P9	0.64	1.21	1.02	0.89	0.94
P6 X P10	0.82	1.53	1.31	1.09	1.19
P7 X P8	0.75	1.41	1.22	1.10	1.12
P7 X P9	1.18	2.35	2.10	1.95	1.89
P7 X P10	1.99	4.01	3.86	--	2.47
P8 X P9	1.52	3.05	2.81	2.63	2.50
P8 X P10	0.55	1.06	0.91	--	0.63
P9 X P10	1.30	2.62	2.46	--	1.59
COL.MEAN	1.30	2.50	2.34	2.15	1.85
Group mean					
Parents	1.06	2.04	1.90	1.67	
Crosses	1.35	2.61	2.44	2.32	
Checks					
Madhuri	1.41	2.80	2.63	2.48	
Shaktiman-2	1.05	2.10	2.02	1.92	
Mean	1.23	2.45	2.33	2.20	

CD (A) at 0.05 level = 0.0565

CD (B) at 0.05 level = 0.0152

Interaction CD (0.05) = 0.1130

A =

B =

A X B =

Genotypes

Growth stages

Interaction

Table3c: Leaf Area Index (LAI) in QPM (Kharif 2003, Palem)

Genotypes	45DAS	60DAS	75DAS	90DAS	Row mean
Parents					
P1	0.70	1.40	1.23	1.11	1.11
P2	1.16	2.12	2.06	1.92	1.82
P3	0.54	1.04	0.96	0.78	0.83
P4	0.55	1.12	1.01	--	0.89
P5	0.65	1.23	1.14	1.01	1.01
P6	0.70	1.39	1.22	1.12	1.11
P7	0.68	1.23	1.16	1.03	1.03
P8	1.76	2.34	2.23	2.07	2.10
P9	0.60	1.12	1.08	0.92	0.93
P10	1.14	2.23	2.17	2.03	1.89
Crosses					
P1 X P2	0.69	1.30	1.18	--	1.06
P1 X P3	1.47	2.36	2.21	2.01	2.01
P1 X P4	1.25	2.21	2.11	1.96	1.88
P1 X P5	0.65	1.21	1.14	1.03	1.01
P1 X P6	0.74	1.23	1.17	1.09	1.06
P1 X P7	0.70	1.36	1.23	1.12	1.10
P1 X P8	1.17	2.21	2.12	2.06	1.89
P1 X P9	1.73	2.37	2.09	--	2.01
P1 X P10	1.93	3.76	3.66	--	3.11
P2 X P3	0.58	1.09	0.87	--	0.80
P2 X P4	1.74	3.16	2.98	--	2.62
P2 X P5	2.01	4.00	3.81	--	3.27
P2 X P6	0.54	1.12	1.07	0.94	0.92
P2 X P7	1.75	3.35	3.24	3.16	2.88
P2 X P8	1.43	2.81	2.73	--	2.32
P2 X P9	0.62	1.34	1.24	1.06	1.33
P2 X P10	1.58	2.82	2.71	2.64	2.44
P3 X P4	1.24	2.41	2.28	2.11	2.01
P3 X P5	1.67	3.10	3.02	2.91	2.68
P3 X P6	1.43	2.56	2.42	--	2.13
P3 X P7	0.66	1.22	1.16	--	1.01
P3 X P8	1.37	2.54	2.37	2.19	2.12
P3 X P9	1.36	2.54	2.38	2.12	2.10
P3 X P10	0.89	1.55	1.42	--	1.29
P4 X P5	1.78	3.21	3.11	--	2.70
P4 X P6	1.88	2.96	2.78	2.56	2.55
P4 X P7	0.55	1.25	1.03	--	0.94
P4 X P8	0.82	1.62	1.42	--	1.28
P4 X P9	1.67	2.20	2.11	--	1.99
P4 X P10	1.80	3.56	3.37	--	2.91
P5 X P6	2.01	4.02	3.89	3.76	3.42
P5 X P7	0.81	1.63	1.46	--	1.30
P5 X P8	1.91	3.70	3.51	3.32	3.11
P5 X P9	1.38	2.70	2.56	2.42	2.27
P5 X P10	0.68	1.22	1.13	1.01	1.01
P6 X P7	0.60	1.18	0.99	--	0.92
P6 X P8	0.80	1.56	1.32	1.19	1.22
P6 X P9	0.86	1.61	1.43	1.26	1.29
P6 X P10	0.62	1.21	1.03	0.84	0.93
P7 X P8	0.71	1.38	1.22	1.01	1.08
P7 X P9	2.00	3.92	3.76	3.51	3.30
P7 X P10	0.85	1.72	1.54	--	1.37
P8 X P9	1.40	2.86	2.63	2.42	2.33
P8 X P10	0.54	1.12	1.04	--	0.90
P9 X P10	1.15	2.21	2.09	--	1.82
COL.MEAN	1.14	2.14	2.00	1.89	1.75
Group mean					
Parents	0.85	1.52	1.42	1.33	
Crosses	1.20	2.28	2.14	2.08	
Checks					
Madhuri	0.40	0.78	0.61	0.52	
Shaktiman-2	1.60	3.10	2.92	2.71	
Mean	0.82	1.59	1.77	1.61	

CD (A) at 0.05 level = 0.0409

CD (B) at 0.05 level = 0.0110

Interaction CD (0.05) = 0.0818

A =

B =

A X B =

Genotypes

Growth stages

Interaction

Table3d: Leaf Area Index (LAI) in QPM (Rabi 2002-03, Pa1em)

Genotypes	45DAS	60DAS	75DAS	90DAS	Row mean
Parents					
P1	0.71	1.42	1.24	1.10	1.12
P2	1.14	2.14	2.07	1.91	1.82
P3	0.52	1.05	0.98	0.79	0.84
P4	0.53	1.11	1.03	--	0.89
P5	0.63	1.25	1.15	1.00	1.01
P6	0.71	1.40	1.21	1.14	1.12
P7	0.67	1.25	1.17	1.01	1.03
P8	1.72	2.31	2.24	2.08	2.09
P9	0.70	1.35	1.12	1.00	1.04
P10	1.12	2.24	2.18	2.05	1.90
Crosses					
P1 X P2	0.66	1.21	1.12	--	0.99
P1 X P3	1.45	2.38	2.19	2.03	2.01
P1 X P4	1.23	2.20	2.14	1.98	1.89
P1 X P5	0.65	1.23	1.10	0.98	0.99
P1 X P6	0.72	1.25	1.19	1.11	1.07
P1 X P7	0.68	1.34	1.25	1.15	1.11
P1 X P8	1.14	2.20	2.13	2.08	1.89
P1 X P9	1.71	3.36	3.08	--	2.72
P1 X P10	1.92	3.75	3.67	--	3.11
P2 X P3	0.67	1.30	1.12	--	1.03
P2 X P4	1.74	3.36	3.12	--	2.74
P2 X P5	2.00	3.90	3.77	--	3.22
P2 X P6	0.55	1.11	1.08	0.95	0.92
P2 X P7	1.76	3.34	3.25	3.17	2.88
P2 X P8	1.45	2.82	2.74	--	2.34
P2 X P9	0.71	1.45	1.24	1.11	1.13
P2 X P10	1.60	2.80	2.72	2.62	2.44
P3 X P4	1.20	2.32	2.10	1.93	1.89
P3 X P5	1.63	3.16	2.94	2.71	2.61
P3 X P6	1.45	2.54	2.43	--	2.14
P3 X P7	0.68	1.21	1.17	--	1.02
P3 X P8	1.38	2.51	2.38	2.22	2.12
P3 X P9	1.32	2.56	2.30	2.14	2.08
P3 X P10	0.90	1.53	1.40	--	1.27
P4 X P5	1.72	3.19	3.01	--	2.64
P4 X P6	1.90	3.72	3.51	3.36	3.12
P4 X P7	0.56	1.17	1.05	--	0.92
P4 X P8	0.81	1.63	1.43	--	1.29
P4 X P9	1.66	3.22	3.12	--	2.66
P4 X P10	1.82	3.58	3.38	--	2.92
P5 X P6	1.93	3.74	3.51	3.32	3.13
P5 X P7	1.92	3.65	3.42	--	2.99
P5 X P8	1.40	2.73	2.51	2.36	2.25
P5 X P9	0.82	1.65	1.47	1.38	1.33
P5 X P10	0.69	1.24	1.15	1.02	1.03
P6 X P7	0.78	1.52	1.39	--	1.23
P6 X P8	0.79	1.80	1.57	1.42	1.40
P6 X P9	0.88	1.62	1.44	1.27	1.30
P6 X P10	0.81	1.62	1.45	1.32	1.30
P7 X P8	0.65	1.18	1.02	0.94	0.95
P7 X P9	1.92	3.74	3.52	3.31	3.12
P7 X P10	0.86	1.60	1.41	--	1.29
P8 X P9	1.45	2.88	2.65	2.41	2.35
P8 X P10	0.56	1.13	1.05	--	0.91
P9 X P10	1.20	2.41	2.10	--	1.90
COL.MEAN	1.11	2.25	1.97	1.77	1.80
Group mean					
Parents	0.84	1.55	1.44	1.34	
Crosses	1.17	2.40	2.09	1.93	
Checks					
Madhuri	0.41	0.79	0.62	0.51	
Shaktiman-2	1.63	3.15	2.93	2.72	
Mean	1.02	1.97	1.78	1.62	

CD (A) at 0.05 level = 0.0417

CD (B) at 0.05 level = 0.0112

Interaction CD (0.05) = 0.0834

A =

B =

A X B =

Genotypes

Growth stages

Interaction

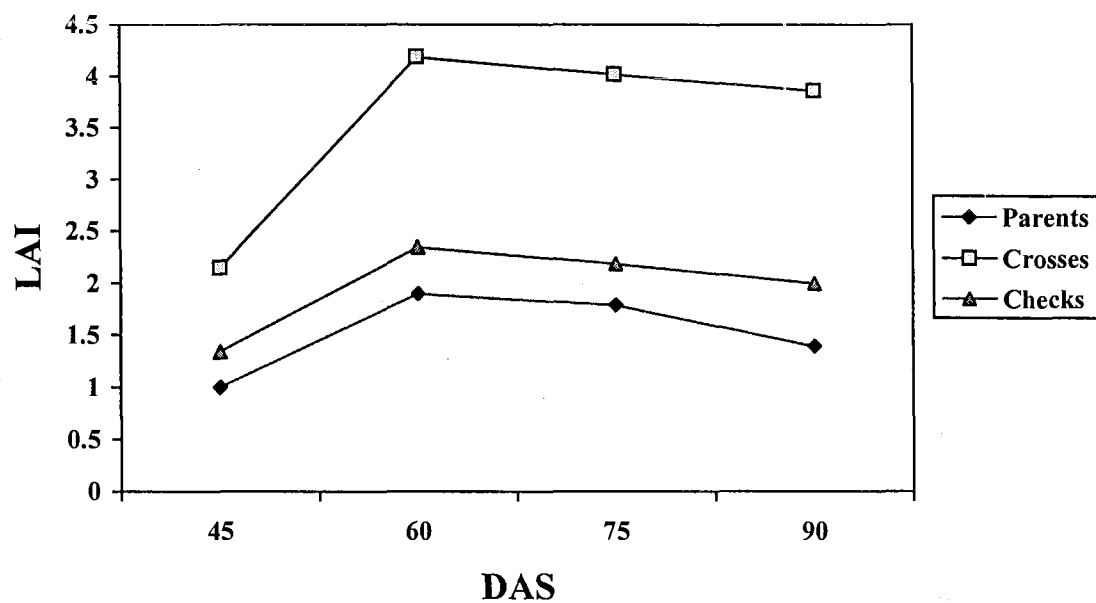


Fig 1a: Leaf Area Index in Parents, superior cross and Checks in QPM (Kharif Rajendranagar)

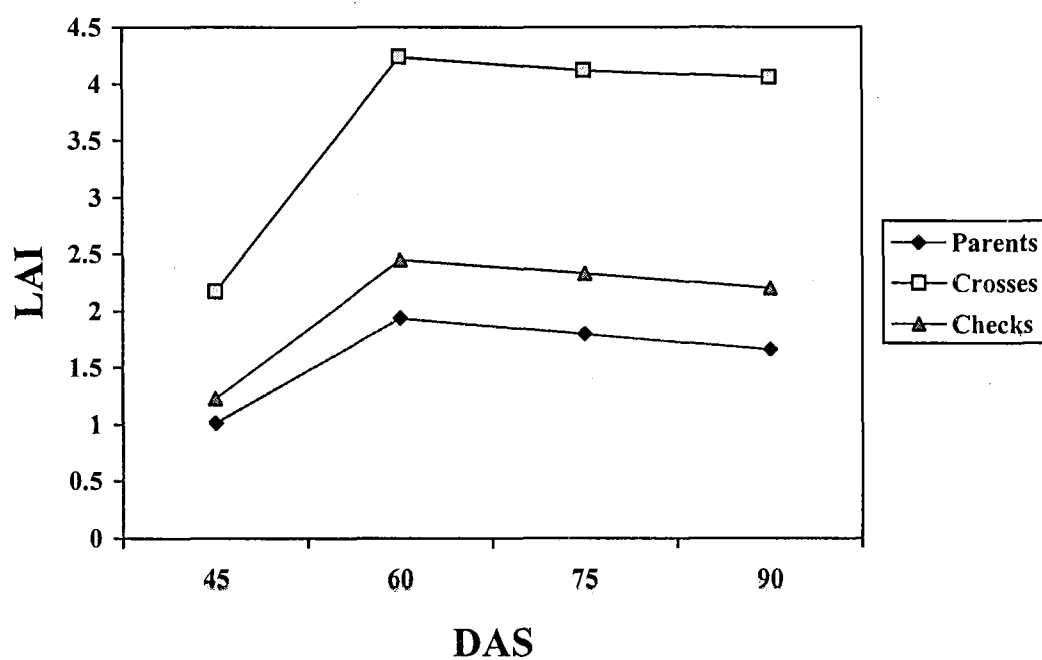


Fig 1b: Leaf Area Index in Parents, superior cross and Checks in QPM (Rabi Rajendranagar)

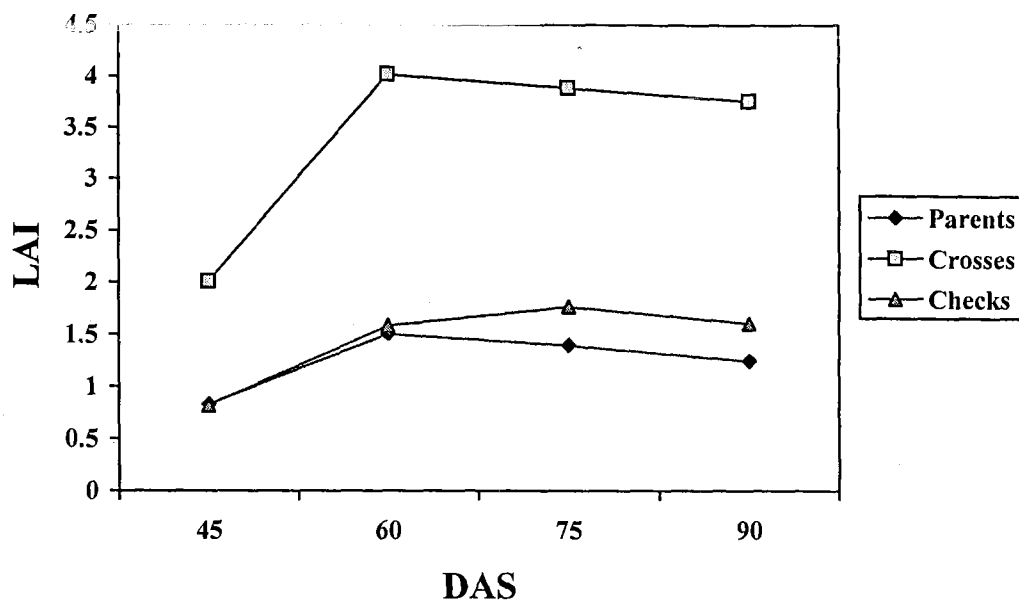


Fig 1c: Leaf Area Index in Parents, superior cross and Checks in QPM (Kharif Palem)

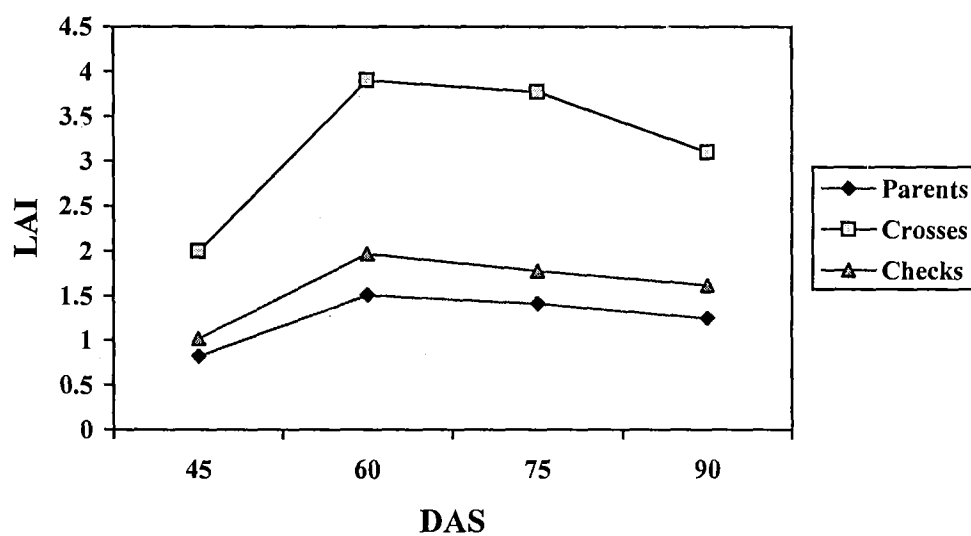


Fig 1d: Leaf Area Index in Parents, superior cross and Checks in QPM (Rabi Palem)

least (1.28) at 45 DAS. In all the genotypes, LAI increased upto 60DAS and decreased towards maturity. The range in LAI at flowering was 1.21(P9) to 3.8(P10) in parents and 1.06(P8 XP10) to 4.24 (P4 X P6) single crosses have higher LAI compared to parents. The check Madhuri recorded 2.80 whereas Shaktiman-2 recorded 2.10 LAI. (Fig.1b)

Significant differences were observed among genotypes during *Rabi* at Palem (Table 3d). Single cross P2 XP5 recorded the highest (3.22) and the least (0.84) by P3 parent. Highest LAI (2.07) was recorded at 60 DAS and the least (1.09) at 45 DAS. In all the genotypes, LAI increased upto 60DAS and decreased towards maturity. The range in LAI at flowering was 1.05 (P3) to 2.31 (P8) in parents and 1.11 (P2 XP6) to 3.90 (P2 X P5). Single crosses have higher LAI compared to parents. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 0.79 and 3.15 respectively. (Fig.1d)

4.2.8 Leaf Dry weight (LDW) (g m^{-2})

The LDW values differed significantly among genotypes during *Kharif* at Rajendra nagar (Table 4a). P2 X P9 has recorded highest mean dry weight (287.1) and the least (157.40) by P3. Highest LDW was recorded at 90 DAS. In all the genotypes, LDW increased from 60 DAS to 90 DAS and decreased towards maturity. The range in LDW at flowering was 165.4 (P3) to 232.6 (P10) in parents and 180.1 (P3 X P6) to P2 X P9 (295.10) in single crosses. Through out the crop growth period, single crosses maintained highest LDW than parents. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 234.20 and 243.60g/m² respectively. (Fig.2b)

For this character the values differed significantly among genotypes during *Kharif* at Palem (Table 4c). P2 X P9 has recorded highest mean dry weight (290.85) and the least (157.80) by P2. Highest LDW was recorded at 90 DAS. In all the genotypes, LDW increased from 60 DAS to 90 DAS and decreased towards maturity. The range in LDW at flowering was 170.30 (P2) to 290.2 (P9) in parents and 176.30 (P7 X P8) to P2 X P9 (305.1) in single crosses. Through out the crop growth period,

Table4a: Leaf Dry Weight (LDW) in QPM (Kharif 2003, Rajendranagar)

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Genotypes	60DAS	75DAS	90DAS	At harvest	Row mean
Parents					
P1	100.80	170.80	190.83	180.80	160.81
P2	92.30	172.30	194.30	185.30	161.05
P3	95.40	165.40	190.40	178.40	157.40
P4	148.10	228.10	251.10	--	209.10
P5	96.60	176.60	201.60	188.60	165.85
P6	124.60	204.60	226.60	216.60	193.10
P7	112.20	192.20	213.20	210.20	181.95
P8	161.20	231.20	251.20	240.20	220.95
P9	120.80	200.80	228.80	220.80	192.80
P10	152.60	232.60	256.60	240.60	220.60
Crosses					
P1 X P2	140.20	230.20	250.20	--	206.86
P1 X P3	120.30	200.30	227.30	218.30	191.55
P1 X P4	223.60	293.60	313.60	298.60	282.35
P1 X P5	125.30	195.30	222.30	210.30	188.30
P1 X P6	118.60	203.80	225.60	212.30	190.08
P1 X P7	142.30	212.30	236.30	227.30	204.55
P1 X P8	146.20	226.60	248.10	236.30	214.30
P1 X P9	160.40	240.40	265.40	--	222.06
P1 X P10	145.80	220.80	248.80	--	205.13
P2 X P3	125.80	205.80	225.80	--	185.80
P2 X P4	148.20	233.20	258.20	--	213.20
P2 X P5	163.80	233.60	263.10	--	220.16
P2 X P6	110.80	200.80	226.80	218.80	189.30
P2 X P7	150.20	235.20	258.20	249.20	223.20
P2 X P8	152.90	227.90	247.90	--	209.56
P2 X P9	225.10	295.10	320.10	308.10	287.10
P2 X P10	170.30	250.60	274.40	261.10	239.10
P3 X P4	128.20	213.20	235.20	232.20	202.20
P3 X P5	120.30	200.30	224.30	214.30	189.80
P3 X P6	100.20	180.10	205.50	--	161.93
P3 X P7	96.80	186.80	206.80	--	163.46
P3 X P8	142.30	222.40	246.10	238.30	212.28
P3 X P9	143.80	228.80	248.80	233.80	213.80
P3 X P10	105.60	185.60	210.60	--	167.26
P4 X P5	161.20	236.60	251.40	--	216.40
P4 X P6	175.60	255.20	280.40	267.10	244.58
P4 X P7	160.80	245.80	265.80	--	224.10
P4 X P8	150.30	225.30	243.30	--	206.30
P4 X P9	151.20	221.20	245.20	--	205.86
P4 X P10	96.80	181.80	202.80	--	160.46
P5 X P6	138.20	218.20	240.20	232.20	207.20
P5 X P7	100.40	175.40	200.40	--	158.73
P5 X P8	168.20	253.60	270.10	254.40	236.58
P5 X P9	112.80	192.80	215.80	203.80	181.30
P5 X P10	137.80	212.80	238.80	230.80	205.05
P6 X P7	118.80	208.80	228.80	--	185.46
P6 X P8	142.60	227.60	249.60	235.60	213.85
P6 X P9	131.80	221.80	245.80	225.80	206.30
P6 X P10	108.60	183.60	206.60	201.60	175.10
P7 X P8	101.30	186.30	211.30	202.30	175.30
P7 X P9	148.70	233.70	257.70	265.70	226.45
P7 X P10	138.10	218.10	240.10	--	198.76
P8 X P9	123.30	203.30	225.30	210.30	190.55
P8 X P10	140.10	215.60	234.20	--	196.63
P9 X P10	149.10	220.60	253.10	--	207.60
COL.MEAN	135.77	215.19	238.20	227.94	201.26
Group mean					
Parents	120.46	197.46	220.46	206.83	
Crosses	139.17	219.13	242.14	235.54	
Checks					
Madhuri	141.20	211.10	234.50	220.60	
shaktiman-2	143.60	218.20	243.40	225.80	
Mean	142.40	214.90	238.90	222.90	

CD (A) at 0.05 level = 5.3832
 CD (B) at 0.05 level = 1.4217
 Interaction CD (0.05) = 10.7664

A = Genotypes
 B = Growth stages
 A X B = Interaction

Table4b: Leaf Dry Weight (LDW) in QPM (Rabi 2002-03, Rajendranagar) 103

Genotypes	60DAS	75DAS	90DAS	At harvest	Row mean
Parents					
P1	101.80	171.80	191.80	181.80	161.80
P2	94.300	174.30	196.30	184.30	162.30
P3	96.400	181.40	205.40	200.40	170.90
P4	148.60	223.60	245.60	--	205.93
P5	98.60	188.60	120.60	110.60	129.60
P6	125.60	200.60	223.60	220.60	192.60
P7	117.20	187.20	140.20	132.20	144.20
P8	162.20	242.20	265.20	250.20	229.95
P9	121.50	206.50	226.50	218.50	193.25
P10	154.60	224.60	248.60	236.60	216.10
Crosses					
P1 X P2	141.20	216.20	165.20	--	174.20
P1 X P3	122.30	202.30	225.30	214.30	191.05
P1 X P4	224.10	299.10	320.10	311.10	288.60
P1 X P5	119.30	282.40	314.10	308.20	256.00
P1 X P6	164.50	186.50	210.50	205.50	191.75
P1 X P7	146.70	215.40	242.30	228.90	208.33
P1 X P8	167.60	250.60	275.60	260.60	238.60
P1 X P9	160.90	248.90	270.90	--	226.90
P1 X P10	146.80	235.80	260.80	--	214.47
P2 X P3	127.80	287.80	310.80	--	242.13
P2 X P4	150.20	228.20	250.20	--	209.53
P2 X P5	164.50	186.40	210.60	--	187.17
P2 X P6	111.60	291.60	318.60	305.60	256.85
P2 X P7	151.20	232.20	252.20	340.20	243.95
P2 X P8	154.90	235.90	250.90	--	213.90
P2 X P9	225.60	215.60	232.60	224.60	224.60
P2 X P10	170.80	252.30	270.60	262.60	239.08
P3 X P4	129.20	210.20	235.20	225.20	199.95
P3 X P5	121.20	205.20	225.20	217.20	192.20
P3 X P6	101.30	176.20	194.40	--	157.30
P3 X P7	98.80	275.80	300.80	--	225.13
P3 X P8	144.30	220.60	242.40	235.20	210.63
P3 X P9	144.80	235.80	253.80	240.80	218.80
P3 X P10	107.60	178.60	200.60	--	162.27
P4 X P5	162.20	235.40	260.60	--	219.40
P4 X P6	167.60	250.80	276.50	262.30	239.30
P4 X P7	161.30	230.30	250.30	--	213.87
P4 X P8	150.80	235.80	268.80	--	218.47
P4 X P9	152.20	220.20	244.20	--	205.53
P4 X P10	98.80	178.80	200.80	--	159.47
P5 X P6	139.20	221.20	245.20	232.20	209.45
P5 X P7	100.90	180.90	200.90	--	160.90
P5 X P8	169.20	240.60	264.40	251.20	231.35
P5 X P9	113.80	183.80	205.80	200.80	176.05
P5 X P10	138.30	224.30	245.30	232.30	210.05
P6 X P7	119.80	189.80	145.80	--	151.80
P6 X P8	144.60	225.60	248.60	230.60	212.35
P6 X P9	132.50	220.50	240.50	232.50	206.50
P6 X P10	109.60	179.60	202.60	195.60	171.85
P7 X P8	104.30	184.30	213.30	202.30	176.05
P7 X P9	149.70	221.70	241.70	220.70	208.45
P7 X P10	138.60	215.60	240.60	--	198.27
P8 X P9	124.10	205.10	226.10	210.10	191.35
P8 X P10	141.10	213.60	235.40	--	196.70
P9 X P10	150.10	230.10	250.10	--	210.10
COL.MEAN	137.94	219.24	236.46	228.99	207.02
Group mean					
Parents	122.08	200.08	206.38	192.78	
Crosses	141.46	223.50	243.14	242.02	
Checks					
Madhuri	143.20	225.10	252.40	227.80	
Shaktiman-2	144.60	224.50	248.30	230.70	
Mean	143.90	224.90	250.40	228.90	

CD (A) at 0.05 level = 5.6211
 CD (B) at 0.05 level = 1.5159
 Interaction CD (0.05) = 11.2421

A = Genotypes
 B = Growth stages
 A X B = Interaction

Table4c: Leaf Dry Weight (LDW) in QPM (Kharif, 2003, Palem)
($g m^{-2}$)

Genotypes	45-60DAS	60-75DAS	75-90DAS	90DAS- At harvest	Row mean
Parents					
P1	98.80	173.80	193.80	180.80	161.80
P2	90.30	170.30	195.30	175.30	157.80
P3	92.40	177.40	197.40	185.40	163.15
P4	144.10	235.10	255.10	--	211.43
P5	93.60	213.60	238.60	220.60	191.60
P6	122.60	202.60	228.60	210.60	191.10
P7	110.20	290.20	315.20	300.20	253.95
P8	158.20	240.20	260.20	245.20	225.95
P9	117.80	287.80	300.80	280.80	246.80
P10	148.60	232.60	252.60	240.60	218.60
Crosses					
P1 X P2	137.20	228.20	250.20	--	205.20
P1 X P3	118.30	278.30	304.30	290.30	247.80
P1 X P4	218.60	298.60	320.60	300.60	284.60
P1 X P5	123.30	203.30	225.30	210.30	190.55
P1 X P6	115.60	185.10	206.30	196.50	175.88
P1 X P7	140.30	225.30	250.30	235.30	212.80
P1 X P8	142.20	224.20	244.20	230.20	210.20
P1 X P9	157.40	230.40	250.40	--	212.73
P1 X P10	143.80	225.80	245.80	--	158.63
P2 X P3	122.80	192.80	210.80	--	175.47
P2 X P4	144.20	225.80	250.80	--	206.94
P2 X P5	160.80	240.60	260.30	--	220.57
P2 X P6	108.80	188.80	210.80	198.80	176.80
P2 X P7	146.20	225.20	246.20	230.20	211.95
P2 X P8	147.90	230.90	250.90	--	209.90
P2 X P9	223.10	305.10	325.10	310.10	290.85
P2 X P10	166.30	242.60	265.10	250.20	231.05
P3 X P4	125.20	200.20	225.20	208.20	189.70
P3 X P5	198.30	225.30	245.30	230.30	224.80
P3 X P6	97.20	178.40	200.50	--	158.70
P3 X P7	94.80	180.80	200.80	--	158.80
P3 X P8	140.30	228.10	250.60	239.50	214.63
P3 X P9	140.80	225.80	245.80	230.80	210.80
P3 X P10	102.60	182.60	200.60	--	181.94
P4 X P5	158.20	239.20	260.10	--	219.17
P4 X P6	163.60	240.60	265.30	251.30	230.20
P4 X P7	156.80	230.80	250.80	--	212.80
P4 X P8	148.30	229.30	253.30	--	210.30
P4 X P9	149.20	225.20	250.20	--	208.20
P4 X P10	94.80	180.80	205.80	--	160.46
P5 X P6	135.20	220.20	242.20	230.20	206.95
P5 X P7	98.40	180.40	206.40	--	161.74
P5 X P8	165.20	240.60	260.80	247.50	228.53
P5 X P9	110.80	180.80	205.80	186.80	171.05
P5 X P10	134.80	225.80	350.80	232.80	236.05
P6 X P7	114.80	284.80	308.80	--	236.14
P6 X P8	138.60	226.60	250.60	230.60	211.60
P6 X P9	128.80	218.80	238.80	221.80	202.05
P6 X P10	105.60	275.60	300.60	284.60	241.60
P7 X P8	99.30	176.30	200.30	187.30	165.80
P7 X P9	145.70	230.70	250.70	230.70	214.45
P7 X P10	136.10	223.10	243.10	--	200.77
P8 X P9	120.30	200.30	225.30	210.30	189.00
P8 X P10	137.10	225.60	247.30	--	203.44
P9 X P10	146.10	225.10	257.10	--	209.43
COL.MEAN	134.19	223.21	247.24	232.79	205.48
Group mean					
Parents	117.66	223.36	243.76	226.60	
Crosses	137.86	223.39	248.01	235.01	
Checks					
Madhuri	138.20	220.20	245.20	236.20	
Shaktiman-2	140.60	215.40	240.90	228.50	
Mean	139.40	217.90	242.90	232.40	

CD (A) at 0.05 level = 5.6764

A =

Genotypes

CD (B) at 0.05 level = 1.5308

B =

Growth stages

Interaction CD (0.05) = 11.2528

A X B =

Genotypes

Table4d: Leaf Dry Weight (LDW) in QPM (Rabi 2002-03, Palem)

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Genotypes	60DAS	75DAS	90DAS	At harvest	Row mean
Parents					
P1	99.20	172.20	195.20	180.20	161.70
P2	91.30	178.30	198.20	181.20	162.25
P3	92.90	180.90	204.90	190.90	167.40
P4	144.80	220.80	245.80	--	203.80
P5	94.20	182.20	205.20	191.60	168.30
P6	124.60	205.60	228.60	210.60	192.35
P7	110.70	190.70	214.30	201.30	179.25
P8	158.70	240.70	263.70	250.70	228.45
P9	118.80	288.80	210.80	201.80	205.05
P10	150.20	230.20	255.20	242.20	219.45
Crosses					
P1 X P2	138.20	224.20	246.20	--	202.87
P1 X P3	118.80	298.80	320.80	304.80	260.80
P1 X P4	219.00	289.00	310.00	300.00	279.50
P1 X P5	123.80	205.80	228.80	210.80	192.30
P1 X P6	117.60	185.80	207.60	196.50	176.88
P1 X P7	142.30	238.30	258.30	242.30	220.30
P1 X P8	142.60	228.30	250.40	228.10	212.35
P1 X P9	158.40	240.40	260.40	--	219.73
P1 X P10	145.80	225.80	250.80	--	207.47
P2 X P3	124.80	208.80	210.80	--	181.47
P2 X P4	145.20	228.20	251.20	--	208.20
P2 X P5	161.80	250.40	272.30	--	228.17
P2 X P6	110.80	180.80	200.80	187.80	170.05
P2 X P7	147.20	226.80	250.80	235.80	215.15
P2 X P8	148.60	223.90	248.90	--	207.16
P2 X P9	223.60	215.60	237.90	221.90	224.75
P2 X P10	166.70	254.60	265.10	248.50	233.73
P3 X P4	125.70	205.70	225.70	208.70	191.45
P3 X P5	200.30	270.30	292.30	280.30	260.80
P3 X P6	99.20	174.10	200.60	--	157.97
P3 X P7	96.80	170.80	193.80	--	153.80
P3 X P8	140.80	220.10	245.30	230.40	209.15
P3 X P9	141.80	224.80	250.80	231.80	212.30
P3 X P10	104.60	174.60	198.60	--	159.26
P4 X P5	158.70	238.50	260.90	--	219.36
P4 X P6	164.60	242.40	267.20	250.30	231.13
P4 X P7	157.20	240.20	265.20	--	220.86
P4 X P8	148.70	232.70	255.70	--	212.36
P4 X P9	150.00	230.00	250.00	--	210.00
P4 X P10	96.80	170.80	195.80	--	154.46
P5 X P6	135.70	220.70	240.70	230.70	206.95
P5 X P7	100.00	180.00	205.00	--	161.67
P5 X P8	165.80	240.60	265.40	250.20	230.50
P5 X P9	111.20	181.20	202.20	190.20	171.20
P5 X P10	135.80	215.80	236.80	220.80	202.30
P6 X P7	115.30	185.30	210.30	--	170.30
P6 X P8	139.60	223.60	245.60	230.60	209.85
P6 X P9	129.80	210.80	230.80	216.80	197.05
P6 X P10	107.60	177.60	200.60	187.60	168.35
P7 X P8	100.30	180.30	205.30	193.30	169.80
P7 X P9	146.70	230.70	250.70	238.70	216.70
P8 X P10	137.10	224.10	248.10	--	203.10
P8 X P9	122.30	204.30	224.30	210.30	190.30
P8 X P10	138.10	220.10	245.10	--	201.10
P9 X P10	146.80	235.80	262.80	--	215.13
COL.MEAN	135.24	217.12	237.611	223.46	242.59
Group mean					
Parents	118.54	209.04	222.19	205.60	
Crosses	138.95	218.92	241.04	229.89	
Checks					
Madhuri	139.60	228.40	248.20	230.50	
Shaktiman-2	141.20	225.10	250.40	240.90	
Mean	140.4	226.90	249.40	235.40	

CD (A) at 0.05 level = 5.6801

A =

Genotypes

CD (B) at 0.05 level = 1.5318

B =

Growth stages

Interaction CD (0.05) = 11.3602

A X B =

Interaction

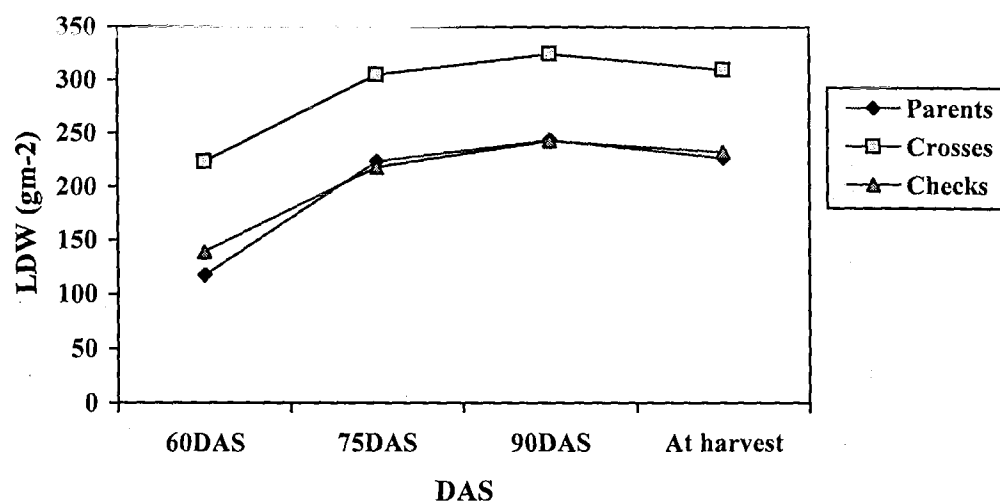


Fig 2a: Leaf Dry Weight in Parents, superior cross and Checks in QPM (Kharif Palem)

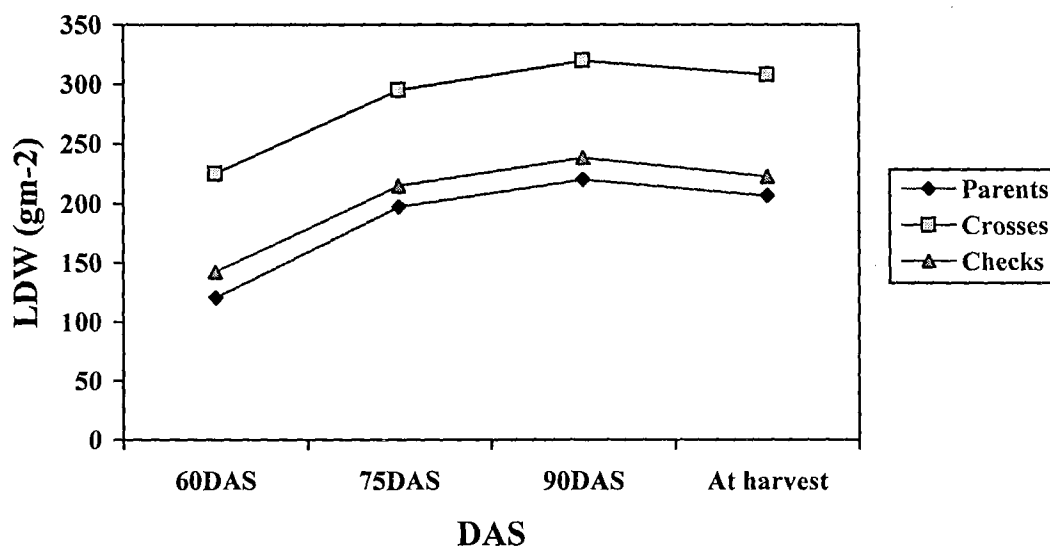


Fig2b: Leaf Dry Weight in Parents, superior cross and Checks in QPM (Kharif Rajendranagar)

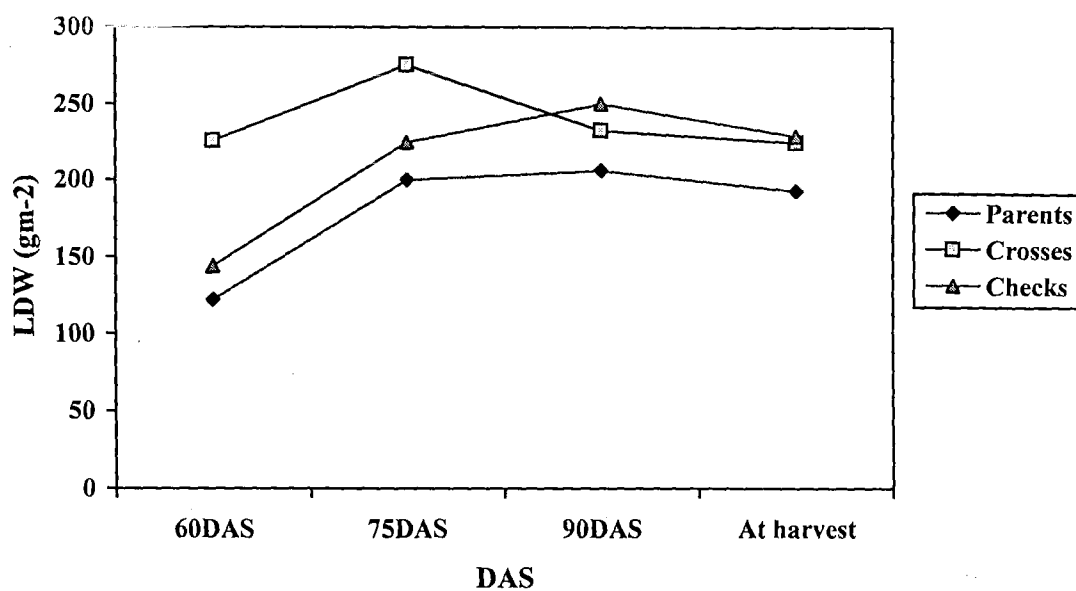


Fig 2c: Leaf Dry Weight in Parents, superior cross and Checks in QPM (Rabi Rajendranagar)

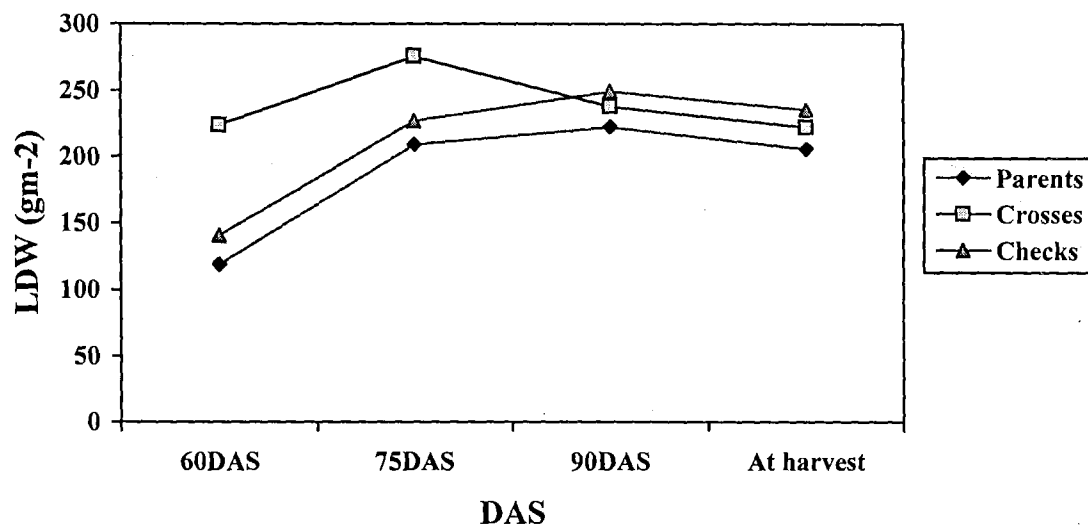


Fig 2d: Leaf Dry Weight in Parents, superior cross and Checks in QPM (Rabi Palem)

single crosses maintained highest LDW than parents. The check Madhuri recorded 245.20 whereas Shaktiman-2 recorded 240.60g/m² (Fig.2a)

The LDW values differed significantly among genotypes during *Rabi* at Rajendra nagar (Table 4b). P1 X P4 has recorded highest mean dry weight (288.60) and the least (144.20) by P7. Highest LDW was recorded at 90 DAS. In all the genotypes, LDW increased from 60 DAS to 90 DAS and decreased towards maturity. The range in LDW at flowering was 171.80(P1) to 242.20 (P8) in parents and 176.20 (P3 X P6) to P1 XP4 (299.10) in single crosses. Through out the crop growth period, single crosses maintained highest LDW than parents. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 252.20 and 248.60g/m² respectively (Fig.2c).

For this character the values differed significantly among genotypes during *Rabi* at Palem (Table 4d). P1 X P4 has recorded highest mean dry weight (279.50) and the least (161.70) by P1. Highest LDW was recorded at 90 DAS. In all the genotypes, LDW increased from 60 DAS to 90 DAS and decreased towards maturity. The range in LDW at flowering was 172.20(P1) to 288.80 (P9) in parents and 170.86 (P4 X P10) to P1 X P3 (298.80) in single crosses. Through out the crop growth period, single crosses maintained highest LDW than parents. The check Madhuri recorded 248.60 whereas Shaktiman-2 recorded 250.20g/m² (Fig 2d)

4.2.9 Crop growth rate (CGR) (gm⁻²d⁻¹)

At Rajendranagar during *Kharif* highest CGR (30.25) was noticed in P4 X P6 and the least in (15.30) in P7 (Table 5a). Significant differences were observed among different stages of crop growth. Highest CGR (27.47) was recorded at 60-75 DAS and the least (13.87) at 45-60 DAS. The CGR increased upto 60-75 DAS and then decreased a little at 75- 90 and remained constant at maturity. At flowering stage it ranged from 21 (P9) to 30.6 (P6) in parents and 21.60 (P7 X P9) to 38.4 (P2 X P10) in single crosses. Single crosses maintained higher CGR than parents at different stages

Table5a: Crop Growth Rate (CGR) in QPM (Kharif 2003, Rajendranagar)
($g\ m^{-2}\ d^{-1}$)

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Genotypes	45-60DAS	60-75DAS	75-90DAS	90DAS-	Row mean
				At harvest	

Parents

P1	11.12	22.10	17.20	17.10	16.88
P2	10.91	21.60	16.40	16.20	16.28
P3	11.99	22.40	17.10	16.80	17.08
P4	10.79	21.40	16.20	--	16.13
P5	12.23	22.40	17.40	16.80	17.21
P6	16.41	30.60	25.40	25.20	24.41
P7	9.61	21.00	15.50	15.10	15.31
P8	10.30	21.50	16.30	15.40	15.88
P9	10.00	21.20	16.10	15.20	15.63
P10	10.50	21.70	16.60	16.10	16.23

Crosses

P1 X P2	16.09	30.60	26.10	--	24.26
P1 X P3	15.41	30.10	25.20	24.90	23.91
P1 X P4	13.19	27.40	24.40	24.10	22.28
P1 X P5	13.11	27.20	24.10	23.70	22.03
P1 X P6	12.99	27.10	23.70	23.20	21.75
P1 X P7	15.50	30.60	26.30	25.50	24.48
P1 X P8	13.09	27.50	24.30	23.70	22.15
P1 X P9	15.71	29.80	24.50	--	23.33
P1 X P10	18.39	34.60	28.80	--	27.26
P2 X P3	14.82	28.20	24.10	--	22.37
P2 X P4	12.99	27.30	23.70	--	21.33
P2 X P5	14.19	27.70	23.80	--	21.89
P2 X P6	13.10	26.80	22.60	22.60	21.27
P2 X P7	13.59	26.70	22.40	22.10	21.20
P2 X P8	18.60	35.20	30.60	--	28.13
P2 X P9	14.88	27.80	23.40	23.20	22.32
P2 X P10	19.30	38.60	31.60	30.10	29.90
P3 X P4	13.60	26.90	22.80	22.80	21.53
P3 X P5	13.19	26.60	22.10	22.10	20.99
P3 X P6	13.20	27.30	24.40	--	21.63
P3 X P7	13.50	27.40	23.10	--	21.33
P3 X P8	13.40	27.10	23.20	23.10	21.70
P3 X P9	13.39	27.20	24.30	23.40	22.07
P3 X P10	18.91	34.80	28.80	--	27.50
P4 X P5	18.49	34.90	28.90	--	27.43
P4 X P6	19.50	38.70	32.40	30.40	30.25
P4 X P7	10.79	22.80	18.20	--	17.26
P4 X P8	11.19	23.40	17.60	--	17.39
P4 X P9	10.61	22.60	16.40	--	16.53
P4 X P10	18.29	34.60	28.80	--	27.22
P5 X P6	19.20	36.80	31.40	30.33	29.43
P5 X P7	18.09	34.20	23.40	--	25.22
P5 X P8	18.60	34.80	29.20	28.40	27.75
P5 X P9	17.40	32.10	28.10	27.60	26.30
P5 X P10	16.90	31.10	25.46	25.40	24.72
P6 X P7	11.20	22.20	17.20	--	16.86
P6 X P8	10.20	22.10	16.80	16.27	16.34
P6 X P9	11.11	23.60	21.20	20.60	19.13
P6 X P10	10.59	22.10	17.40	17.10	16.79
P7 X P8	10.79	22.40	16.20	16.20	16.39
P7 X P9	18.80	34.30	28.60	27.40	27.28
P7 X P10	10.40	22.60	15.40	--	16.13
P8 X P9	10.59	22.80	17.60	17.20	17.05
P8 X P10	10.10	23.10	17.10	--	16.80
P9 X P10	12.11	23.40	18.20	--	17.90

COL.MEAN 13.87 27.47 22.51 21.30 21.44

Group mean

Parents 11.39 21.59 17.42 15.39

Crosses 14.42 28.56 23.64 23.66

Checks

Madhuri	18.90	30.80	24.40	24.10
Shaktiman-2	18.50	31.20	25.60	25.40
Mean	18.70	31.00	25.00	24.75

CD (A) at 0.05 level = 0.5954

CD (B) at 0.05 level = 0.1606

Interaction CD (0.05) = 1.1907

A = Genotypes

B = Growth stages

x v n =

Table5b: Crop Growth Rate (CGR) in QPM (Rabi 2002-03, Rajendranagar)
($g\ m^{-2}\ d^{-1}$)

Genotypes	45-60DAS	60-75DAS	75-90DAS	90DAS- At harvest	Row mean
Parents					
P1	10.80	22.00	16.60	16.40	16.45
P2	10.60	21.80	16.10	15.80	16.08
P3	11.40	22.10	17.10	16.20	16.70
P4	10.30	21.10	16.20	--	15.86
P5	11.60	22.00	27.20	16.60	19.35
P6	16.10	30.60	25.40	24.40	24.13
P7	9.40	20.60	15.10	14.80	14.98
P8	10.00	21.40	16.20	15.20	15.70
P9	10.00	21.00	15.80	15.20	15.50
P10	10.20	21.40	16.40	15.80	15.95
Crosses					
P1 X P2	15.80	30.20	25.80	--	23.93
P1 X P3	15.00	29.60	24.60	24.30	23.38
P1 X P4	13.00	27.10	24.10	23.60	21.95
P1 X P5	13.10	27.20	23.60	23.10	21.75
P1 X P6	12.80	27.00	23.10	22.60	21.38
P1 X P7	14.80	30.40	25.40	24.50	23.78
P1 X P8	12.60	27.10	23.70	23.10	21.63
P1 X P9	15.40	29.60	23.90	--	22.96
P1 X P10	18.00	33.40	27.60	--	26.33
P2 X P3	14.30	28.00	24.10	--	22.13
P2 X P4	12.60	27.20	23.30	--	21.03
P2 X P5	14.00	27.40	23.40	--	21.60
P2 X P6	13.00	26.40	22.10	21.80	20.83
P2 X P7	13.20	26.30	21.80	21.60	20.73
P2 X P8	18.40	34.80	28.80	--	27.33
P2 X P9	14.40	27.10	23.20	22.60	21.83
P2 X P10	18.90	38.40	30.80	30.60	29.68
P3 X P4	13.30	26.60	22.60	22.20	21.18
P3 X P5	12.90	26.10	21.90	21.40	20.58
P3 X P6	13.20	26.40	23.40	--	21.00
P3 X P7	13.50	27.40	22.60	--	21.17
P3 X P8	13.10	26.40	22.60	22.40	21.13
P3 X P9	13.20	27.20	23.40	22.80	21.65
P3 X P10	18.60	33.60	27.60	--	26.60
P4 X P5	18.50	34.10	28.20	--	26.93
P4 X P6	19.10	38.20	31.80	29.80	29.73
P4 X P7	10.60	22.60	17.80	--	17.00
P4 X P8	10.80	23.10	17.20	--	17.03
P4 X P9	10.40	22.40	16.10	--	16.30
P4 X P10	17.60	33.40	27.60	--	26.20
P5 X P6	16.00	30.10	24.40	24.50	23.75
P5 X P7	17.40	33.20	22.60	--	31.93
P5 X P8	17.10	31.90	27.80	26.70	25.88
P5 X P9	18.20	34.10	28.10	27.80	27.05
P5 X P10	19.00	36.60	30.20	29.10	28.73
P6 X P7	11.10	22.00	16.90	--	16.67
P6 X P8	18.20	33.40	27.40	26.60	26.40
P6 X P9	11.00	23.10	20.60	20.10	18.70
P6 X P10	10.60	22.10	17.10	16.40	16.55
P7 X P8	10.40	22.00	15.40	15.40	15.80
P7 X P9	10.20	21.60	15.90	15.20	15.73
P7 X P10	10.10	21.80	15.20	--	15.70
P8 X P9	10.00	22.00	17.10	16.60	16.43
P8 X P10	10.10	22.40	16.40	--	16.30
P9 X P10	12.00	23.00	17.80	--	17.80
COL.MEAN	13.56	27.06	22.13	20.61	21.14
Group mean					
Parents	11.04	22.40	18.21	16.71	
Crosses	14.12	28.09	23.00	22.99	
Checks					
Madhuri	18.00	29.60	23.20	23.40	
Shaktiman-2	17.40	30.60	24.80	24.60	
Mean	17.70	30.10	24.00	24.00	

CD (A) at 0.05 level = 0.5715

A = Genotypes

Table5c: Crop Growth Rate (CGR) in QPM (Kharif 2003, Palem)

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Genotypes	45-60DAS	60-75DAS	75-90DAS	90DAS-	Row mean
				At harvest	
Parents					
P1	10.60	21.80	16.60	16.70	16.43
P2	10.20	21.20	15.40	15.40	15.55
P3	11.40	22.00	17.20	16.20	16.70
P4	10.10	21.00	16.10	--	15.73
P5	11.20	22.00	17.10	15.90	16.55
P6	15.80	25.80	23.40	24.80	22.45
P7	9.10	20.30	15.20	14.80	14.85
P8	10.00	21.00	16.30	14.20	15.38
P9	9.400	20.60	15.40	14.40	14.95
P10	10.20	21.20	15.90	15.20	15.63
Crosses					
P1 X P2	15.40	30.40	24.40	--	23.04
P1 X P3	15.10	29.60	25.60	24.20	23.63
P1 X P4	12.60	27.10	23.40	23.60	21.68
P1 X P5	12.40	26.40	22.80	23.10	21.18
P1 X P6	12.30	26.80	21.90	22.90	20.98
P1 X P7	15.00	29.80	23.60	24.50	23.23
P1 X P8	12.60	27.10	24.40	23.10	21.80
P1 X P9	15.40	29.10	23.60	--	22.70
P1 X P10	17.80	33.40	27.80	--	26.33
P2 X P3	13.90	27.40	24.10	--	21.80
P2 X P4	12.80	26.80	22.30	--	20.63
P2 X P5	13.40	27.20	23.40	--	21.33
P2 X P6	12.60	26.20	22.60	22.00	20.85
P2 X P7	13.10	26.10	21.40	21.80	20.60
P2 X P8	17.80	34.40	27.07	--	26.42
P2 X P9	14.40	26.80	22.50	22.60	21.58
P2 X P10	18.60	37.40	32.10	29.20	29.33
P3 X P4	13.40	26.10	21.20	22.20	20.73
P3 X P5	12.80	25.40	20.60	21.60	20.10
P3 X P6	12.80	26.20	21.40	--	20.13
P3 X P7	13.30	26.80	21.40	--	20.50
P3 X P8	13.20	26.40	22.10	22.40	21.03
P3 X P9	13.10	26.10	23.40	23.00	21.40
P3 X P10	13.40	33.40	27.60	--	24.80
P4 X P5	13.20	33.10	28.10	--	24.80
P4 X P6	18.90	37.80	32.60	29.80	29.78
P4 X P7	10.10	22.10	17.60	--	16.60
P4 X P8	10.80	23.20	16.40	--	16.80
P4 X P9	10.20	21.40	16.10	--	15.90
P4 X P10	17.40	33.00	27.20	--	25.86
P5 X P6	18.40	35.40	30.27	29.17	28.31
P5 X P7	17.80	33.60	23.10	--	24.83
P5 X P8	18.00	33.60	28.10	27.80	26.88
P5 X P9	17.00	31.80	27.80	26.70	25.83
P5 X P10	15.40	30.20	24.80	24.50	23.73
P6 X P7	10.60	21.80	16.20	--	16.20
P6 X P8	10.00	21.00	15.90	16.10	15.75
P6 X P9	10.20	22.40	20.20	19.80	18.15
P6 X P10	10.10	21.80	16.80	16.40	16.28
P7 X P8	10.20	21.90	15.40	15.80	15.83
P7 X P9	18.10	32.20	27.40	26.80	26.13
P7 X P10	10.20	22.00	14.80	--	15.66
P8 X P9	9.40	22.20	16.70	16.80	16.28
P8 X P10	9.60	22.40	16.90	--	16.30
P9 X P10	11.80	22.60	17.20	--	17.20
COL. MEAN	13.14	26.63	21.66	21.27	20.60
Group mean					
Parents	10.80	21.69	16.86	16.40	
Crosses	13.66	27.73	22.67	23.03	
Checks					
Madhuri	17.60	29.80	23.60	23.40	
Shaktiman-2	17.90	30.60	24.80	24.50	
Mean	17.75	30.00	24.20	23.95	

CD (A) at 0.05 level = 0.5706

CD (B) at 0.05 level = 0.1539

Interaction CD (0.05) = 1.1411

A =

B =

A X B =

Genotypes

Growth stages

Interaction

Table5d: Crop Growth Rate (CGR) in QPM (Rabi 2002-03, Raichur,
($g\ m^{-2}\ d^{-1}$)

Genotypes 45-60DAS 60-75DAS 75-90DAS 90DAS- Row mean
At harvest

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Parents					
P1	10.40	20.80	16.10	16.10	15.85
P2	10.10	21.60	15.40	15.20	15.58
P3	11.10	21.40	16.80	15.80	16.28
P4	9.80	20.60	15.40	--	11.45
P5	11.20	22.10	17.30	15.40	16.50
P6	15.40	29.40	24.50	23.60	23.23
P7	9.40	20.20	14.80	14.20	14.65
P8	9.80	21.00	15.40	14.80	15.25
P9	10.80	21.40	16.80	15.90	16.23
P10	9.90	20.80	16.20	15.20	15.53
Crosses					
P1 X P2	14.90	29.40	24.60	--	17.23
P1 X P3	14.10	29.10	23.40	23.40	22.50
P1 X P4	12.60	26.40	23.10	23.20	21.33
P1 X P5	12.40	26.80	23.00	22.80	21.25
P1 X P6	12.10	26.20	22.60	22.10	20.75
P1 X P7	13.60	29.20	24.50	23.80	22.78
P1 X P8	12.10	26.40	22.60	22.80	20.98
P1 X P9	15.20	28.40	23.20	--	16.70
P1 X P10	17.80	32.30	26.70	--	19.20
P2 X P3	13.40	26.40	23.40	--	15.80
P2 X P4	11.80	26.80	22.80	--	15.35
P2 X P5	13.40	26.60	23.00	--	15.75
P2 X P6	12.60	25.80	21.80	20.60	20.20
P2 X P7	12.80	25.40	20.90	21.10	20.05
P2 X P8	17.60	33.60	27.90	--	19.78
P2 X P9	13.60	26.80	22.40	22.00	21.20
P2 X P10	12.80	37.20	29.40	28.40	26.95
P3 X P4	17.60	26.20	21.80	21.60	21.80
P3 X P5	12.10	25.40	21.10	20.60	19.80
P3 X P6	12.60	25.80	22.80	--	15.30
P3 X P7	12.80	26.80	22.40	--	15.50
P3 X P8	12.40	26.10	21.60	21.80	20.48
P3 X P9	12.80	26.40	23.10	22.10	21.10
P3 X P10	17.40	32.40	27.40	--	19.30
P4 X P5	17.30	33.40	27.80	--	19.63
P4 X P6	18.80	37.40	30.60	28.90	28.93
P4 X P7	10.10	21.40	17.10	--	12.15
P4 X P8	10.20	22.30	16.40	--	12.23
P4 X P9	9.60	21.60	15.80	--	11.75
P4 X P10	16.40	32.40	26.70	--	18.88
P5 X P6	18.20	35.40	29.80	28.40	27.95
P5 X P7	16.20	31.40	22.10	--	17.43
P5 X P8	17.80	33.60	27.60	27.20	26.05
P5 X P9	16.60	30.80	27.20	26.10	25.18
P5 X P10	15.80	29.60	23.60	23.60	23.15
P6 X P7	10.60	21.20	16.20	--	12.00
P6 X P8	10.20	21.00	15.10	14.80	15.28
P6 X P9	10.60	22.80	20.10	19.40	18.23
P6 X P10	10.20	21.80	16.40	15.80	16.05
P7 X P8	10.00	21.60	14.80	15.00	15.35
P7 X P9	17.30	32.60	26.80	25.90	25.65
P7 X P10	9.400	21.20	14.50	--	11.28
P8 X P9	9.60	21.40	16.40	15.80	15.80
P8 X P10	9.80	22.00	15.80	--	11.90
P9 X P10	11.80	22.60	17.00	--	12.88
COL.MEAN	12.99	26.34	21.31	12.79	18.36
Group mean					
Parents	10.79	21.93	16.87	16.24	
Crosses	13.49	27.32	22.30	22.28	
Checks					
Madhuri	17.60	28.60	22.30	22.40	
Shaktiman-2	17.10	29.40	23.60	23.80	
Mean	17.35	29.00	22.95	23.10	

CD (A) at 0.05 level = 0.5306

CD (B) at 0.05 level = 0.1431

Interaction CD (0.05) = 1.0613

A = Genotypes
B = Growth stages
A X B = Interaction

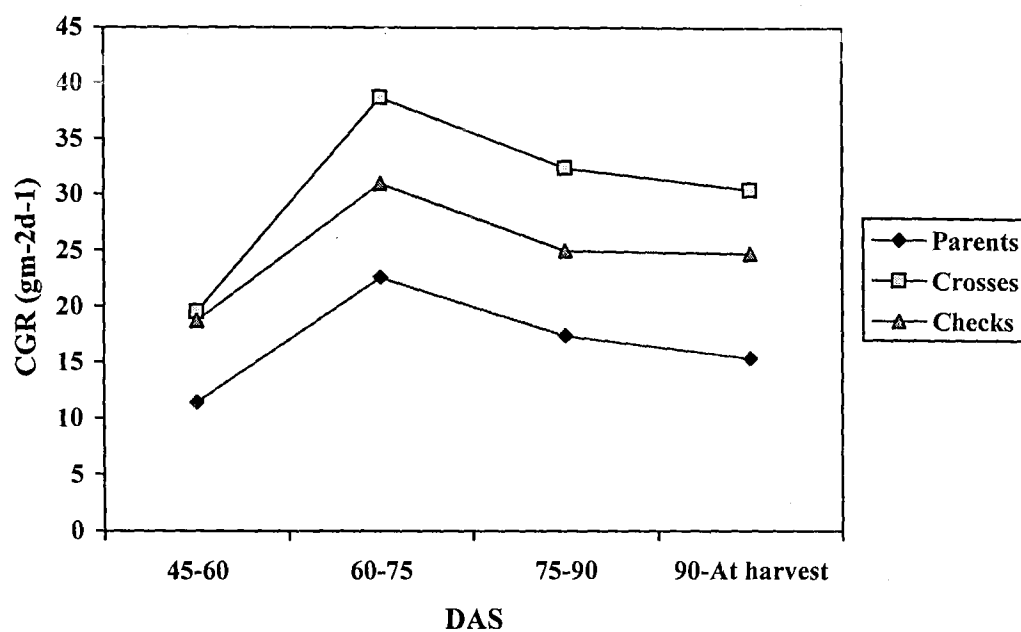


Fig 3a: Crop Growth Rate in Parents, superior cross and Checks in QPM (Kharif Rajendranagar)

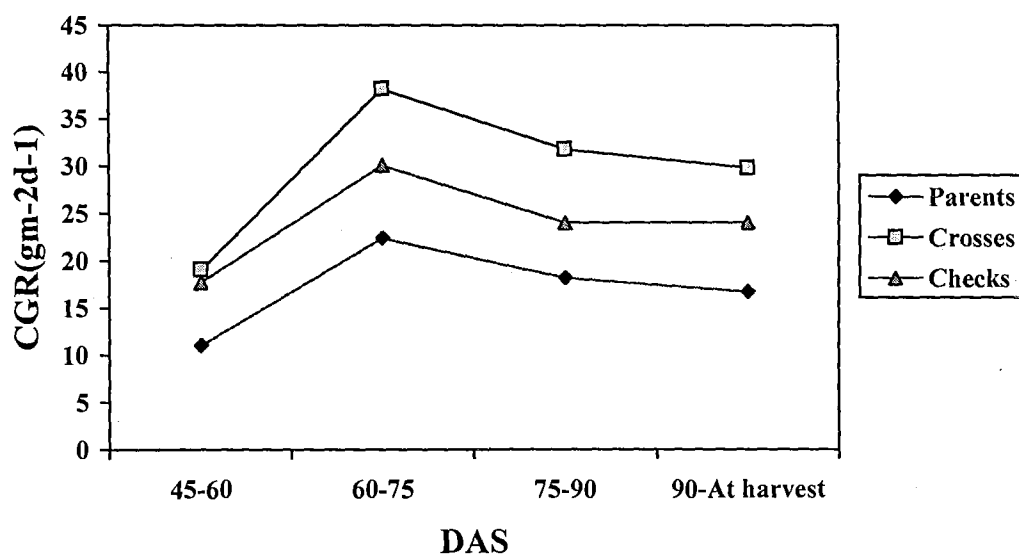


Fig 3b: Crop Growth Rate in Parents, superior cross and Checks in QPM (Rabi Rajendranagar)

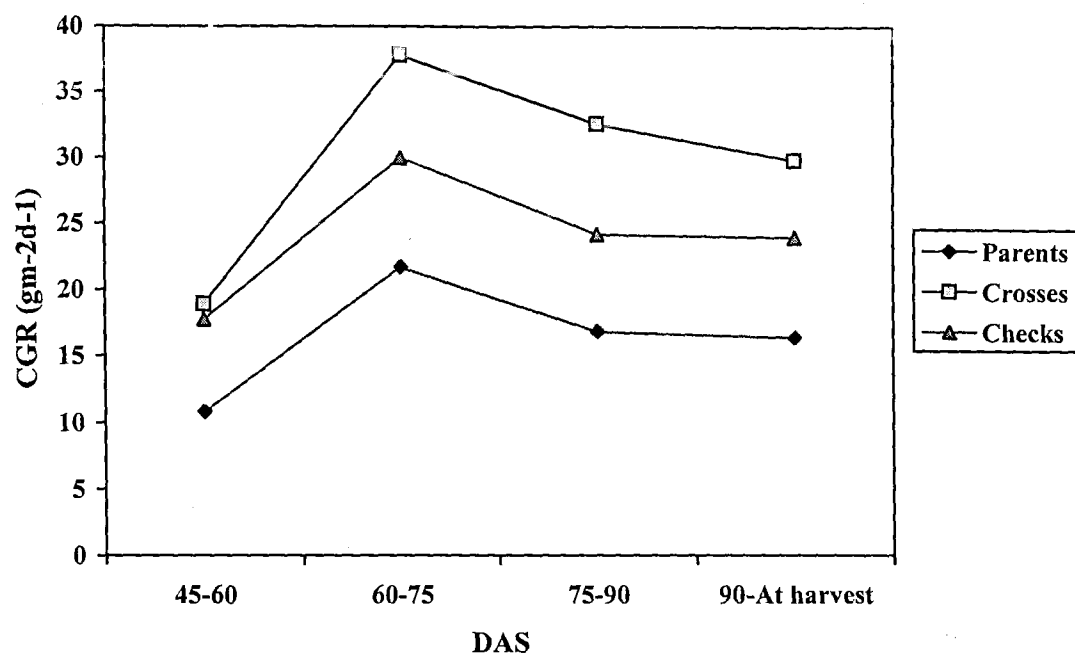


Fig 3c: Crop Growth Rate in Parents, superior cross and Checks in QPM (Kharif Palem)

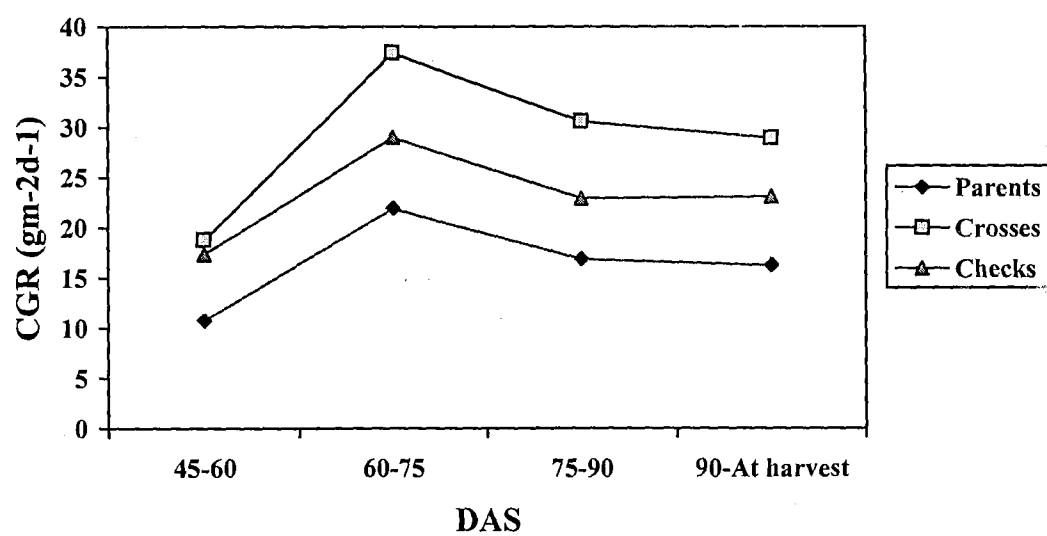


Fig 3d: Crop Growth Rate in Parents, superior cross and Checks in QPM (Rabi Palem)

of crop growth. The checks Madhuri recorded 30.80 whereas Shaktiman-2 recorded 31.20g/m²/day (Fig.3a)

At Palem during *Kharif* highest CGR (28.31) was noticed in P5 X P6 and the least (14.85) in P7 (Table 5c). Significant differences were observed among different stages of crop growth. Highest CGR (26.63) was recorded at 60-75 DAS and the least (13.14) at 45-60 DAS. The CGR increased upto 60-75 DAS and then decreased a little at 75- 90 and remained constant at maturity. At flowering stage it ranged from 20.30 (P7) to 25.8 (P6) in parents and 21.00 (P6 X P8) to 37.8 (P4 X P6) in single crosses. Single crosses maintained higher CGR than parents at different stages of crop growth. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 29.80 and 30.60g/m²/day respectively.(Fig.3c)

Significant differences were noticed among genotypes with respect to CGR during *Rabi* at Rajendranagar (Table 5b). Of all the genotypes highest CGR (29.73) was noticed in P1 X P6 and the least (14.98) in P7. Significant differences were observed among different stages of crop growth. Highest CGR (27.05) was recorded at 60-75 DAS and the least (13.56) at 45-60 DAS. The CGR increased upto 60-75 DAS and then decreased a little at 75- 90 and remained constant at maturity. At flowering stage it ranged from 21 (P9) to 30.6 (P6) in parents and 21.6 (P7 X P8) to 38.4 (P2 X P10) in single crosses. Single crosses maintained higher CGR than parents at different stages of crop growth. The checks Madhuri recorded 29.60 whereas Shaktiman-2 recorded 30.60g/m²/day(Fig.3b)

During *Rabi* at Palem highest CGR (28.93) was noticed in P4 X P6 and the least (14.65) in P7 (Table 5d). Significant differences were observed among different stages of crop growth. Highest CGR (26.34) was recorded at 60-75 DAS and the least (13.00) at 45-60 DAS. The CGR increased upto 60-75 DAS and then decreased a little at 75- 90 and remained constant at maturity. At flowering stage it ranged from 20.2 (P7) to 29.4 (P6) in parents and 21.00 (P6 X P8) to 37.4 (P4 X P6) in single crosses. Single crosses maintained higher CGR than parents at different

stages of crop growth. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 23.60 and 29.40g/m²/day respectively (Fig. 3d).

4.2.10 Relative growth rate (RGR) ($\text{g g}^{-1} \text{d}^{-1}$)

At Rajendranagar during *Kharif* highest RGR (0.052) was noticed in P4 XP6 and the least (0.034) in P6 X P8 and P3 X P9 crosses (Table 6a). Significant differences were observed among different stages of crop growth. Highest RGR (0.082) was recorded at 45-60DAS and the least (0.0177) at maturity. In all the genotypes the RGR decreased continuously from 25-40 DAS towards maturity. At flowering stage it ranged from 0.041 (P7) to 0.061 (P5) in parents and 0.04 (P1 X P8) to 0.069 (P4 X P6) in single crosses. Hybrids maintained higher RGR than parents at different stages of crop growth. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 0.042 and 0.048g/m²/day respectively (Fig. 4a).

During *Kharif* at Palem highest RGR (0.052) was noticed in P4 XP6 and the least (0.033) in P3 X P9 (Table 6c). Significant differences were observed among different stages of crop growth. Highest RGR (0.0688) was recorded at 45-60 DAS and the least (0.014) at maturity. In all the genotypes the RGR decreased continuously from 25-40 DAS towards maturity. At flowering stage it ranged from 0.039 (P7) to 0.059 (P5) in parents and 0.038 (P8 X P9) to 0.068 (P4 X P6) in single crosses. Hybrids maintained higher RGR than parents at different stages of crop growth. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 0.042 and 0.046g/m²/day respectively. (Fig 4c)

Significant differences were noticed among genotypes with respect to RGR during *Rabi* at Rajendranagar (Table 6b). Of all the genotypes highest RGR (0.078) was noticed in P2 X P5 and the least (14.98) in P7. Significant differences were observed among different stages of crop growth. Highest RGR (0.078) was recorded at 45-60 DAS and the least (0.033) at maturity. In all the genotypes the RGR decreased continuously from 25-40 DAS towards maturity. At flowering stage it ranged from

Table 6a: Relative Growth Rate (RGR) in QPM (Kharif, 2003, Rajendranagar)

(99-12-1)

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Genotypes	45-60DAS	60-75DAS	75-90DAS	90DAS- At harvest	Row mean
Parents					
P1	0.061	0.042	0.022	0.014	0.035
P2	0.072	0.053	0.021	0.015	0.040
P3	0.081	0.059	0.024	0.017	0.045
P4	0.073	0.054	0.022	--	0.049
P5	0.090	0.061	0.028	0.019	0.049
P6	0.061	0.053	0.024	0.014	0.038
P7	0.060	0.041	0.024	0.016	0.035
P8	0.082	0.056	0.025	0.017	0.045
P9	0.060	0.045	0.024	0.016	0.036
P10	0.063	0.044	0.021	0.014	0.036
Crosses					
P1 X P2	0.064	0.044	0.022	--	0.043
P1 X P3	0.062	0.043	0.023	0.015	0.036
P1 X P4	0.069	0.042	0.021	0.014	0.036
P1 X P5	0.064	0.044	0.022	0.015	0.036
P1 X P6	0.061	0.045	0.024	0.016	0.037
P1 X P7	0.063	0.046	0.026	0.017	0.038
P1 X P8	0.060	0.041	0.024	0.017	0.035
P1 X P9	0.079	0.058	0.021	--	0.052
P1 X P10	0.092	0.063	0.029	--	0.061
P2 X P3	0.065	0.042	0.021	--	0.042
P2 X P4	0.078	0.055	0.022	--	0.051
P2 X P5	0.076	0.054	0.024	--	0.051
P2 X P6	0.068	0.045	0.023	0.014	0.038
P2 X P7	0.083	0.044	0.022	0.016	0.041
P2 X P8	0.089	0.058	0.026	--	0.057
P2 X P9	0.071	0.056	0.028	0.017	0.043
P2 X P10	0.082	0.052	0.023	0.016	0.043
P3 X P4	0.062	0.046	0.028	0.016	0.038
P3 X P5	0.073	0.057	0.027	0.017	0.043
P3 X P6	0.075	0.055	0.025	--	0.051
P3 X P7	0.065	0.044	0.025	--	0.044
P3 X P8	0.067	0.046	0.024	0.016	0.038
P3 X P9	0.063	0.041	0.020	0.013	0.034
P3 X P10	0.064	0.042	0.021	--	0.042
P4 X P5	0.078	0.055	0.024	--	0.052
P4 X P6	0.093	0.069	0.028	0.019	0.052
P4 X P7	0.068	0.041	0.025	--	0.044
P4 X P8	0.069	0.047	0.026	--	0.047
P4 X P9	0.063	0.041	0.024	--	0.042
P4 X P10	0.061	0.043	0.022	--	0.042
P5 X P6	0.078	0.051	0.027	0.018	0.044
P5 X P7	0.073	0.052	0.029	--	0.051
P5 X P8	0.088	0.048	0.024	0.017	0.044
P5 X P9	0.067	0.042	0.022	0.013	0.036
P5 X P10	0.069	0.051	0.023	0.014	0.039
P6 X P7	0.079	0.055	0.021	--	0.051
P6 X P8	0.062	0.041	0.020	0.013	0.034
P6 X P9	0.072	0.059	0.027	0.018	0.044
P6 X P10	0.078	0.055	0.028	0.017	0.044
P7 X P8	0.074	0.060	0.024	0.017	0.044
P7 X P9	0.077	0.059	0.025	0.016	0.044
P7 X P10	0.069	0.048	0.022	--	0.046
P8 X P9	0.061	0.042	0.027	0.017	0.037
P8 X P10	0.060	0.041	0.021	--	0.040
P9 X P10	0.069	0.047	0.022	--	0.046
COL. MEAN	0.071	0.049	0.024	0.015	0.048
Group mean					
Parents	0.070	0.051	0.024	0.016	
Crosses	0.085	0.049	0.024	0.016	
Checks					
Madhuri	0.063	0.042	0.020	0.014	
shaktiman-2	0.069	0.048	0.023	0.015	
Mean	0.066	0.045	0.022	0.015	

CD (A) at 0.05 level = 0.0017
 CD (B) at 0.05 level = 0.0004
 Interaction CD (0.05) = 0.0033

A = Genotypes
 B = Growth stages
 A X B = Interaction

Table 6b: Relative Growth Rate (RGR) in QPM (Rabi 2002-03,
Rajendranagar)

(99⁻¹d⁻¹)

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Genotypes	45-60DAS	60-75DAS	75-90DAS	90DAS- At harvest	Row mean
Parents					
P1	0.060	0.041	0.021	0.013	0.034
P2	0.070	0.052	0.020	0.014	0.039
P3	0.079	0.057	0.022	0.016	0.044
P4	0.071	0.053	0.020	--	0.048
P5	0.088	0.060	0.026	0.017	0.048
P6	0.060	0.051	0.023	0.014	0.037
P7	0.059	0.040	0.023	0.016	0.034
P8	0.081	0.054	0.023	0.016	0.043
P9	0.058	0.044	0.023	0.015	0.035
P10	0.061	0.043	0.020	0.013	0.034
Crosses					
P1 X P2	0.065	0.044	0.021	--	0.043
P1 X P3	0.060	0.042	0.021	0.014	0.034
P1 X P4	0.067	0.041	0.020	0.013	0.035
P1 X P5	0.061	0.042	0.022	0.014	0.035
P1 X P6	0.059	0.043	0.023	0.015	0.035
P1 X P7	0.061	0.045	0.025	0.016	0.037
P1 X P8	0.059	0.040	0.023	0.017	0.035
P1 X P9	0.080	0.059	0.022	--	0.053
P1 X P10	0.090	0.061	0.027	--	0.059
P2 X P3	0.063	0.040	0.020	--	0.041
P2 X P4	0.077	0.056	0.021	--	0.051
P2 X P5	0.076	0.051	0.023	--	0.050
P2 X P6	0.067	0.045	0.021	0.013	0.037
P2 X P7	0.083	0.056	0.022	0.018	0.045
P2 X P8	0.086	0.052	0.023	--	0.053
P2 X P9	0.070	0.055	0.027	0.016	0.042
P2 X P10	0.083	0.056	0.026	0.017	0.046
P3 X P4	0.063	0.045	0.026	0.015	0.037
P3 X P5	0.072	0.054	0.023	0.017	0.041
P3 X P6	0.060	0.046	0.025	--	0.043
P3 X P7	0.063	0.043	0.024	--	0.043
P3 X P8	0.065	0.045	0.023	0.015	0.037
P3 X P9	0.061	0.040	0.020	0.012	0.033
P3 X P10	0.064	0.044	0.020	--	0.042
P4 X P5	0.078	0.054	0.023	--	0.051
P4 X P6	0.091	0.048	0.022	0.019	0.045
P4 X P7	0.066	0.040	0.024	--	0.043
P4 X P8	0.067	0.046	0.025	--	0.046
P4 X P9	0.061	0.040	0.023	--	0.041
P4 X P10	0.060	0.041	0.021	--	0.040
P5 X P6	0.081	0.042	0.022	0.014	0.040
P5 X P7	0.071	0.051	0.028	--	0.050
P5 X P8	0.087	0.047	0.023	0.016	0.043
P5 X P9	0.065	0.041	0.021	0.012	0.035
P5 X P10	0.067	0.050	0.022	0.013	0.038
P6 X P7	0.077	0.053	0.020	--	0.050
P6 X P8	0.061	0.040	0.019	0.012	0.033
P6 X P9	0.070	0.057	0.026	0.017	0.043
P6 X P10	0.077	0.054	0.027	0.016	0.044
P7 X P8	0.073	0.059	0.023	0.015	0.042
P7 X P9	0.076	0.058	0.024	0.016	0.043
P7 X P10	0.067	0.046	0.020	--	0.044
P8 X P8	0.064	0.043	0.021	0.015	0.036
P8 X P9	0.062	0.042	0.025	--	0.043
P9 X P10	0.068	0.046	0.020	--	0.044
COL.MEAN	0.070	0.048	0.023	0.015	0.041
Group mean					
Parents	0.069	0.050	0.022	0.015	
Crosses	0.070	0.048	0.023	0.015	
Checks					
Madhuri	0.061	0.042	0.020	0.013	
Shaktiman-2	0.067	0.047	0.022	0.014	
Mean	0.064	0.045	0.020	0.013	

CD (A) at 0.05 level = 0.0017
 CD (B) at 0.05 level = 0.0005
 Interaction CD (0.05) = 0.0034

A = Genotypes
 B = Growth stages
 A X B = Interaction

Table6c: Relative Growth Rate (RGR) in QPM (Kharif 2003, Palem)

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Genotypes	45-60DAS	60-75DAS	75-90DAS	90DAS- At harvest	Row mean
Parents					
P1	0.060	0.040	0.020	0.012	0.033
P2	0.069	0.051	0.020	0.014	0.038
P3	0.078	0.055	0.021	0.015	0.042
P4	0.070	0.052	0.020	--	0.047
P5	0.089	0.059	0.025	0.016	0.047
P6	0.059	0.050	0.022	0.013	0.036
P7	0.058	0.039	0.022	0.015	0.034
P8	0.080	0.053	0.021	0.016	0.043
P9	0.058	0.043	0.023	0.015	0.035
P10	0.060	0.042	0.020	0.012	0.034
Crosses					
P1 X P2	0.064	0.042	0.020	--	0.042
P1 X P3	0.060	0.041	0.021	0.013	0.034
P1 X P4	0.065	0.040	0.020	0.012	0.034
P1 X P5	0.060	0.042	0.021	0.013	0.034
P1 X P6	0.058	0.042	0.022	0.015	0.034
P1 X P7	0.061	0.044	0.024	0.015	0.036
P1 X P8	0.057	0.040	0.023	0.016	0.034
P1 X P9	0.078	0.056	0.020	--	0.051
P1 X P10	0.090	0.060	0.025	--	0.058
P2 X P3	0.062	0.040	0.020	--	0.040
P2 X P4	0.075	0.055	0.021	--	0.050
P2 X P5	0.064	0.043	0.022	--	0.043
P2 X P6	0.065	0.044	0.020	0.012	0.035
P2 X P7	0.086	0.055	0.024	0.017	0.045
P2 X P8	0.079	0.050	0.022	--	0.050
P2 X P9	0.069	0.054	0.026	0.015	0.041
P2 X P10	0.081	0.056	0.025	0.015	0.044
P3 X P4	0.060	0.046	0.024	0.016	0.036
P3 X P5	0.070	0.054	0.026	0.014	0.041
P3 X P6	0.070	0.053	0.022	--	0.050
P3 X P7	0.061	0.042	0.023	--	0.042
P3 X P8	0.064	0.044	0.022	0.014	0.036
P3 X P9	0.060	0.040	0.020	0.011	0.033
P3 X P10	0.075	0.055	0.019	--	0.049
P4 X P5	0.077	0.053	0.022	--	0.050
P4 X P6	0.092	0.068	0.028	0.019	0.052
P4 X P7	0.065	0.040	0.023	--	0.042
P4 X P8	0.066	0.045	0.025	--	0.045
P4 X P9	0.060	0.039	0.023	--	0.040
P4 X P10	0.060	0.040	0.020	--	0.040
P5 X P6	0.077	0.052	0.025	0.017	0.043
P5 X P7	0.070	0.050	0.027	--	0.049
P5 X P8	0.085	0.046	0.022	0.015	0.042
P5 X P9	0.068	0.040	0.021	0.012	0.035
P5 X P10	0.066	0.050	0.021	0.012	0.037
P6 X P7	0.076	0.052	0.020	--	0.049
P6 X P8	0.060	0.039	0.019	0.011	0.032
P6 X P9	0.069	0.056	0.025	0.016	0.041
P6 X P10	0.076	0.054	0.026	0.016	0.043
P7 X P8	0.071	0.058	0.022	0.015	0.041
P7 X P9	0.075	0.058	0.023	0.015	0.043
P7 X P10	0.066	0.045	0.020	--	0.043
P8 X P9	0.058	0.038	0.021	0.015	0.033
P8 X P10	0.064	0.042	0.022	--	0.042
P9 X P10	0.069	0.048	0.020	0.000	0.045
COL. MEAN	0.069	0.048	0.022	0.013	0.040
Group mean					
Parents	0.068	0.048	0.021	0.014	
Crosses	0.069	0.048	0.022	0.014	
Checks					
Madhuri	0.060	0.042	0.020	0.012	
shakthiman-2	0.066	0.045	0.021	0.014	
Mean	0.063	0.044	0.021	0.013	

CD (A) at 0.05 level = 0.0016

CD (B) at 0.05 level = 0.0004

Interaction CD (0.05) = 0.0033

A =

B =

A X B =

Genotypes

Growth stages

Interaction

Table6d: Relative Growth Rate (RGR) in QPM (Rabi 2002-03, Palem)

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Genotypes	45-60DAS	60-75DAS	75-90DAS	90DAS- At harvest	Row mean
Parents					
P1	0.059	0.040	0.020	0.011	0.033
P2	0.068	0.050	0.020	0.013	0.038
P3	0.077	0.054	0.020	0.014	0.041
P4	0.060	0.051	0.019	--	0.043
P5	0.080	0.051	0.021	0.015	0.042
P6	0.058	0.050	0.022	0.013	0.036
P7	0.056	0.038	0.021	0.014	0.032
P8	0.058	0.042	0.020	0.015	0.034
P9	0.087	0.058	0.024	0.016	0.046
P10	0.059	0.041	0.020	0.011	0.033
Crosses					
P1 X P2	0.074	0.049	0.019	--	0.047
P1 X P3	0.059	0.040	0.020	0.013	0.033
P1 X P4	0.064	0.039	0.021	0.012	0.034
P1 X P5	0.059	0.041	0.020	0.012	0.033
P1 X P6	0.057	0.040	0.021	0.014	0.033
P1 X P7	0.060	0.043	0.023	0.015	0.035
P1 X P8	0.056	0.040	0.022	0.015	0.033
P1 X P9	0.079	0.058	0.020	--	0.052
P1 X P10	0.089	0.059	0.024	--	0.057
P2 X P3	0.061	0.039	0.020	--	0.040
P2 X P4	0.076	0.051	0.021	--	0.049
P2 X P5	0.063	0.042	0.021	--	0.042
P2 X P6	0.064	0.043	0.020	0.011	0.034
P2 X P7	0.087	0.054	0.024	0.017	0.045
P2 X P8	0.080	0.051	0.021	--	0.050
P2 X P9	0.068	0.054	0.025	0.014	0.040
P2 X P10	0.079	0.052	0.024	0.014	0.042
P3 X P4	0.060	0.045	0.023	0.013	0.035
P3 X P5	0.070	0.053	0.025	0.015	0.041
P3 X P6	0.069	0.052	0.021	--	0.047
P3 X P7	0.060	0.041	0.022	--	0.041
P3 X P8	0.064	0.043	0.021	0.012	0.035
P3 X P9	0.060	0.040	0.020	0.011	0.033
P3 X P10	0.074	0.054	0.019	--	0.049
P4 X P5	0.075	0.052	0.020	--	0.049
P4 X P6	0.091	0.066	0.027	0.018	0.050
P4 X P7	0.064	0.040	0.022	--	0.042
P4 X P8	0.065	0.044	0.024	--	0.044
P4 X P9	0.060	0.039	0.023	--	0.040
P4 X P10	0.059	0.040	0.020	--	0.039
P5 X P6	0.080	0.054	0.026	0.017	0.044
P5 X P7	0.070	0.048	0.026	--	0.048
P5 X P8	0.084	0.047	0.021	0.015	0.042
P5 X P9	0.063	0.040	0.020	0.011	0.034
P5 X P10	0.065	0.049	0.021	0.012	0.037
P6 X P7	0.075	0.051	0.020	--	0.048
P6 X P8	0.060	0.038	0.019	0.011	0.032
P6 X P9	0.068	0.055	0.024	0.015	0.041
P6 X P10	0.075	0.054	0.025	0.016	0.042
P7 X P8	0.070	0.057	0.022	0.015	0.041
P7 X P9	0.074	0.058	0.022	0.014	0.042
P7 X P10	0.065	0.044	0.020	--	0.043
P8 X P9	0.059	0.039	0.020	0.014	0.033
P8 X P10	0.257	0.043	0.023	--	0.107
P9 X P10	0.070	0.047	0.020	--	0.045
COL.MEAN	0.072	0.047	0.022	0.013	0.042
Group mean					
Parents	0.066	0.048	0.021	0.013	
Crosses	0.073	0.047	0.022	0.014	
Checks					
Madhuri	0.060	0.042	0.019	0.012	
Shaktiman-2	0.065	0.045	0.020	0.013	
Mean	0.062	0.043	0.019	0.012	

CD (A) at 0.05 level = NS
 CD (B) at 0.05 level = 0.0048
 Interaction CD (0.05) = NS

A = Genotypes
 B = Growth stages
 A X B = Interaction

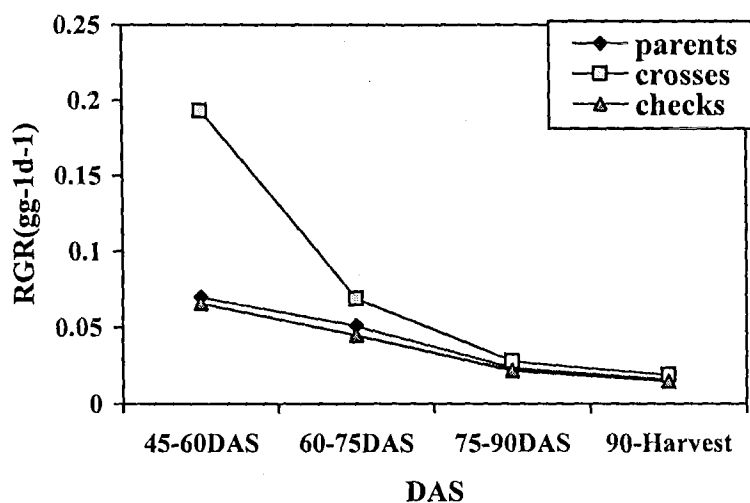


Fig 4a: Relative growth rate in parents, crosses and checks in QPM (Kharif Rajendranagar)

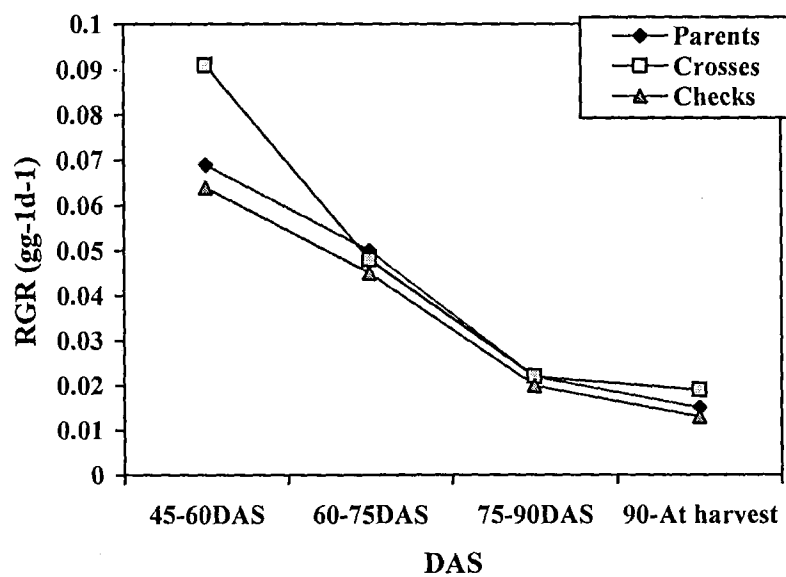


Fig 4b: Relative Growth Rate in Parents, Crosses and Checks in QPM (Rabi Rajendranagar)

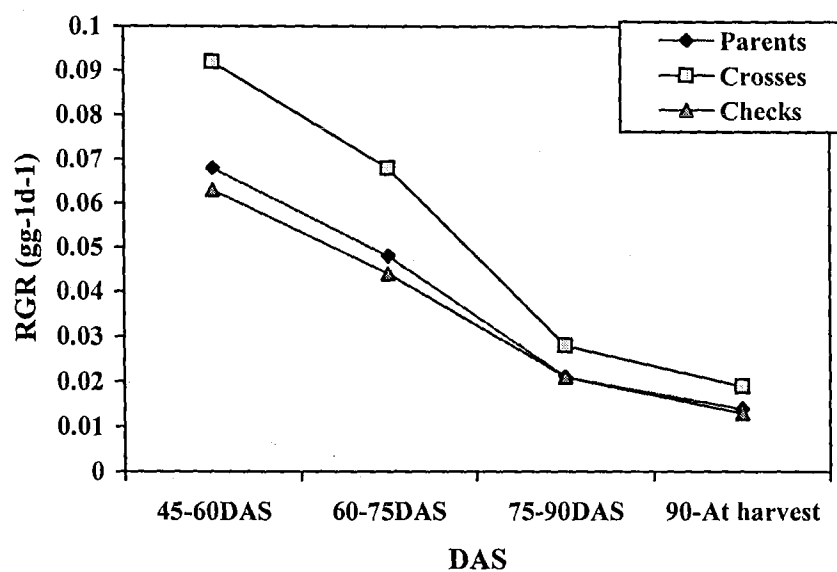


Fig 4c: Relative growth rate in Parents, superior cross and Checks in QPM (Kharif Palem)

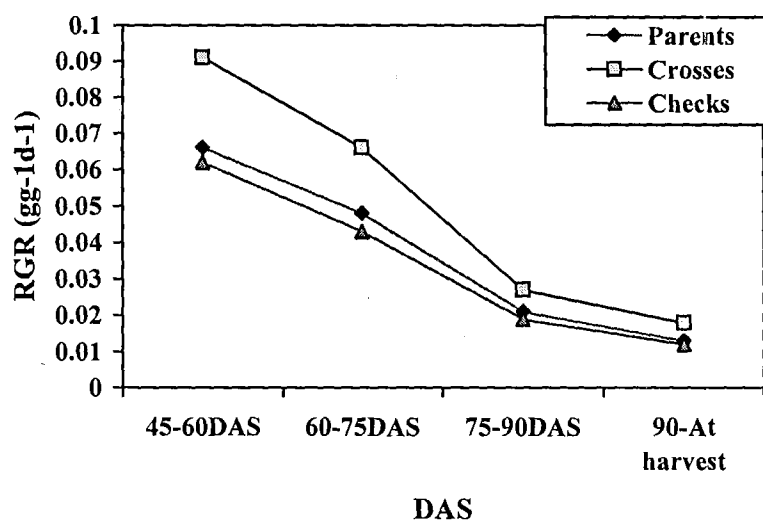


Fig.4d: Relative Growth Rate in Parents, superior cross and Checks in QPM (Rabi Palem)

0.041 (P1) to 0.06 (P5) in parents and 0.040 (P1 X P8) to 0.061 (P1 X P10) in single crosses. Hybrids maintained higher RGR than parents at different stages of crop growth. The checks Madhuri recorded 0.042 whereas Shaktiman-2 recorded 0.047g/m²/day (Fig 4b).

During *Rabi* at Palem highest RGR (0.084) was noticed in P8 X P10 and the least (0.032) in P7 (Table 6d). Significant differences were observed among different stages of crop growth. Highest RGR (0.072) was recorded at 45-60 DAS and the least (0.014) at maturity. In all the genotypes the RGR decreased continuously from 25-40 DAS towards maturity. At flowering stage it ranged from 0.038 (P7) to 0.054 (P3) in parents and 0.038 (P6 X P8) to 0.066 (P4 X P6) in single crosses. Hybrids maintained higher RGR than parents at different stages of crop growth. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 0.042 and 0.045g/m²/day respectively (Fig 4d)

4.2.11 Net assimilation rate (NAR) (g m⁻² d⁻¹)

At Rajendranagar during *Kharif* P1 X P10 recorded highest mean NAR (10.93) and the least (5.92) by parental line P3 (Table 7a). There were significant differences among different stages of crop growth also. Highest NAR was recorded at 60-75 DAS and the least at 45-60 DAS. In all the genotypes, NAR increased from 45-60 DAS to 60-75 DAS and decreased and then remained constant. At flowering stage it ranged from 7.34 (P3) to 9.62 (P6) in parents and 8.28 (P7 X P8) to 12.19 (P1 X P10) in single crosses. Single crosses maintained higher RGR than parents at different stages of crop growth. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 8.89 and 9.23g/m²/day respectively (Fig 5a).

During *Kharif* at Palem P5 X P6 recorded highest mean NAR (10.57) and the least by (5.92) parental line P5 (Table 7c). There were significant differences among different stages of crop growth also. Highest NAR was recorded at 60-75 DAS and the least at 45-60 DAS. In all the genotypes, NAR increased from 45-60 DAS to 60-75

Table7a: Net Assimilation Rate (NAR) in QPM (Kharif 2003, Rajendranagar)

 $(\text{gm}^{-2}\text{d}^{-1})$

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Genotypes	45-60DAS	60-75DAS	75-90DAS	90DAS- At harvest	Row mean
Parents					
P1	6.51	8.39	6.10	6.00	6.75
P2	6.70	8.64	6.44	6.52	7.08
P3	5.81	7.34	5.23	5.30	5.92
P4	7.12	8.96	7.87	--	7.98
P5	6.34	8.05	6.50	6.20	6.77
P6	7.78	9.62	7.72	8.65	8.44
P7	5.81	7.56	6.70	6.72	6.69
P8	6.12	7.95	6.50	7.40	6.99
P9	6.45	8.28	6.11	6.20	6.76
P10	6.72	8.46	6.23	6.56	6.99
Crosses					
P1 X P2	6.52	8.32	6.23	--	7.02
P1 X P3	7.24	9.64	6.42	6.20	7.38
P1 X P4	7.63	9.23	7.41	7.54	7.95
P1 X P5	8.72	9.69	6.52	6.23	7.79
P1 X P6	8.65	10.11	7.72	7.62	8.53
P1 X P7	8.83	11.24	8.42	8.49	9.25
P1 X P8	8.03	9.82	7.26	7.25	8.09
P1 X P9	8.52	10.51	8.50	--	9.18
P1 X P10	10.56	12.19	10.05	--	10.93
P2 X P3	7.08	9.50	7.15	--	7.91
P2 X P4	8.48	10.37	8.28	--	9.04
P2 X P5	7.52	9.63	7.54	--	8.23
P2 X P6	7.72	9.98	7.12	8.28	8.28
P2 X P7	8.65	10.15	8.45	6.29	8.39
P2 X P8	7.21	9.38	7.26	--	5.96
P2 X P9	7.42	9.39	7.47	8.51	8.19
P2 X P10	8.01	10.02	8.21	9.05	8.82
P3 X P4	7.15	8.49	6.51	7.42	7.39
P3 X P5	9.21	11.09	10.54	11.16	10.50
P3 X P6	8.42	10.10	8.26	--	8.93
P3 X P7	7.26	9.50	7.23	--	7.99
P3 X P8	8.12	10.64	8.41	8.50	8.92
P3 X P9	7.52	9.79	7.56	8.52	8.35
P3 X P10	8.24	10.68	8.46	--	9.13
P4 X P5	7.95	9.97	7.72	--	8.55
P4 X P6	9.54	11.33	9.42	9.56	9.96
P4 X P7	7.34	9.12	7.62	--	8.02
P4 X P8	7.50	9.59	7.56	--	8.22
P4 X P9	6.76	8.81	6.72	--	7.43
P4 X P10	8.46	10.45	8.42	--	9.11
P5 X P6	9.08	11.19	9.61	9.64	9.88
P5 X P7	7.12	9.28	7.05	--	7.82
P5 X P8	8.17	10.19	8.65	7.02	8.51
P5 X P9	6.23	8.31	6.45	7.23	7.06
P5 X P10	5.64	8.61	10.41	11.56	9.06
P6 X P7	6.09	7.99	6.12	--	6.73
P6 X P8	6.45	9.75	7.23	8.14	7.89
P6 X P9	6.48	8.96	6.93	7.95	7.58
P6 X P10	6.92	8.73	6.42	7.38	7.36
P7 X P8	6.45	8.28	6.39	7.42	7.14
P7 X P9	7.86	9.95	7.62	8.74	8.54
P7 X P10	8.23	10.36	8.63	--	9.07
P8 X P9	7.08	9.12	7.24	8.14	7.90
P8 X P10	6.42	8.31	6.52	--	7.08
P9 X P10	7.08	9.12	7.46	--	7.88
COL.MEAN	7.47	9.46	7.50	7.75	8.08
Group mean					
Parents	6.54	8.33	6.54	6.62	
Crosses	7.68	9.70	7.89	7.95	
Checks					
Madhuri	7.16	7.70	7.62	7.65	
Shaktiman-2	7.23	7.54	7.15	7.75	
Mean	7.19	7.62	7.39	7.70	

CD (A) at 0.05 level = 0.2448
 CD (B) at 0.05 level = 0.0660

A = Genotypes
 B = Growth stages

Table 7b: Net Assimilation Rate (NAR) in QPM (Rabi 2002-03, Rajendranagar)

($g\ m^{-2}\ d^{-1}$)

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Genotypes	45-60DAS	60-75DAS	75-90DAS	90DAS- At harvest	Row mean
Parents					
P1	6.67	8.45	6.26	6.01	6.85
P2	6.81	8.70	6.52	6.45	7.12
P3	5.96	7.50	5.45	5.32	6.06
P4	6.68	8.44	6.54	--	7.22
P5	7.01	9.11	7.21	7.18	7.63
P6	7.42	9.65	7.46	8.92	8.36
P7	6.21	8.05	6.01	6.52	6.70
P8	5.54	7.61	5.56	5.96	6.17
P9	6.62	8.01	6.52	6.23	6.85
P10	6.24	8.32	6.45	6.30	6.83
Crosses					
P1 X P2	6.27	8.50	6.38	--	7.05
P1 X P3	7.40	10.43	7.24	8.24	8.33
P1 X P4	7.12	9.11	7.15	8.96	8.09
P1 X P5	7.75	9.31	7.26	8.45	8.19
P1 X P6	8.46	9.72	6.42	6.92	7.88
P1 X P7	8.72	9.20	7.25	8.62	8.45
P1 X P8	8.56	10.30	8.28	8.45	8.89
P1 X P9	8.23	10.84	7.78	--	8.95
P2 X P10	8.54	11.69	9.42	--	9.88
P2 X P3	7.02	9.42	7.12	--	7.85
P2 X P4	8.56	10.72	8.34	--	9.21
P2 X P5	7.52	8.41	6.24	--	7.49
P2 X P6	7.65	9.70	7.54	8.42	8.33
P2 X P7	8.54	10.25	8.39	8.54	8.93
P2 X P8	7.62	9.65	7.84	--	8.37
P2 X P9	7.54	9.50	7.26	8.56	8.22
P2 X P10	8.23	10.64	8.53	8.92	9.08
P3 X P4	7.12	9.05	8.02	8.21	8.09
P3 X P5	9.52	12.12	10.56	10.52	10.68
P3 X P6	8.65	10.70	9.65	--	9.69
P3 X P7	7.86	8.96	6.12	--	7.65
P3 X P8	8.09	10.60	8.35	8.47	8.88
P3 X P9	7.23	9.81	8.72	9.92	8.92
P3 X P10	8.24	10.18	8.50	--	8.99
P4 X P5	7.23	9.15	9.12	--	8.50
P4 X P6	8.96	10.99	8.77	8.56	9.32
P4 X P7	7.32	9.12	9.08	--	8.50
P4 X P8	7.01	9.00	9.12	--	8.41
P4 X P9	6.23	8.65	6.45	--	7.19
P4 X P10	7.92	9.21	9.12	--	8.75
P5 X P6	9.09	12.34	10.65	10.62	10.68
P5 X P7	7.45	7.61	7.42	--	7.49
P5 X P8	8.32	10.44	8.58	10.47	9.45
P5 X P9	6.34	8.98	6.12	6.34	6.95
P5 X P10	5.81	7.92	6.23	7.14	6.78
P6 X P7	6.52	8.12	6.12	--	6.92
P6 X P8	7.12	9.42	7.32	8.64	8.13
P6 X P9	7.06	9.00	7.01	9.20	8.07
P6 X P10	7.64	9.05	8.62	9.72	8.76
P7 X P8	7.92	9.25	9.28	9.50	8.99
P7 X P9	8.52	10.66	9.15	9.28	9.40
P7 X P10	8.65	10.50	8.64	--	9.26
P8 X P9	7.23	9.56	7.39	8.72	8.23
P8 X P10	6.47	8.51	6.92	--	7.30
P9 X P10	6.07	8.23	6.45	--	6.92
COL. MEAN	7.46	9.43	7.64	8.18	8.17
Group mean					
Parents	6.52	8.38	6.41	6.54	
Crosses	7.67	9.66	7.74	8.77	
Checks					
Madhuri	6.07	8.23	6.45	7.60	
Shaktiman-2	7.12	9.76	7.10	8.02	
Mean	6.59	8.99	6.77	7.81	

CD (A) at 0.05 level = 0.2409

CD (B) at 0.05 level = 0.0650

Interaction CD (0.05) = 0.1010

A = Genotypes
B = Growth stages

Table7c: Net Assimilation Rate (NAR) in QPM (Kharif 2003, Palem)
($g\ m^{-2}\ d^{-1}$)

Genotypes	45-60DAS	60-75DAS	75-90DAS	90DAS- At harvest	Row mean
Parents					
P1	6.71	8.72	9.28	10.52	8.81
P2	6.32	8.48	7.49	7.25	7.39
P3	6.49	8.58	7.85	7.53	7.61
P4	6.71	8.82	6.95	--	7.49
P5	5.18	7.62	5.54	5.32	5.92
P6	7.36	9.32	7.74	8.14	8.14
P7	5.61	7.81	5.41	5.32	6.04
P8	6.92	8.61	6.54	6.34	7.10
P9	6.86	8.58	6.94	6.84	7.31
P10	6.92	8.69	6.96	6.76	7.33
Crosses					
P1 X P2	5.72	7.77	5.23	--	6.24
P1 X P3	7.12	9.72	7.47	8.41	8.18
P1 X P4	7.10	9.11	7.12	8.52	7.96
P1 X P5	7.50	9.29	7.29	8.32	8.10
P1 X P6	8.18	9.72	7.27	8.81	8.49
P1 X P7	8.78	10.78	8.34	9.23	9.28
P1 X P8	8.84	10.38	8.36	9.21	9.20
P1 X P9	8.15	9.93	8.92	--	9.00
P1 X P10	8.16	11.36	8.63	--	9.38
P2 X P3	7.24	9.13	7.47	--	7.94
P2 X P4	8.21	10.13	8.08	--	8.80
P2 X P5	11.9	10.60	8.92	--	10.48
P2 X P6	7.35	9.74	7.48	8.42	8.25
P2 X P7	8.39	9.44	9.42	10.32	9.39
P2 X P8	7.14	8.56	6.65	--	7.45
P2 X P9	7.19	8.18	6.98	7.08	7.36
P2 X P10	8.24	10.18	8.45	9.45	9.08
P3 X P4	9.36	11.08	9.28	8.28	9.50
P3 X P5	8.28	10.16	9.17	9.17	9.20
P3 X P6	9.45	11.12	9.28	--	9.95
P3 X P7	7.49	9.52	7.14	--	8.05
P3 X P8	9.02	12.02	10.43	9.43	10.23
P3 X P9	7.25	9.22	8.45	6.45	7.84
P3 X P10	9.01	11.02	8.14	--	9.39
P4 X P5	8.92	10.90	8.65	--	9.49
P4 X P6	9.18	10.48	7.12	9.12	8.98
P4 X P7	7.42	8.28	8.15	--	7.95
P4 X P8	7.79	9.74	9.42	--	8.98
P4 X P9	6.43	8.34	8.54	--	7.77
P4 X P10	8.02	10.26	9.16	--	9.14
P5 X P6	9.15	11.47	10.54	11.12	10.57
P5 X P7	7.54	9.44	7.45	--	8.14
P5 X P8	8.27	10.72	10.67	10.16	9.96
P5 X P9	7.18	9.10	7.54	7.72	7.89
P5 X P10	7.17	9.80	7.62	7.54	8.03
P6 X P7	6.78	8.72	6.27	--	7.25
P6 X P8	7.54	9.88	7.89	7.12	8.11
P6 X P9	6.69	8.96	7.62	8.68	7.99
P6 X P10	6.05	8.50	8.45	9.48	8.12
P7 X P8	6.39	8.32	6.49	7.15	7.09
P7 X P9	8.67	10.76	8.57	9.53	9.38
P7 X P10	7.48	9.58	7.45	--	8.17
P8 X P9	6.95	8.88	6.98	7.98	7.70
P8 X P10	7.12	9.12	8.15	--	8.13
P9 X P10	7.75	9.49	8.63	--	8.62
COL.MEAN					
COL.MEAN	7.61	9.53	7.92	8.26	8.51
Group mean					
Parents	6.50	8.52	7.07	7.11	
Crosses	7.85	9.75	8.12	8.66	
Checks					
Madhuri	9.42	11.62	9.12	10.21	
Shaktiman-2	10.28	12.85	10.42	11.24	
Mean	9.85	11.24	9.77	10.73	

CD (A) at 0.05 level = 0.2669

CD (B) at 0.05 level = 0.0720

Interaction CD (0.05) = 0.5338

A =

B =

A X B =

Genotypes

Growth stages

Interaction

Table 7d: Net Assimilation Rate (NAR) in QPM (Rabi 2002-03; Palem)

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Genotypes	45-60DAS	60-75DAS	75-90DAS	90DAS- At harvest	Row mean
Parents					
P1	6.76	8.56	6.23	7.12	7.17
P2	6.37	8.42	7.33	7.98	7.53
P3	6.52	8.52	7.73	8.31	7.77
P4	6.70	8.79	6.92	--	7.47
P5	5.25	7.75	5.37	6.17	6.14
P6	7.42	9.72	7.79	8.81	8.44
P7	5.72	7.94	5.57	6.43	6.42
P8	6.91	8.92	7.79	8.63	8.06
P9	6.92	8.94	7.82	8.71	8.09
P10	7.01	9.52	7.32	8.13	7.99
Crosses					
P1 X P2	5.80	7.92	5.36	--	6.36
P1 X P3	7.23	9.25	7.52	8.56	8.14
P1 X P4	7.23	10.59	7.42	8.31	8.39
P1 X P5	7.56	9.23	7.42	8.39	8.15
P1 X P6	8.25	10.72	8.82	9.73	9.38
P1 X P7	8.65	10.85	8.92	9.81	9.56
P1 X P8	8.84	10.84	8.93	9.72	9.58
P1 X P9	8.32	10.52	8.74	--	9.19
P1 X P10	8.25	9.75	7.82	--	8.60
P2 X P3	7.45	9.49	7.73	--	8.22
P2 X P4	8.01	10.25	8.87	--	9.04
P2 X P5	8.82	9.12	7.73	--	8.55
P2 X P6	7.42	10.42	8.32	9.58	8.94
P2 X P7	8.43	10.75	8.57	9.92	9.42
P2 X P8	7.23	8.79	6.43	--	7.48
P2 X P9	7.25	9.83	7.72	8.32	8.28
P2 X P10	8.33	10.75	8.82	9.52	9.36
P3 X P4	9.23	11.52	8.12	9.17	9.51
P3 X P5	8.32	10.42	8.31	9.13	9.05
P3 X P6	9.25	11.50	10.32	--	10.35
P3 X P7	7.54	10.92	8.58	--	9.01
P3 X P8	9.14	10.52	8.23	9.32	9.30
P3 X P9	7.34	8.56	6.41	7.52	7.46
P3 X P10	9.15	10.45	8.24	--	9.28
P4 X P5	8.85	10.93	8.72	--	9.50
P4 X P6	9.45	11.73	9.57	10.37	10.28
P4 X P7	7.52	9.83	7.73	--	8.36
P4 X P8	7.93	9.99	7.53	--	8.48
P4 X P9	6.52	8.73	7.64	--	7.63
P4 X P10	8.12	9.83	7.72	--	8.55
P5 X P6	9.35	11.42	9.30	10.25	10.08
P5 X P7	7.73	9.83	7.45	--	8.33
P5 X P8	8.35	10.73	8.45	9.12	9.16
P5 X P9	7.43	9.82	8.73	8.55	8.63
P5 X P10	6.62	8.82	6.55	6.13	7.03
P6 X P7	6.61	8.92	6.73	--	7.42
P6 X P8	7.73	9.72	7.83	8.71	8.49
P6 X P9	6.78	8.97	6.73	7.52	7.50
P6 X P10	7.14	9.53	7.43	8.12	8.06
P7 X P8	7.42	9.72	7.83	8.51	8.37
P7 X P9	8.80	10.84	8.64	9.57	9.46
P7 X P10	7.53	9.72	7.93	--	8.39
P8 X P9	6.98	8.99	6.89	7.50	7.59
P8 X P10	7.34	9.49	8.38	--	8.40
P9 X P10	7.93	10.92	7.82	--	8.89
COL.MEAN	7.65	9.79	7.80	8.58	8.30
Group mean					
Parents	6.56	8.71	6.99	7.81	
Crosses	7.89	10.03	7.98	8.85	
Checks					
Madhuri	9.72	11.83	10.72	10.89	
Shaktiman-2	10.52	11.65	9.34	10.43	
Mean	10.12	11.74	10.03	10.66	

CD (A) at 0.05 level = 0.2611

A = Genotypes

CD (B) at 0.05 level = 0.0704

B = Growth stages

Interaction CD (0.05) = 0.5221

A X B = Interaction

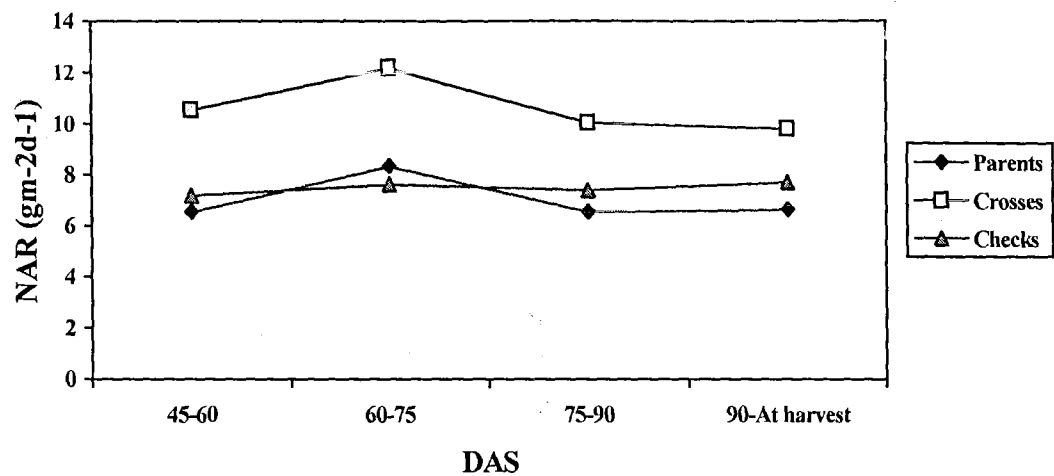


Fig 5a: Net Assimilation Rate in Parents, superior cross and Checks in QPM (kharif Rajendranagar)

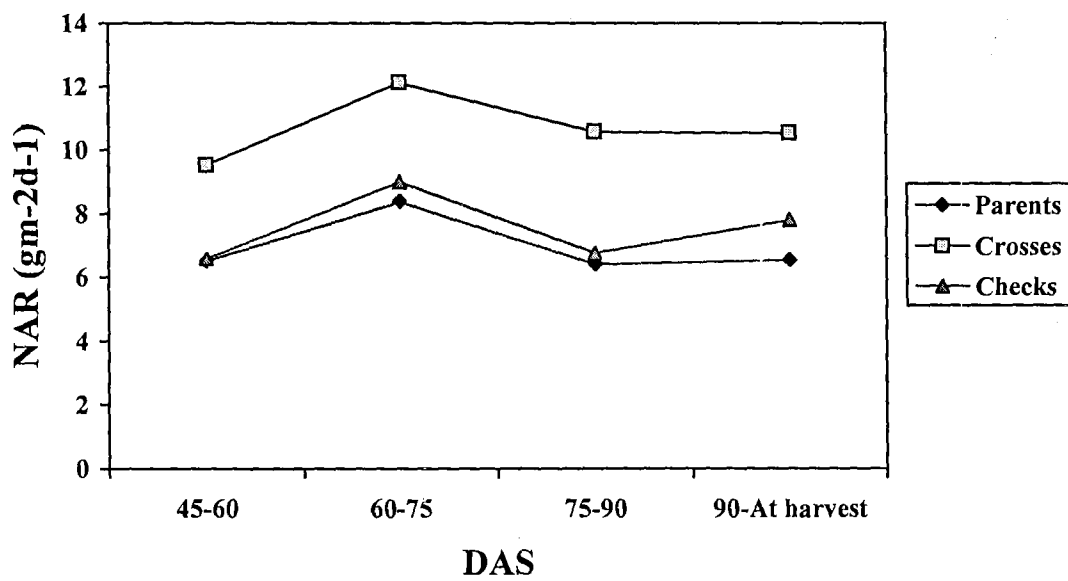


Fig 5b: Net Assimilation Rate in Parents, superior cross and Checks in QPM (Rabi Rajendranagar)

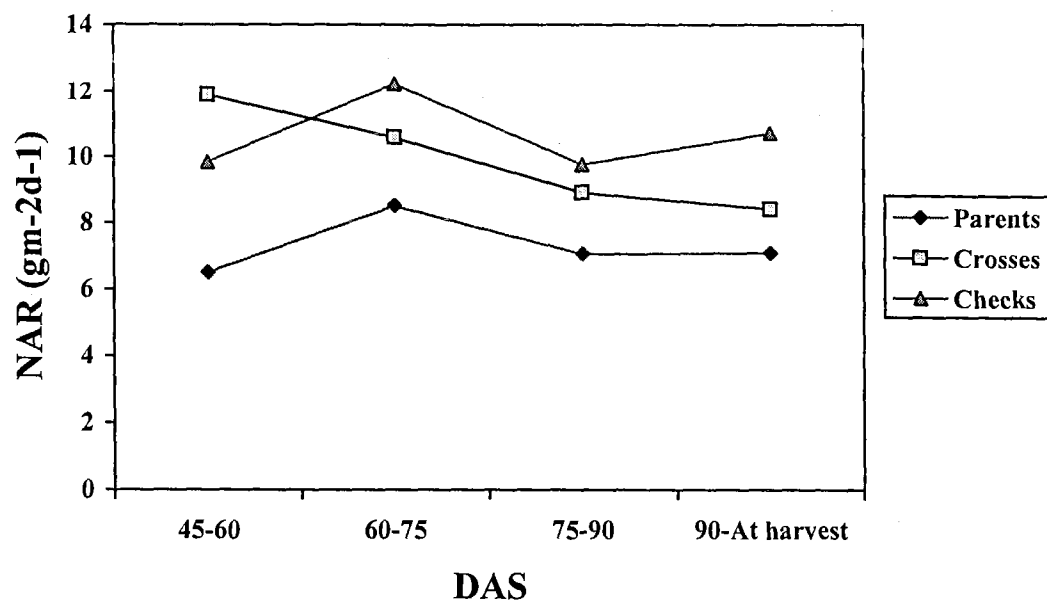


Fig 5c: Net Assimilation Rate in Parents, superior cross and Checks in QPM (Kharif Palem)

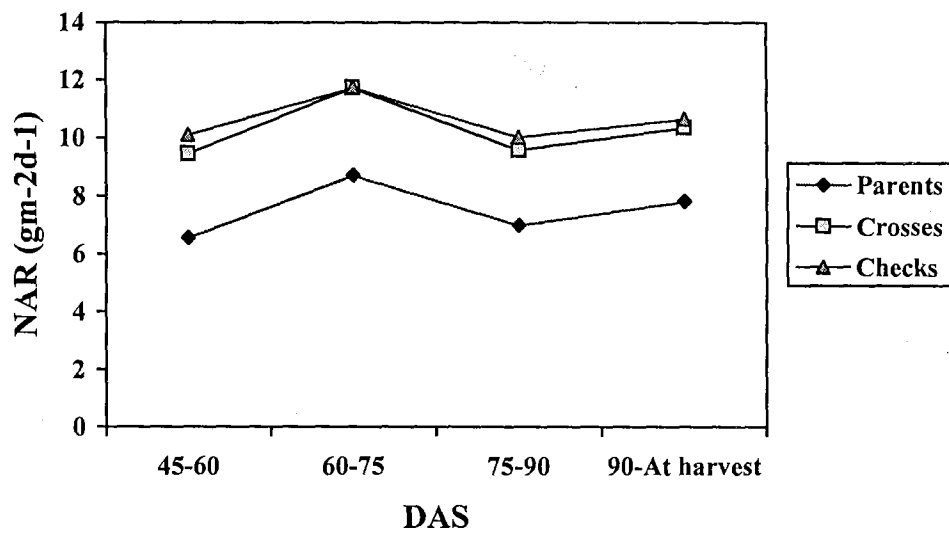


Fig 5d: Net Assimilation Rate in Parents, superior cross and Checks in QPM (Rabi Palem)

DAS and decreased and then remained constant. At flowering stage it ranged from 7.62 (P5) to 9.32 (P6) in parents and 7.77 (P1 X P2) to 12.02 (P3 X P8) in single crosses. Single crosses maintained higher RGR than parents at different stages of crop growth. The checks Madhuri recorded 8.82 whereas Shaktiman-2 recorded 9.56g/m²/day (Fig 5c).

Differences in NAR among the genotypes were significant at Rajendranagar during *Rabi*. Of all the genotypes P3 X P5 and P5 X P6 recorded highest mean NAR (10.68) and the least (6.06) by parental line P3 (Table 7b). There were significant differences among different stages of crop growth also. Highest NAR was recorded at 60-75 DAS and the least at 45-60 DAS. In all the genotypes, NAR increased from 45-60 DAS to 60-75 DAS and decreased and then remained constant. At flowering stage it ranged from 7.5 (P3) to P6 (9.65) in parents and 8.12 (P6 X P7) to 12.34 (P5 X P6) in single crosses. Single crosses maintained higher RGR than parents at different stages of crop growth. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 8.57 and 8.35g/m²/day respectively (Fig 5b).

During *Rabi* at Palem P4 X P6 recorded highest mean NAR (11.73) and the least (7.75) by parental line P5 (Table 7d). There were significant differences among different stages of crop growth also. Highest NAR was recorded at 60-75 DAS and the least at 45-60 DAS. In all the genotypes, NAR increased from 45-60 DAS to 60-75 DAS and decreased and then remained constant. At flowering stage it ranged from 7.75 (P5) to 10.72 (P6) in parents and 7.92 (P1 X P2) to 16.32 (P3 X P4) in single crosses. Single crosses maintained higher RGR than parents at different stages of crop growth. The checks Madhuri recorded 8.23 whereas Shaktiman-2 recorded 9.39g/m²/day (Fig 5d).

4.2.12 Specific leaf weight (SLW) (mg cm⁻²)

The genotypes differed significantly with respect to SLW at Rajendranagar during *Kharif*. Of all the genotypes, mean highest SLW (12.2) was recorded in P2 X

P3 and least (7.20) in P2 (Table 8a). Significant differences were observed among different stages of crop growth. Highest SLW (12.75) was at 90DAS and least at 60 DAS (7.44). In all the genotypes, SLW increased from 60DAS to maturity. Single crosses maintained highest SLW at all growth stages than parents. At flowering 6.53(P2) to 10.2 (P10) in parents and in single crosses P8 X P9 (6.91) to P4 X P5 (11.90). The checks Madhuri recorded 13.40 whereas Shaktiman-2 recorded 12.10 mg/cm² (Fig 6a).

At Palem during *Kharif* the genotypes differed significantly with respect to SLW (Table 8c). Of all the genotypes, mean highest SLW (11.98) was recorded in P2 X P5 and P4 X P7 and least (7.59) in P2. Significant differences were observed among different stages of crop growth. Highest SLW (12.5) was at 90DAS and least (7.02) at 60 DAS. In all the genotypes, SLW increased from 60DAS to maturity. Single crosses maintained highest SLW at all growth stages than parents. At flowering 4.01 (P3) to 7.11 (P8) in parents and in single crosses P4 X P10 (4.01) to P5 X P6 (8.88). Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 11.45 and 13.05 mg/cm² respectively (Fig 6c).

The genotypes differed significantly with respect to SLW at Rajendranagar during *Rabi* (Table 8b). Of all the genotypes, mean highest SLW (12.02) was recorded in P2 X P3 and P3 X P5 and least (7.47) in P2. Significant differences were observed among different stages of crop growth. Highest SLW (12.2) was at 90DAS and least at 60 DAS (7.6). In all the genotypes, SLW increased from 60DAS to maturity. Single crosses maintained highest SLW at all growth stages than parents. At flowering 6.73(P2) to 9.91(P8) in parents and in single crosses P8 X P9 (7.52) to P2 X P3 (11.98). Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 12.14 and 11.41 mg/cm² respectively (Fig 6b).

At Palem during *Rabi* the genotypes differed significantly with respect to SLW (Table 8d). Of all the genotypes, mean highest SLW (12.24) was recorded in P4 X P7 and least (7.33) in P3. Significant differences were observed among different stages of

Genotypes	50DAS	75DAS	90DAS	Row mean
	At harvest			

Parents

P1	6.26	8.12	10.10	11.50	9.01
P2	4.79	6.53	8.12	9.35	7.20
P3	4.25	7.10	9.50	10.12	7.74
P4	6.72	8.12	10.10	--	8.31
P5	7.80	8.80	10.12	11.53	9.56
P6	5.66	8.72	10.35	11.51	9.06
P7	5.15	7.20	10.10	11.82	8.57
P8	7.21	8.72	9.92	10.73	9.15
P9	6.18	7.75	10.13	11.52	8.90
P10	7.70	10.20	12.50	13.20	10.90

Crosses

P1 X P2	8.05	10.10	12.20	--	10.12
P1 X P3	6.42	8.72	10.81	12.13	9.52
P1 X P4	8.25	10.12	12.52	13.71	11.15
P1 X P5	8.40	10.60	12.10	13.41	11.10
P1 X P6	7.96	10.72	12.13	13.80	11.15
P1 X P7	8.10	10.80	13.50	14.63	11.76
P1 X P8	8.01	10.80	11.19	12.52	10.63
P1 X P9	8.20	10.90	13.10	--	10.09
P1 X P10	8.30	11.10	12.90	--	10.76
P2 X P3	8.40	11.20	14.10	--	11.23
P2 X P4	8.50	11.00	13.80	--	11.10
P2 X P5	8.93	10.82	12.91	--	10.88
P2 X P6	4.80	7.10	10.13	11.73	8.44
s2 X P7	8.75	11.60	13.90	14.10	12.09
P2 X P8	8.45	11.10	13.80	--	11.12
P2 X P9	8.10	10.60	12.30	14.10	11.28
P2 X P10	8.20	10.50	12.20	13.50	11.10
P3 X P4	7.00	9.20	11.30	12.50	10.00
P3 X P5	8.80	11.00	13.40	14.13	11.83
P3 X P6	7.50	10.00	11.80	--	9.77
P3 X P7	5.15	7.30	10.20	--	7.55
P3 X P8	8.00	10.30	12.50	13.51	11.08
P3 X P9	8.18	10.50	12.10	13.42	11.05
P3 X P10	8.40	10.90	12.80	--	10.70
P4 X P5	8.80	11.90	13.20	--	11.30
P4 X P6	9.10	11.70	13.80	13.75	12.09
P4 X P7	8.30	10.10	12.20	--	10.20
P4 X P8	8.60	10.80	12.10	--	10.50
P4 X P9	8.90	11.50	13.70	--	11.36
P4 X P10	4.20	8.10	10.20	--	7.50
P5 X P6	9.00	11.60	13.80	13.92	12.08
P5 X P7	5.90	7.80	10.70	--	8.13
P5 X P8	9.00	11.60	13.60	14.31	12.13
P5 X P9	6.80	8.10	10.30	11.13	9.08
P5 X P10	7.96	9.32	11.40	12.72	10.35
P6 X P7	7.50	9.30	11.10	--	9.30
P6 X P8	8.93	10.82	12.91	13.51	11.54
P6 X P9	6.99	9.12	11.73	11.98	9.96
P6 X P10	5.74	7.81	10.72	11.81	9.02
P7 X P8	7.04	9.13	11.23	12.13	9.88
P7 X P9	8.24	10.12	12.72	13.12	11.05
P7 X P10	8.10	10.20	12.80	--	10.37
P8 X P9	5.80	6.91	8.12	9.72	7.64
P8 X P10	5.34	7.80	10.10	--	7.75
P8 X P10	8.65	11.40	13.40	--	11.15

COL. MEAN	7.45	9.70	11.80	12.55	9.98

Group mean

Parents	6.17	8.26	10.09	11.26
Crosses	7.73	10.05	12.17	16.26

Checks

Madhuri	8.80	11.20	13.40	14.31
shaktiman-2	7.46	9.89	12.10	13.50
Mean	8.15	10.55	12.75	13.91

CD (A) at 0.05 level = 0.3033

CD (B) at 0.05 level = 0.0818

Interaction CD (0.05) = 0.6066

A =

B =

A X B =

Genotypes

Growth stages

Interaction

Table 8b: Specific Leaf Weight (SLW) in QPM (Rabi 2002-03, Rajendranagar)

(mg cm^{-2})

Genotypes	60DAS	75DAS	90DAS	At harvest	Row mean
Parents					
P1	6.72	8.91	10.19	11.01	9.21
P2	4.91	6.73	8.42	9.81	7.47
P3	4.82	6.84	8.91	9.84	7.60
P4	6.81	8.91	9.99	--	8.57
P5	7.15	8.45	10.92	11.17	9.42
P6	5.81	7.92	9.31	10.45	8.37
P7	5.32	8.35	10.45	11.51	8.91
P8	7.81	9.91	11.13	12.18	10.26
P9	6.55	7.85	9.19	11.01	8.65
P10	7.18	9.51	11.81	12.81	10.33
Crosses					
P1 X P2	7.31	10.13	11.48	--	9.64
P1 X P3	8.51	10.81	12.17	12.99	11.12
P1 X P4	6.91	8.18	10.73	11.51	9.33
P1 X P5	8.50	10.41	11.81	12.91	10.91
P1 X P6	8.41	10.13	12.42	13.31	11.07
P1 X P7	7.81	9.01	10.49	11.50	9.70
P1 X P8	8.51	10.65	12.13	13.81	11.28
P1 X P9	8.42	10.13	12.73	--	10.43
P1 X P10	8.60	10.71	11.92	--	10.41
P2 X P3	8.91	11.98	13.18	--	11.36
P2 X P4	8.32	10.15	12.42	--	10.29
P2 X P5	8.82	10.88	12.95	--	10.88
P2 X P6	4.51	7.82	10.13	11.91	8.59
P2 X P7	8.92	10.13	12.41	13.14	11.15
P2 X P8	8.82	10.51	12.81	--	10.71
P2 X P9	8.51	10.41	11.89	12.08	10.72
P2 X P10	8.37	9.95	11.51	12.81	10.66
P3 X P4	7.51	9.13	10.92	11.51	9.77
P3 X P5	8.85	11.50	13.50	14.21	12.02
P3 X P6	7.15	9.41	11.98	--	9.51
P3 X P7	5.92	7.91	8.99	--	7.61
P3 X P8	8.34	10.14	11.71	12.55	10.69
P3 X P9	8.32	9.95	10.99	11.99	10.31
P3 X P10	8.51	10.14	11.92	--	10.19
P4 X P5	8.72	11.12	13.13	--	10.99
P4 X P6	9.32	10.43	12.14	13.71	11.40
P4 X P7	8.51	9.15	11.13	--	9.59
P4 X P8	8.77	10.71	11.98	--	10.49
P4 X P9	8.81	10.13	11.83	--	10.26
P4 X P10	4.51	7.85	9.99	--	7.45
P5 X P6	9.42	11.53	12.81	13.89	11.91
P5 X P7	5.92	8.13	10.12	--	8.06
P5 X P8	9.45	11.34	13.12	14.10	12.00
P5 X P9	6.32	8.13	9.84	10.99	8.82
P5 X P10	7.99	9.13	11.12	12.83	10.27
P6 X P7	7.32	9.41	11.52	--	9.42
P6 X P8	8.98	9.91	11.52	12.81	10.81
P6 X P9	6.78	9.13	10.92	11.99	9.71
P6 X P10	5.92	7.73	9.45	10.54	8.41
P7 X P8	7.43	9.14	10.98	11.99	9.89
P7 X P9	8.81	10.18	12.10	12.99	11.02
P7 X P10	8.34	10.41	11.92	--	10.22
P8 X P9	5.45	7.52	9.81	10.81	8.40
P8 X P10	5.81	8.17	10.23	--	8.07
P9 X P10	8.92	10.27	11.72	--	10.30
COL.MEAN	7.59	9.51	11.29	11.47	9.90
Group mean					
Parents	6.31	8.34	10.03	11.09	
Crosses	7.87	9.77	11.57	12.57	
Checks					
Madhuri	8.48	10.35	12.14	14.01	
Shaktiman-2	7.91	9.65	11.41	12.82	
Mean	8.19	10.00	11.77	13.42	

CD (A) at 0.05 level = 0.2824

CD (B) at 0.05 level = 0.0762

Interaction CD (0.05) = 0.5647

A =

B =

A X B =

Genotypes

Growth stages

Interaction

Table8c: Specific Leaf Weight (SLW) in QPM (Kharif 2003, Palem)
(mg cm⁻²)

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Genotypes	60DAS	75DAS	90DAS	Row mean	
At harvest					
Parents					
P1	6.12	8.73	10.14	11.73	9.18
P2	4.52	6.14	8.79	10.91	7.59
P3	4.01	6.51	8.93	10.99	7.61
P4	6.31	7.81	9.92	--	8.01
P5	7.02	10.01	12.45	13.13	10.65
P6	5.31	7.42	9.91	10.82	8.37
P7	5.04	6.94	8.99	9.72	7.67
P8	7.11	8.01	10.74	11.94	9.45
P9	6.02	9.01	11.08	12.05	9.54
P10	7.01	9.51	11.85	12.91	10.32
Crosses					
P1 XP2	7.81	9.53	10.99	--	9.44
P1 XP3	6.18	8.92	11.99	12.89	9.99
P1 XP4	8.12	10.53	12.85	13.90	11.35
P1 XP5	7.32	9.42	11.75	12.85	10.34
P1 XP6	7.52	9.02	10.42	11.82	9.70
P1 XP7	8.01	10.51	11.91	12.81	10.81
P1 XP8	8.05	10.41	12.02	13.04	10.88
P1 XP9	8.10	11.01	13.55	--	10.88
P1 XP10	8.01	9.81	11.01	--	9.61
P2 XP3	7.89	10.91	12.53	--	13.45
P2 XP4	8.50	9.85	11.95	--	10.10
P2 XP5	8.20	11.01	13.81	--	11.00
P2 XP6	4.02	9.01	12.01	13.95	9.75
P2 XP7	8.81	10.81	12.91	13.99	11.63
P2 XP8	8.13	11.01	12.05	--	10.39
P2 XP9	8.01	9.05	11.41	12.48	10.24
P2 XP10	8.11	10.01	12.55	12.85	10.88
P3 XP4	6.51	8.52	10.51	11.85	9.35
P3 XP5	8.12	10.11	12.01	13.72	10.99
P3 XP6	6.85	7.99	10.15	--	8.33
P3 XP7	5.01	8.02	10.01	--	7.68
P3 XP8	7.71	9.91	11.82	12.92	10.59
P3 XP9	8.01	11.05	12.01	13.05	11.03
P3 XP10	8.02	9.95	11.91	--	9.96
P4 XP5	8.20	10.12	12.72	--	10.34
P4 XP6	8.01	10.01	12.05	13.15	10.81
P4 XP7	8.72	11.61	13.15	--	11.16
P4 XP8	7.95	10.91	12.51	--	10.45
P4 XP9	8.30	9.70	11.58	--	9.86
P4 XP10	4.01	7.81	9.82	--	7.21
P5 XP6	8.88	10.81	11.72	12.81	11.06
P5 XP7	5.01	7.92	9.81	--	7.58
P5 XP8	8.53	10.23	12.14	13.71	11.15
P5 XP9	6.01	8.23	9.98	10.98	8.80
P5 XP10	7.51	9.91	11.83	12.92	10.54
P6 XP7	7.10	9.51	11.91	--	9.51
P6 XP8	6.82	9.12	11.71	11.93	9.89
P6 XP9	6.41	8.51	10.34	11.58	9.21
P6 XP10	5.01	8.05	10.01	11.08	8.54
P7 XP8	6.45	8.15	10.13	12.42	9.29
P7 XP9	8.14	10.75	12.14	13.02	11.01
P7 XP10	7.81	10.67	13.51	--	10.66
P8 XP9	4.91	7.01	9.52	11.17	8.15
P8 XP10	5.14	8.17	11.23	--	8.18
P9 XP10	7.81	9.81	10.99	--	9.54
COL.MEAN	7.02	9.34	11.38	12.38	9.81
Group mean					
Parents	5.85	8.01	10.28	11.58	
Crosses	7.28	9.63	11.62	12.68	
Checks					
Madhuri	7.81	9.15	11.45	12.99	
Shaktiman-2	7.16	10.09	13.05	13.78	
Mean	7.49	9.62	12.25	13.39	

CD (A) at 0.05 level = 0.2575

CD (B) at 0.05 level = 0.0694

Interaction CD (0.05) = 0.5149

A =

B =

A X B =

Genotypes

Growth stages

Interaction

(mg cm⁻²)

Genotypes	60DAS	75DAS	90DAS	At harvest	Row mean
Parents					
P1	6.44	8.34	10.14	11.20	9.03
P2	4.98	6.99	8.24	10.41	7.66
P3	4.38	6.45	8.53	9.94	7.33
P4	6.72	8.95	10.15	--	8.60
P5	7.46	9.64	11.82	12.90	10.46
P6	5.75	7.41	9.81	11.20	8.54
P7	5.43	8.34	9.42	10.92	8.53
P8	7.75	8.55	9.72	11.82	9.46
P9	6.62	8.74	9.98	10.92	9.07
P10	7.62	10.14	12.73	13.82	11.08
Crosses					
P1 X P2	7.92	10.51	12.81	--	10.41
P1 X P3	6.78	8.91	10.73	11.82	9.56
P1 X P4	7.81	9.92	11.85	12.92	10.63
P1 X P5	7.90	10.34	12.13	13.74	11.03
P1 X P6	7.93	9.57	11.75	12.91	10.54
P1 X P7	8.52	10.41	12.48	13.82	11.31
P1 X P8	8.65	10.54	12.85	13.91	11.49
P1 X P9	8.70	11.65	13.52	--	11.29
P1 X P10	8.40	10.50	12.48	--	10.46
P2 X P3	7.98	9.84	11.98	--	9.93
P2 X P4	8.51	11.43	12.89	--	10.94
P2 X P5	8.65	10.51	12.82	--	10.66
P2 X P6	4.43	7.74	10.52	11.85	8.64
P2 X P7	8.98	9.84	11.63	12.92	10.84
P2 X P8	8.52	10.74	12.82	--	10.69
P2 X P9	8.42	10.51	12.82	13.92	11.42
P2 X P10	7.99	9.53	11.42	12.98	10.48
P3 X P4	6.89	8.65	10.57	11.87	9.50
P3 X P5	6.98	8.45	10.91	11.99	9.58
P3 X P6	6.93	8.74	11.42	--	9.03
P3 X P7	5.42	7.82	9.81	--	7.68
P3 X P8	7.92	9.73	11.37	12.88	10.48
P3 X P9	8.43	10.44	12.51	13.72	11.28
P3 X P10	8.51	10.81	13.11	--	10.81
P4 X P5	8.48	11.03	12.98	--	10.83
P4 X P6	8.52	10.32	12.14	13.73	11.19
P4 X P7	8.98	11.05	13.95	--	11.32
P4 X P8	7.99	9.85	11.90	--	9.91
P4 X P9	8.32	10.41	12.82	--	10.51
P4 X P10	4.44	7.15	10.01	--	7.20
P5 X P6	8.91	9.81	11.92	12.64	10.82
P5 X P7	5.35	7.53	9.82	--	7.56
P5 X P8	8.60	10.41	12.12	13.84	11.24
P5 X P9	6.56	9.43	11.82	12.91	10.18
P5 X P10	7.85	9.85	11.52	12.78	10.50
P6 X P7	7.53	10.05	11.45	--	9.67
P6 X P8	7.01	9.46	11.82	12.23	10.13
P6 X P9	6.82	9.56	10.87	11.74	9.75
P6 X P10	5.55	8.43	10.93	11.85	9.19
P7 X P8	6.93	9.14	11.73	12.85	10.16
P7 X P9	8.65	10.57	11.75	12.57	10.89
P7 X P10	7.94	9.83	11.38	--	9.72
P8 X P9	5.01	7.21	9.63	11.42	8.32
P8 X P10	5.64	7.64	9.84	--	7.71
P9 X P10	8.05	10.12	12.23	--	10.13
COL.MEAN	7.34	9.45	11.46	12.44	9.63
Group mean					
Parents	6.32	8.36	10.05	11.49	

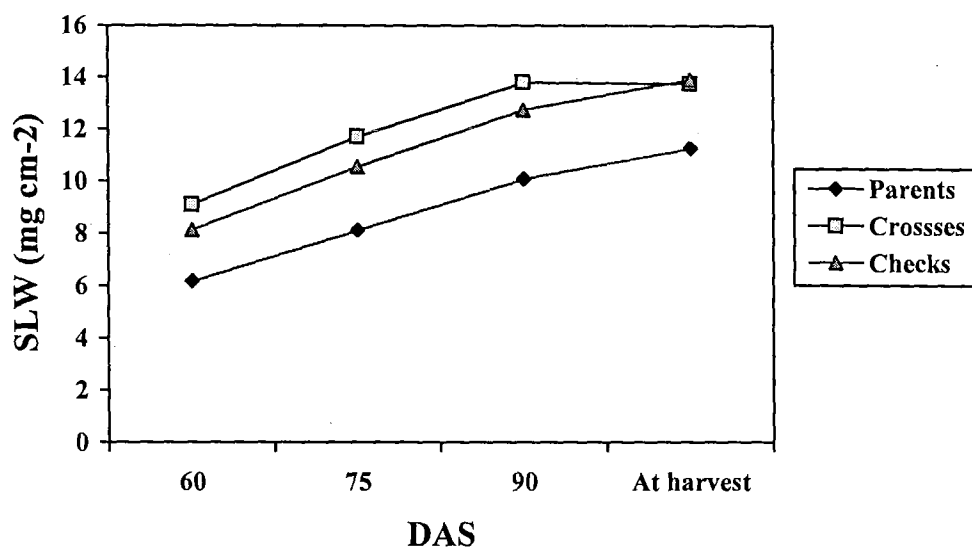


Fig 6a: Specific Leaf Weight in Parents, superior cross and Checks in QPM (Kharif Rajendranagar)

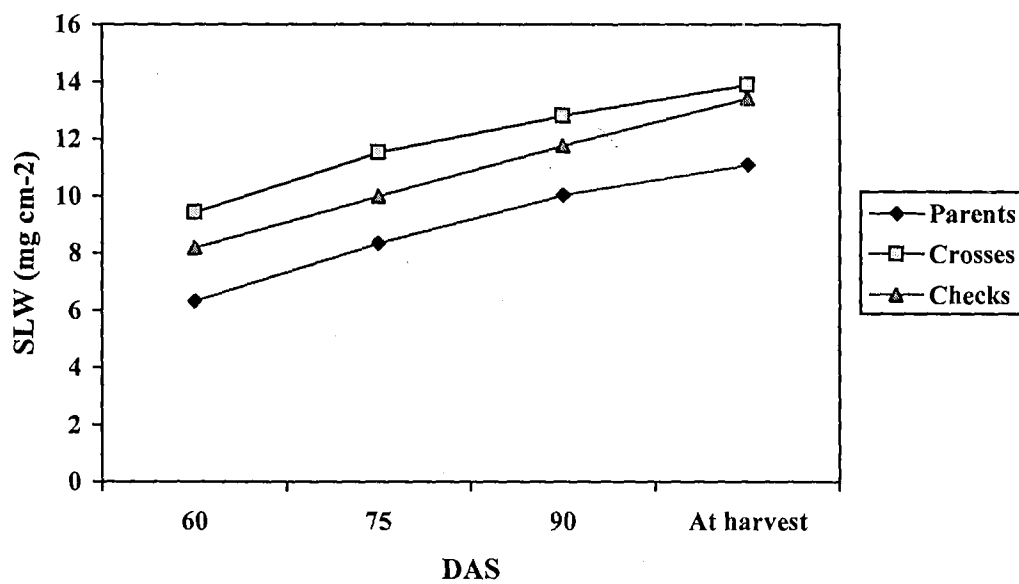


Fig 6b: Specific Leaf Weight in Parents, superior cross and Checks in QPM (Rabi Rajendranagar)

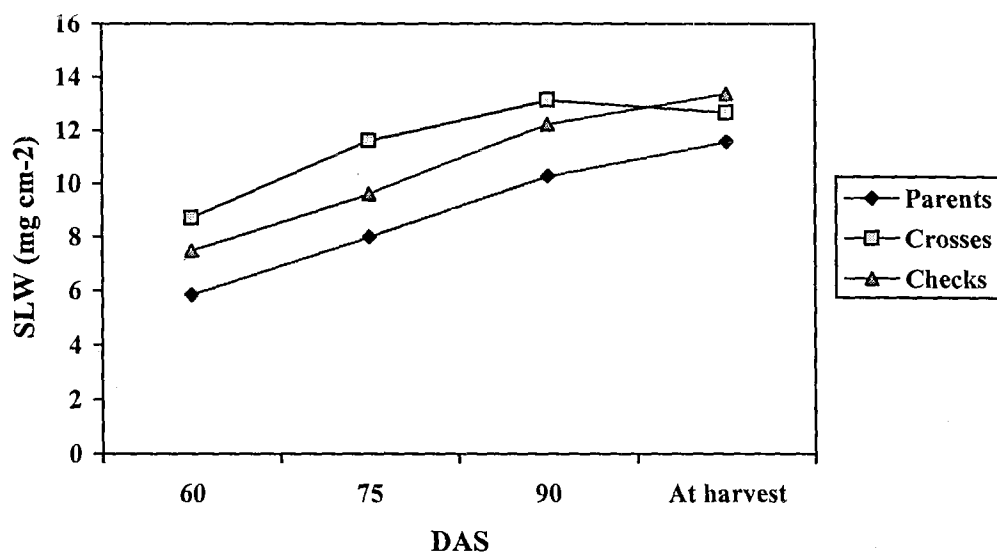


Fig 6c: Specific Leaf weight in Parents, superior cross and Checks in QPM (Kharif Palem)

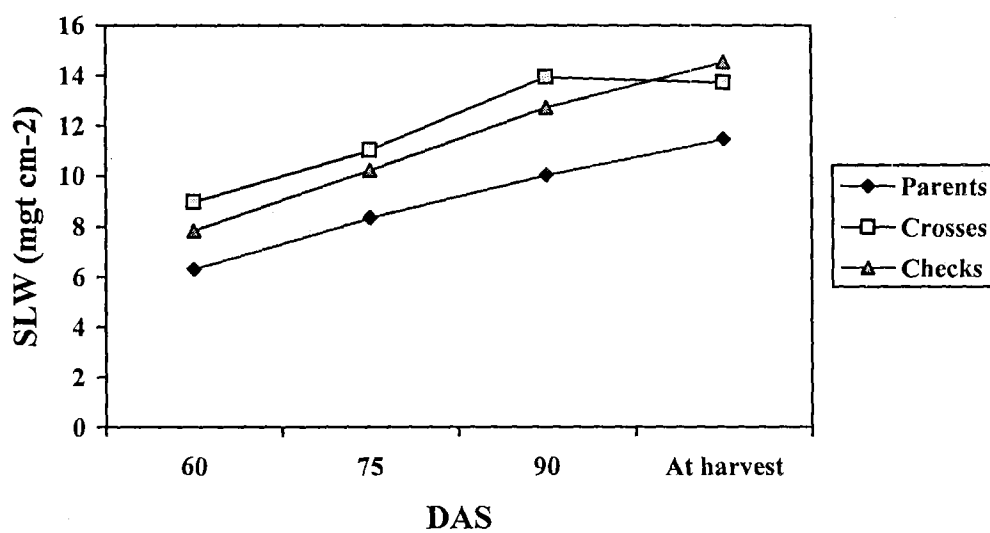


Fig 6d: Specific Leaf Weight in Parents, superior cross and Checks in Parents, Crosses and Checks in QPM (Rabi Palem)

crop growth. Highest SLW (12.70) was at 90DAS and least (7.6) at 60 DAS. In all the genotypes, SLW increased from 60DAS to maturity. At flowering 6.73(P2) to 9.91 (P8) in parents and in single crosses P8 X P9 (7.52) to P2 X P3 (11.98). Single crosses maintained highest SLW at all growth stages than parents. The checks Madhuri recorded 13.01 whereas Shaktiman-2 recorded 12.44 mg/cm² (Fig 6d).

4.2.13 Total bio mass (Kg/plot)

The mean values for parents ranged from 1.75 to 4.48 kg/plot during *Kharif* at Rajendranagar. The average value of parents was 2.25 kg/plot, while the mean values of hybrids ranged from 1.98 to 4.43 kg/plot with an average of 3.51 kg/plot. The parent P8 recorded maximum value of 2.82 kg/plot. In cross combination P4 X P5 recorded maximum value of 4.43 kg/plot which is superior over the checks., while the checks recorded 2.96 and 4.04 respectively.

The range of mean values for parents was from 1.69 to 4.20 kg/plot during *Kharif* at Palem. The average value of parents was 2.31 kg/plot with the parental line P5 recording maximum value of 2.84 kg/plot. The mean value for crosses it was 2.64 to 4.2 kg/plot with an average of 3.70 kg/plot. Among the crosses P8 X P10 recorded 4.2 kg/plot which is superior over the checks.. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 3.65 and 4.5 respectively.

The range of mean values for this character was from 1.73 to 4.53 kg/plot cm during *Rabi* at Rajendranagar. The average value of parents was 2.22 kg/plot, while for crosses it was 3.74 kg/plot. The parent P10 recorded maximum value of 2.6 kg/plot. Among the crosses P4 X P6 recorded 4.53 kg/plot which is significantly superior over the checks.. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 3.18 and 3.85, respectively.

During *Rabi* at Palem, the mean values of parents ranged from 1.50 to 4.28 kg/plot. The average value for parents was 2.16 kg/plot, while for crosses it was

3.68 kg/plot. The parent P4 recorded maximum value of 2.51 kg/plot. Among the crosses P5X P8 recorded maximum value of 4.28 kg/plot which is same as one of the check.. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 3.4 and 4.3 respectively.

4.2.14 Total Chlorophyll content (mg/g)

The mean values for was character ranged from 1.11 to 1.62 mg/g during *Kharif* at Rajendranagar. The average of parents was 1.29mg/g while the average of hybrids was 1.39mg/g. The maximum chlorophyll content was recorded by parent P10 (1.40 mg/g) and in the crosses P4 X P6 recorded maximum chlorophyll content of 1.62 mg/g which is significantly superior over the checks. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 1.45 and 1.57 respectively

The range of mean values for parents was from 1.14 to 1.68 mg/g during *Kharif* at Palem. The average of parents was 1.32mg/g while the average for crosses was 1.44mg/g. The maximum chlorophyll content recorded by parent P10 (1.46 mg/g) and in the crosses P1 X P10 recorded maximum chlorophyll content of 1.68 mg/g which is superior over the checks. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 1.49 and 1.61 respectively.

The range of mean values of parents for this character was from 1.09 to 1.64 mg/g during *Rabi* at Rajendranagar. The mean value for parents was 1.25 mg/g while for crosses, it ranged from 1.15 to 1.64mg/g with an average of 1.37mg/g, the maximum chlorophyll content was recorded by parent P10 (2.6mg/g) and in the crosses P4 X P6 recorded maximum chlorophyll content of 1.64 mg/g which is superior over the checks. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 1.42 and 1.51 respectively.

During *Rabi* at Palem, the range was from 1.07 to 1.58 mg/g. The mean value for parents was 1.25mg/g, while for crosses it was 1.37mg/g. The maximum

chlorophyll content recorded by parent P4 (1.37 mg/g) and in the crosses P1 X P10 recorded maximum chlorophyll content of 1.58 mg/g which is superior over the checks. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 1.42 and 1.51 respectively

4.2.15 Harvest index (%)

The range of mean values for harvest index was from 28.46 to 52.33 during *Kharif* at Rajendranagar. The mean for parents was 46.77, while for crosses it was 44.63. The parent P5 recorded highest harvest index of 52.33, among the crosses P4 X P5 recorded 48.55 which is significantly superior over the checks. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 46.1 and 42.7 respectively.

During *Kharif* at Palem the range of mean values for harvest index was from 35.50 to 56.10. The mean value for parents was 48.13, while for crosses it was 47.44. The parent P5 recorded highest harvest index of 56.10, among the crosses P7 X P9 recorded 55.26 which are significantly superior over the checks.. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 42.4 and 48.8 respectively.

The range of mean values for harvest index was from 28.39 to 53.48 during *Rabi* at Rajendranagar .The average mean value for parents were 47.73 while for crosses, it was 44.26. The parent P5 recorded highest harvest index of 53.48, among the crosses P4 X P5 recorded 50.65 which is significantly superior over the checks.. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 38.1 and 45.5 respectively.

During *Rabi* at Palem the range of mean values for harvest index was from 36.67 to 54.54%. The mean value for parents was 49.29, while for crosses it was 47.49. The parent P1 recorded highest harvest index of 54.54, among the crosses P4 X P6 recorded 53.5% which is significantly superior over the checks.. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 39.3 and 47.2 respectively.

4.2.16 Seed Protein content (%)

The range of mean values for protein percent was from 9.10 to 12.00 during *Kharif* at Rajendranagar. The average mean value for parents was 10.50, while for crosses it was 10.30. The parents P2, P4 and P9 recorded highest protein percent of 11.1 and among the crosses P4 X P8 recorded 12.00. No cross out yielded check. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 12.1 and 11.7 respectively.

During *Kharif* at Palem the range of mean values for protein percent was from 9.02 to 12.30. The average mean value for parents was 10.54, while for crosses it was 10.43. The parent P4 and P9 recorded highest protein content of 11.2, among the crosses P4 X P8 recorded 12.3 which is same as one of the check.. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 12.3 and 11.8 respectively.

The range of mean values for protein percent was from 9.13 to 12.5 during *Rabi* at Rajendranagar. The average mean value for parents was 10.54, while for crosses it was 10.43. The parent P2 and P4 recorded highest protein percent of 9.2, among the crosses P4 X P8 recorded 12.5 which is same as Madhuri, followed by P5 XP10 (12.01). Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded maximum of 12.5 and 12.0%, respectively.

During *Rabi* at Palem the range of mean values for protein content was from 9.22 to 12.31. The mean for parents was 10.52, while for crosses it was 10.42. The parent P4 recorded highest protein content of 11.25; among the crosses P4 X P8 recorded 12.3. It recorded same protein content as one of the check. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 12.3 and 11.9 respectively.

4.2.17 Seed protein yield (kg/ha)

The range of mean values for seed protein yield was from 277.50 to 875.33 during *Kharif* at Rajendranagar. The mean for parents was 406.17, while for crosses it

was 605.84. The parent P5 recorded highest seed protein yield/ha of 566.5 and among the crosses P4 X P6 recorded 875.3 which is significantly superior over the checks. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 435.4 and 702.0 respectively.

During *Kharif* at Palem the range of mean values for seed protein yield was from 324.80 to 905.67. The mean for parents was 433.44, while for crosses it was 703.4. The parent P5 recorded highest seed protein yield/ha of 555.5, among the crosses P4 X P6 recorded 905.7 which is significantly superior over the checks. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 578.1 and 944.0 respectively.

The range of mean values for seed protein yield was from 308.00 to 915.40 during *Rabi* at Rajendranagar. The average mean value for parents was 431.15, while for crosses it was 641.18. The parent P5 recorded highest seed protein yield/ha of 591.6. Among the crosses P4 X P6 recorded 915.4 which is significantly superior over the checks. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 475 and 768kg/ha respectively.

During *Rabi* at Palem the range of mean values for seed protein yield was from 315.00 to 944.42. The mean for parents was 438.41, while for crosses it was 710.11. The parent P5 recorded highest seed protein yield/ha of 571.2. Among the crosses P5 X P8 recorded 944.2 which is significantly superior over the checks which is superior over the checks. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 617.5 and 831.3 respectively.

4.2.18 Oil content (%)

The range of mean values for oil percent was from 5.20 to 7.50 during *Kharif* at Rajendranagar. The mean for parents was 6.50, while for crosses it was 6.60. The parent P4 recorded highest oil percent of 7.1. Among the crosses P1 X P8 recorded 7.5

which is superior over the checks Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 7.20 and 6.92 respectively.

During *Kharif* at Palem the range of mean values for oil percent was from 5.22 to 7.94. The mean for parents was 6.63, while for crosses it was 6.81. The parent P3 recorded highest oil per cent of 7.14, among the crosses P1 X P8 recorded 7.94 which is superior over the checks. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 7.25 and 6.72 respectively.

Among the entries the mean values ranged from 5.07 to 7.94 during *Rabi* at Rajendranagar. The average mean value for parents was 6.63, while for crosses it was 6.81. The parent P4 recorded highest oil percent of 7.0; among the crosses P1 X P8 recorded 7.94 which was significantly superior over checks. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 7.12 and 6.71 respectively.

During *Rabi* at Palem the range of mean values for oil percent was from 5.60 to 8.14. The mean for parents was 6.76, while for crosses it was 7.08. The parent P4 recorded highest oil percent of 7.23 and among the crosses P1 X P8 recorded 8.14% which was superior over the checks. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 7.02 and 6.89 respectively.

4.2.19 Oil yield (kg/ha)

The range of mean values for oil yield was from 163.20 to 599.25 during *Kharif* at Rajendranagar. The parental mean was 250.45 while, for crosses, it was 385.89. The parent P8 recorded highest oil yield/ha of 341.7; among the crosses P4 X P6 recorded significantly superior over checks (599.25 kg/ha). Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 288 and 390 respectively.

During *Kharif* at Palem the range of mean values for oil yield/ha was from 205.90 to 629.44. The mean for parents was 273.02 while for crosses, it was 461.31,

the parent P8 recorded highest oil yield/ha of 357, among the crosses P4 X P6¹⁴⁹ recorded 629.4 which was significantly superior over the checks. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 376.0 and 537.6 respectively.

The range of mean values for oil yield was from 182.50 to 659.58 during *Rabi* at Rajendranagar. The average mean value for parents was 270.39, while for crosses it was 428.89. The parent P5 recorded highest oil yield/ha of 360.18, among the crosses P4 X P7 recorded 659.58 followed by P1 X P10 recorded 635.04 which was significantly superior over the checks. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 310.8 and 430.7 respectively.

During *Rabi* at Palem the range of mean values for oil yield was from 211.50 to 637.96. The mean for parents was 283.13 while for crosses; it was 481.28. The parent P5 recorded highest oil yield/ha of 364.00. Among the crosses P1 X P10 recorded 637.96 which is significantly superior over the checks. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 412.5 and 575.4 respectively.

4.2.20 Tryptophan content (g /16 g N)

The range of mean values for tryptophan content was from 0.52 to 0.86 during *Kharif* at Rajendranagar. The mean for parents and crosses was 0.67, the parent P9 recorded highest tryptophan content of 0.86 and among the crosses P1 X P9 recorded 0.85 which was significantly superior over the checks. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 0.70 and 0.81g/16gN respectively.

During *Kharif* at Palem the range of mean values for tryptophan content was from 0.53 to 0.87. The mean for both parents and crosses was 0.68, the parent P9 recorded highest tryptophan content of 0.87 which was significantly superior over the checks and among the crosses P3 X P9 recorded 0.84 which is same as one of the

check. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 0.71 and 0.84 respectively. 150

The range of mean values for tryptophan content was from 0.52 to 0.87 during *Rabi* at Rajendranagar. The average mean value for parents and crosses was 0.67, the parent P9 recorded highest tryptophan content 0.87 which was significantly superior over the checks and among the crosses P3 X P9 recorded 0.83g/16gN which is same as one of the check. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 0.70 and 0.83 respectively.

During *Rabi* at Palem the range of mean values for tryptophan content was from 0.52 to 0.87. The mean for parents was 0.68 and crosses was 0.68, the parent P9 recorded highest tryptophan content of 0.87 which was superior over the checks, among the crosses P4 X P9, P3 X P9 and P2 X P9 recorded 0.83. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 0.71 and 0.86g/16gN respectively.

4.2.21 Grain Yield (Kg/ plot)

The range of mean values for grain yield/plot was from 1.32 to 4.27kg/plot during *Kharif* at Rajendranagar. The mean for parents was 1.96 while for crosses, it was 2.99, the parent P5 recorded highest yield/plot of 2.65, and among the crosses P4 X P6 recorded 4.27 which was significantly superior over the checks.. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 1.99 and 3.06kg respectively.

During *Kharif* at Palem the range of mean values for grain yield/plot was from 1.45 to 4.35. The mean for parents was 2.15 while for crosses, it was 3.41 the parent P5 recorded highest yield/plot of 2.75kg; among the crosses P4 X P6 recorded 4.35kg/plot which was superior over the checks. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 2.34 and 4.01kg respectively.

The range of mean values for grain yield/plot was from 1.31 to 4.39kg/plot during *Rabi* at Rajendranagar. The average mean value for parents was 2.06 while for crosses, it was 3.11, the parent P5 recorded highest yield/plot of 2.89, and among the crosses P4 X P6 recorded 4.39 which is significantly superior over the checks. which was significantly superior over the checks. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 1.90 and 3.61 respectively.

During *Rabi* at Palem the range of mean values for grain yield/plot was from 1.40 to 4.32. The mean for parents was 2.09 while for crosses, it was 3.41, the parent P5 recorded highest yield/plot of 2.8, and among the crosses P4 X P6 recorded 4.32 which was superior over the checks. Standard checks *Viz.*, Madhuri and Shaktiman-2 recorded 2.52 and 4.25 respectively.

4.3 COMBINING ABILITY ANALYSIS

Mean sum of squares, variances of *GCA* and *SCA* along with nature of gene action are presented in Table 9.

The mean sum of square of both *GCA* and *SCA* were found to be significant for all the characters studied except ASI

4.3.1 General combining ability effects

The *GCA* effects estimated for the inbred lines on various characters are presented in Table 10.

4.3.1.1 Days to 50 per cent tasseling

At Rajendranagar during *Kharif* the *GCA* effects for this character ranged between -2.38 days (P4) and 1.31days (P9). Parental lines P1, P2, P3, P4 and P10 exhibited significantly negative *GCA* effects. In contrast, P5, P6, P8 and P9 recorded significantly positive *GCA* effects while at Palem the *GCA* effects for this character

Table 9: Analysis of variance for combining ability for 21 characters in QPM at four locations

Source of variation	df	Days to 50% tasseling						Days to 50% silking					
		Rajendranagar			Palem			Rajendranagar			Palem		
		Kharif	Rabi		Kharif	Rabi		Kharif	Rabi		Kharif	Rabi	
GCA	9	14.18**	24.90**		11.56**	11.93**		12.47**	26.70**		12.64**	10.97**	
SCA	45	10.99**	14.76**		10.38**	16.67**		11.15**	14.59**		9.86**	16.72**	
ERROR	108	0.15	1.05		1.04	1.46		0.22	1.23		1.13	1.20	
σ^2_{gca}		0.0127	0.0882		0.0874	0.1222		0.0188	0.1035		0.0949	0.1012	
σ^2_{sca}		0.1438	0.9977		0.9891	1.3820		0.2122	1.1713		1.0734	1.1448	
$\sigma^2_{gca/sca}$		0.0880	0.0880		0.0830	0.0884		0.0880	0.0880		0.0884	0.0883	

Source of variation	df	ASI						Days to maturity					
		Rajendranagar			Palem			Rajendranagar			Palem		
		Kharif	Rabi		Kharif	Rabi		Kharif	Rabi		Kharif	Rabi	
GCA	9	0.13NS	0.44NS		0.21NS	0.77**		13.79**	21.57**		18.09**	11.42**	
SCA	45	0.08NS	0.38NS		0.38NS	0.20NS		9.98**	13.25**		11.38**	15.56**	
ERROR	108	0.08	0.30		0.31	0.18		0.65	1.52		1.77	2.90	
σ^2_{gca}		0.0070	0.0253		0.0264	0.0152		0.0548	0.1271		0.1484	0.2439	
σ^2_{sca}		0.0794	0.2867		0.2984	0.1717		0.6198	1.4382		1.6789	2.7589	
$\sigma^2_{gca/sca}$		0.0880	0.0880		0.0885	0.0885		0.0884	0.0880		0.0884	0.0884	

Source of variation	df	Plant height						Ear height					
		Rajendranagar			Palem			Rajendranagar			Palem		
		Kharif	Rabi		Kharif	Rabi		Kharif	Rabi		Kharif	Rabi	
GCA	9	1218.58**	488.17**		602.61**	473.98**		254.11**	260.35**		253.42**	215.10**	
SCA	45	461.90**	588.24**		512.67**	563.70**		188.27**	196.81**		133.19**	129.24**	
ERROR	108	6.72	30.69		5.78	6.71		0.60	3.48		6.13	4.35	
σ^2_{gca}		0.0505	2.5726		0.4850	0.5627		0.0505	0.2922		0.5139	0.3649	
σ^2_{sca}		0.5718	29.1041		5.4864	6.3659		0.5718	3.3054		5.8137	4.1280	
$\sigma^2_{gca/sca}$		0.0880	0.0880		0.0884	0.0883		0.0880	0.0884		0.0884	0.8830	

Source of variation	df	LAI						LDW					
		Rajendranagar			Palem			Rajendranagar			Palem		
		Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
GCA	9	0.97**	1.08**	0.58**	0.40**	1109.84**	1527.03**	945.79**	797.12**				
SCA	45	0.95**	1.00**	1.03**	1.17**	625.12**	1729.13**	1353.28**	884.86**				
ERROR	108	0.00	0.00	0.00	0.00	25.63	18.41	26.35	24.20				
σ^2_{gca}		0.0002	0.0003	0.0001	0.0001	2.1486	2.0286	2.2092	2.0286				
σ^2_{sca}		0.0022	0.0028	0.0010	0.0015	24.3077	22.9496	24.9926	2.9496				
$\sigma^2_{gca/sca}$		0.0909	0.1070	0.1000	0.0660	0.088	0.0880	0.0883	0.0883				

Source of variation	df	CGR						RGR					
		Rajendranagar			Palem			Rajendranagar			Palem		
		Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
GCA	9	18.40**	26.16**	18.21**	17.57**	0.000042**	0.000026**	0.000038**	0.000041**				
SCA	45	27.51**	24.52**	24.86**	23.85**	0.00054**	0.000046**	0.00054**	0.000050**				
ERROR	108	0.28	0.29	0.31	0.26	0.000002	0.000002	0.000002	0.000002				
σ^2_{gca}		0.0239	0.0247	0.0264	0.0220	0.0000	0.0000	0.0000	0.0000				
σ^2_{sca}		0.0271	0.2794	0.2989	0.2490	0.0000	0.0000	0.0000	0.0000				
$\sigma^2_{gca/sca}$		0.8820	0.0880	0.0880	0.0880	0.0000	0.0000	0.0000	0.0000				

Source of variation	df	NAR						SLW					
		Rajendranagar			Palem			Rajendranagar			Palem		
		Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
GCA	9	0.53**	0.59**	0.95**	0.57**	0.46**	0.79**	0.88**	1.20**				
SCA	45	1.17**	1.37**	1.09**	1.06**	2.66**	1.64**	1.62**	1.72**				
ERROR	108	0.04	0.04	0.04	0.04	0.06	0.06	0.04	0.06				
σ^2_{gca}		0.2234	0.0040	0.0031	0.0033	0.0055	0.0047	0.0037	0.0048				
σ^2_{sca}		0.0388	0.0456	0.0356	0.0370	0.0617	0.0528	0.0418	0.0537				
$\sigma^2_{gca/sca}$		0.0870	0.0870	0.0870	0.089	0.0890	0.0890	0.0880	0.0890				

Source of variation	df	Total biomass						Total chlorophyll					
		Rajendranagar			Palem			Rajendranagar			Palem		
		Kharif	Rabi		Kharif	Rabi		Kharif	Rabi		Kharif	Rabi	
GCA	9	0.28**	0.15**		0.09**	0.08**		0.0107**	0.0130**		0.0100**	0.008**	
SCA	45	0.70**	0.77**		0.46**	0.59**		0.0150**	0.0150**		0.0140**	0.015**	
ERROR	108	0.04	0.02		0.02	0.05		0.0008	0.0007		0.0009	0.001	
σ^2_{gca}		0.0031	0.0017		0.0014	0.0041		0.0001	0.0001		0.0001	0.0001	
σ^2_{sca}		0.0349	0.0190		0.0158	0.0460		0.0007	0.0007		0.0009	0.0007	
$\sigma^2_{gca/sca}$		0.0880	0.0890		0.0886	0.0891		0.1420	0.1420		0.1110	0.1420	

Source of variation	df	Harvest Index						Seed Protein content(%)					
		Rajendranagar			Palem			Rajendranagar			Palem		
		Kharif	Rabi		Kharif	Rabi		Kharif	Rabi		Kharif	Rabi	
GCA	9	11.43**	15.63**		15.74**	22.60**		0.630**	0.516**		0.596**	0.557**	
SCA	45	19.22**	21.94**		17.47**	15.43**		0.529**	0.549**		0.566**	0.535**	
ERROR	108	0.23	0.43		1.11	0.98		0.039	0.011		0.013	0.010	
σ^2_{gca}		0.0196	0.0365		0.0932	0.0823		0.0033	0.0010		0.0010	0.0008	
σ^2_{sca}		0.2218	0.4127		1.0549	0.9310		0.3710	0.0113		0.0116	0.0095	
$\sigma^2_{gca/sca}$		0.0880	0.0884		0.0883	0.0883		0.0890	0.0884		0.0862	0.0842	

Source of variation	df	Seed protein yield						Oil Per cent					
		Rajendranagar			Palem			Rajendranagar			Palem		
		Kharif	Rabi		Kharif	Rabi		Kharif	Rabi		Kharif	Rabi	
GCA	9	18337**	17347**		12730**	15306**		0.257**	0.213**		0.425**	0.214**	
SCA	45	34016**	35129**		31686**	27950**		0.214**	0.207**		0.229**	0.200**	
ERROR	108	34.43	755.34		1844.72	63.75		0.063	0.005		0.048	0.280	
σ^2_{gca}		2.8862	63.3157		154.6306	5.3440		0.0054	0.0005		0.0040	0.0024	
σ^2_{sca}		32.6522	716.2993		1749.3564	60.4575		0.0606	0.0052		0.0450	0.0272	
$\sigma^2_{gca/sca}$		0.0880	0.0883		0.0883	0.0883		0.0890	0.0960		0.0888	0.0882	

Source of variation	df	Oil yield						Tryptophan content					
		Rajendranagar			Palem			Rajendranagar			Palem		
		Kharif	Rabi		Kharif	Rabi		Kharif	Rabi		Kharif	Rabi	
GCA	9	4148**	4089**		7567**	10547**		0.055**	0.056**		0.055**	0.055**	
SCA	45	14942**	19043**		13942**	14110**		0.001**	0.001**		0.001**	0.001**	
ERROR	108	139.79	102.32		118.44	132.18		0.000	0.000		0.000	0.000	
σ^2_{gca}		34.01	8.5774		9.9284	11.0797		0.0000	0.0000		0.0000	0.0001	
σ^2_{sca}		48.09	97.0375		112.3217	125.3462		0.0004	0.0004		0.0000	0.0006	
$\sigma^2_{gca/sca}$			0.0883		0.0883	0.0883		0.0000	0.0000		0.0000	0.1667	

Source of variation	df	Grain yield/plot					
		Rajendranagar			Palem		
		Kharif	Rabi		Kharif	Rabi	
GCA	9	0.25**	0.23**		0.25**	0.39**	
SCA	45	0.81**	0.83**		0.63**	0.59**	
ERROR	108	0.04	0.03		0.01	0.03	
σ^2_{gca}		0.0004	0.0022		0.0016	0.0025	
σ^2_{sca}		0.0403	0.0249		0.0180	0.0279	
$\sigma^2_{gca/sca}$		0.0890	0.0883		0.0888	0.0896	

Table 10: Estimates of GCA effects of the ten parents for morphological, physiological, biochemical parameters and grain yield at four locations in QPM

	Days to 50% tasseling				Days to 50% silking			
	Rajendranagar		Palem		Rajendranagar		Palem	
	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>
Parents								
P1	-0.33**	-1.15**	-0.33	-0.22	-0.16	-1.17**	-0.35	-0.19
P2	-0.30**	-0.40	-0.32	-0.30	-0.22	-0.50	-0.52	-0.11
P3	-0.52**	-0.73**	-0.17	0.03	-0.44**	-0.50	-0.27	-0.19
P4	-2.38**	-2.65**	-2.08**	-2.22**	-2.27**	-3.00**	-2.18**	-2.36**
P5	0.76**	1.27**	0.17	-0.13	0.70**	1.08**	-0.02	-0.11
P6	1.06**	2.18**	1.00**	-0.22	0.92**	2.17**	1.15**	0.14
P7	-0.19	-0.23	0.08	1.45**	-0.19	0.00	0.15	1.22**
P8	0.95**	0.18	1.42**	0.78*	0.87**	0.42	1.57**	0.72*
P9	1.31**	1.77**	0.83**	1.03**	1.26**	1.75**	0.65*	0.69*
P10	-0.36**	-0.23	-0.33	-0.22	-0.47**	-0.25	-0.18	0.19
SE(gi)	0.113	0.30	0.29	0.34	0.15	0.32	0.28	0.32
SE(gi-gj)	0.17	0.44	0.44	0.52	0.20	0.48	0.46	0.46
	Anthesis silking interval				Days to maturity			
	Rajendranagar		Palem		Rajendranagar		Palem	
	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>
Parents								
P1	0.17*	-0.02	-0.02	0.02	-0.17	-1.08**	-0.25	-0.60
P2	0.08	-0.10	0.07	0.19	-0.26	-0.42	-0.83*	-0.27
P3	0.08	0.23	-0.10	-0.23	-0.59**	-0.67*	-0.42	-0.10
P4	0.11	-0.35*	-0.10	-0.14	-2.12**	-2.67**	-2.50**	-2.27**
P5	-0.06	-0.18	-0.18	0.02	1.13**	1.17**	-0.08	-0.10
P6	-0.14	-0.02	0.15	0.36**	1.05**	1.75**	1.17**	0.23
P7	0.00	0.23	0.07	-0.23	-0.78**	0.25	0.42	1.23**
P8	-0.08	0.23	0.15	-0.06	1.16**	0.08	1.92**	0.73
P9	-0.06	-0.02	-0.18	-0.34**	0.97**	1.67**	1.00**	0.90
P10	-0.11	-0.02	0.15	0.41**	-0.39	-0.08	-0.42	0.23
SE(gi)	0.00	0.17	0.17	0.14	0.22	0.36	0.38	0.48
SE(gi-gj)	0.14	0.22	0.28	0.17	0.35	0.53	0.57	0.73
	Plant height				Ear height			
	Rajendranagar		Palem		Rajendranagar		Palem	
	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>
Parents								
P1	4.89**	-0.76	-2.75**	-4.51**	-0.18	-0.93	4.05**	3.16**
P2	5.19**	-6.34**	-2.51**	-0.55	0.43*	-1.41**	1.01	0.98
P3	19.53**	12.61**	9.62**	8.07**	11.18**	10.98**	5.76**	5.52**
P4	9.81**	-0.87	1.29	0.50	3.15**	4.15**	-4.12**	-3.77**
P5	-6.33**	0.77	-3.48**	-0.45	-3.91**	-4.77**	-0.93	-1.09
P6	-15.33**	-8.45**	-6.00**	-4.60**	-4.82**	-4.82**	-4.80**	-4.13**
P7	-3.44**	-7.12**	-5.07**	-5.47**	-3.10**	-2.85**	-4.24**	-4.25**
P8	-7.44**	1.02	7.13**	5.71**	0.12	-0.13	0.99	1.31*
P9	-0.31	4.99**	-9.54**	-8.97**	-0.16	0.34	-5.06**	-4.57**
P10	-6.56**	4.13**	11.32**	10.26**	-2.71**	-0.57	7.35**	6.85**
SE(gi)	0.22	1.60	0.69	0.74	0.22	0.53	0.72	0.60
SE(gi-gj)	0.00	2.39	1.03	0.50	0.33	0.80	1.06	0.90

	Leaf area index (60 DAS)				Leaf dry weight (90 DAS)			
	Rajendranagar		Palem		Rajendranagar		Palem	
	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>
Parents								
P1	0.07**	0.03	-0.20**	-0.15**	-0.07	5.62**	-2.88*	9.17**
P2	0.13**	0.12**	0.13**	0.10**	7.76**	4.44**	-4.90**	-2.78*
P3	-0.38**	-0.36**	-0.11**	-0.14**	-17.41**	-0.14	-20.07**	-5.43**
P4	0.48**	0.44**	0.20**	0.32**	14.83**	16.41**	6.06**	13.30**
P5	0.39**	0.40**	0.36**	0.23**	-7.55**	-15.64**	1.22	0.09
P6	-0.22**	-0.25**	-0.25**	-0.21**	-4.80**	-5.92**	-3.21*	-12.69**
P7	-0.35**	-0.45**	-0.34**	-0.23**	-7.36**	-19.39**	5.68**	-8.13**
P8	0.01	0.07**	0.11**	0.01	4.85**	12.91**	-1.32	8.31**
P9	-0.09**	-0.16**	0.05**	0.02*	9.55**	1.48	10.94**	-1.85
P10	-0.04**	0.16**	0.07**	0.05**	0.20	0.25	8.48**	0.03
SE(gi)	0.00	0.00	0.00	0.00	1.46	0.73	1.48	1.42
SE(gi-gj)	0.00	0.00	0.00	0.00	2.18	1.85	2.22	2.12

	Crop growth rate (60-75 DAS)				Relative Growth rate (60-75 DAS)			
	Rajendranagar		Palem		Rajendranagar		Palem	
	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>
Parents								
P1	0.58**	0.67**	0.86**	0.50**	.002800	-0.002388*	0.003333*	0.002633*
P2	0.82**	0.98**	1.01**	0.96**	.001033*	0.002634**	.001167*	.001200*
P3	-0.15	-0.17	-0.13	-0.20	0.000800	-0.001221*	-0.000167	-0.000467
P4	-0.07	-0.06	-0.03	-0.05	0.00028	-0.000888*	0.00025	-0.000217
P5	2.33**	2.26**	2.31**	2.29**	.002700*	0.002029**	.001750*	0.000617
P6	0.47**	1.03**	-0.16	0.54**	.003283*	0.000362	.002917*	.002783*
P7	-1.42**	-2.42**	-1.34**	-1.55**	.001217	0.000112	-0.000583	-0.000772
P8	-1.73**	-0.97**	-1.56**	-1.64**	-0.00063	-0.000449	0.001583*	0.002911*
P9	-1.35**	-2.12**	-1.43**	-1.13**	-0.00072	-0.000054	0.001000*	.002117*
P10	0.51**	0.83**	0.47**	0.28*	.001133	-0.000138	0.000583	0.000283
SE(gi)	0.14	0.14	0.17	0.14	0.0000	0.0000	0.0000	0.0000
SE(gi-gj)	0.22	0.22	0.24	0.22	0.0000	0.0000	0.0000	0.0000

	Net assimilation rate (60-75 DAS)				Specific leaf weight (90 DAS)			
	Rajendranagar		Palem		Rajendranagar		Palem	
	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>
Parents								
P1	0.29**	0.19**	0.06	-0.08	0.08	0.17**	0.14*	0.40**
P2	0	0.04	-0.34**	-0.30**	0.16*	0.12	0.22**	0.01
P3	0.01	0.22**	0.44**	0.16**	-0.14*	-0.08	-0.36**	-0.55**
P4	0.10	-0.15*	0.09	0.27**	0.28**	0.01	0.15**	0.28**
P5	0.00	0.07	0.16**	-0.16**	0.16*	0.51**	0.46**	0.30**
P6	0.28**	0.39**	0.20**	0.39**	-0.07	-0.22**	-0.42**	-0.30**
P7	-0.25**	-0.33**	-0.36**	-0.04	-0.10	-0.30**	-0.14*	-0.27**
P8	-0.25**	-0.14*	0.00	-0.09	-0.36**	0.20**	-0.04	-0.21**
P9	-0.29**	-0.20**	-0.40**	-0.22**	-0.16*	-0.33**	-0.12*	0.15*
P10	0.11*	-0.09	0.16**	0.05	0.15*	-0.06	0.12*	0.19**
SE(gi)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SE(gi-gj)	0.00	0.00	0.00	0.00	0.10	0.10	0.10	0.10

	Total Biomass				Total Chlorophyll content			
	Rajendranagar		Palem		Rajendranagar		Palem	
	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>
Parents								
P1	-0.34**	-0.20**	-0.12**	0.02	0.01	0.01	0.01	0.03**
P2	-0.03	-0.04	0.05	-0.01	0.04**	0.04**	0.04**	0.02**
P3	-0.15**	-0.08*	-0.08*	0.06	0.01	0.02**	0.01	0.00
P4	0.17**	0.07	0.15**	-0.05	-0.03**	-0.02**	-0.02**	-0.03**
P5	-0.01	0.04	0.11**	0.05	0.01	0.02*	0.01	0.01
P6	0.07	-0.06	0.03	-0.06	-0.03**	-0.04**	-0.03**	-0.03**
P7	0.04	-0.07	-0.05	-0.14*	0.00	0.00	-0.01	0.01
P8	0.14**	0.13**	0.02	0.14*	-0.05**	-0.05**	-0.05**	-0.04**
P9	0.12*	0.17**	-0.04	-0.06	-0.01	-0.01*	-0.01	-0.01
P10	0.00	0.03	-0.06	0.06	0.04**	0.05**	0.05**	0.03**
SE(gi)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SE(gi-gj)	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00

	Harvest index				Protein content			
	Rajendranagar		Palem		Rajendranagar		Palem	
	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>
Parents								
P1	1.47**	0.34	0.82**	1.96**	-0.17**	-0.13**	-0.04	-0.18**
P2	1.58**	1.81**	0.91**	1.58**	-0.07	-0.06*	-0.13**	-0.08**
P3	-1.33**	-2.28**	0.75**	1.39**	-0.04	-0.06*	-0.06*	-0.03
P4	-0.24	-0.19	-0.95**	-2.38**	0.31**	0.35**	0.34**	0.34**
P5	0.55**	0.68**	1.40**	-0.20	0.26**	0.18**	0.22**	0.22**
P6	-0.29*	1.17**	0.76**	-0.98**	0.04	0.03	0.04	0.00
P7	-0.59**	0.30	-0.41	-0.79**	-0.18**	-0.17**	-0.20**	-0.19**
P8	0.37**	-0.40*	-0.19	-0.06	-0.26**	-0.19**	-0.24**	-0.18**
P9	-0.61**	-0.74**	-2.37**	-1.04**	0.33**	0.29**	0.32**	0.32**
P10	-0.92**	-0.69**	-0.71*	0.53	-0.25**	-0.24**	-0.25**	-0.22**
SE(gi)	0.14	0.17	0.30	0.28	0.00	0.00	0.00	0.00
SE(gi-gj)	0.20	0.28	0.45	0.42	0.1	0.00	0.00	0.00

	Seed protein yield/ha				Oil per cent			
	Rajendranagar		Palem		Rajendranagar		Palem	
	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>
Parents								
P1	-52.74**	-48.91**	-17.22	4.24	0.23**	0.17**	0.16**	0.14**
P2	23.29**	23.39**	40.07**	16.24**	-0.12	-0.07**	-0.04	-0.04
P3	-27.65**	-35.66**	2.47	13.56**	-0.05	-0.10**	-0.01	-0.03
P4	23.71**	21.59**	13.98	18.87**	0.12	0.09**	0.19**	0.13**
P5	79.92**	73.45**	59.21**	62.65**	-0.02	-0.05*	-0.01	-0.05
P6	3.36*	10.09	-6.68	0.09	-0.28**	-0.26**	-0.42**	-0.31**
P7	-27.14**	-27.31**	-40.83**	-43.03**	-0.08	-0.02	-0.17**	-0.03
P8	-7.69**	-9.81	12.18	17.12**	0.08	0.13**	0.17**	0.10*
P9	22.43**	27.98**	-37.96**	-61.64**	-0.02	-0.03	0.01	-0.02
P10	-37.48**	-34.81**	-25.23*	-28.10**	0.14*	0.14**	0.13*	0.10*
SE(gi)	1.69	7.95	12.44	2.31	0.10	0.00	0.00	0.00
SE(gi-gj)	2.53	11.86	18.54	3.44	0.10	0.00	0.10	0.10

	Oil yield / ha				Tryptophan content			
	Rajendranagar		Palem		Rajendranagar		Palem	
	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>
Parents								
P1	-17.03**	-17.93**	13.85**	33.29**	0.04**	0.04**	0.04**	0.04**
P2	13.50**	8.94**	25.36**	9.85**	0.05**	0.05**	0.05**	0.05**
P3	-19.69**	-20.45**	10.06**	4.57	0.02**	0.02**	0.02**	0.02**
P4	15.54**	18.55**	5.46	19.36**	0.08**	0.08**	0.08**	0.08**
P5	35.67**	38.16**	23.68**	27.57**	-0.07**	-0.07**	-0.07**	-0.07**
P6	-16.73**	-18.47**	-22.45**	-20.24**	-0.06**	-0.06**	-0.06**	-0.06**
P7	-17.44**	1.66	-40.06**	-36.14**	-0.04**	-0.04**	-0.04**	-0.04**
P8	10.88**	1.69	16.79**	23.35**	-0.09**	-0.10**	-0.09**	-0.10**
P9	1.07	-2.46	-41.08**	-57.17**	0.10**	0.10**	0.10**	0.10**
P10	-5.80	-9.69**	8.40**	-4.44	-0.02**	-0.03**	-0.02**	-0.02**
SE(gi)	3.42	2.93	2.98	3.32	0.00	0.00	0.00	0.00
SE(gi-gj)	5.11	4.37	4.69	4.96	0.00	0.00	0.00	0.00

	Grain Yield / plot			
	Rajendranagar		Palem	
	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>
Parents				
P1	-0.18**	-0.19**	0.04	0.07
P2	0.16**	0.09*	0.22**	0.14**
P3	-0.20**	-0.11*	0.08*	0.10*
P4	0.01	0.05	-0.04	-0.04
P5	0.28**	0.31**	0.16**	0.22**
P6	0.04	-0.02	-0.02	0.01
P7	-0.08	-0.07	-0.20**	-0.21**
P8	0.02	0.01	0.00	0.13**
P9	0.03	0.04	-0.24**	-0.38**
P10	-0.07	-0.11*	0.00	-0.05
SE(gi)	0.00	0.00	0.00	0.00
SE(gi-gj)	0.1	0.10	0.00	0.10

ranged between -2.08 days (P4) and 1.42 days (P8). Parental lines P2, and P4 exhibited significantly negative *GCA* effects. In contrast, P6, P8 and P9 recorded significantly positive *GCA* effects.

During *Rabi* at Rajendranagar the *GCA* effects for this character ranged between -2.65 days (P4) to 2.18 days (P6). Parental lines P1, P3, and P4 exhibited significantly negative *GCA* effects. In contrast, P5, P6, and P9 recorded significantly positive *GCA* effects. During *Rabi* at Palem the *GCA* effects for this character ranged between -2.22 days (P4) and 1.45 days (P7). Parental line P4 exhibited significantly negative *GCA* effects. In contrast, P7, P8 and P9 recorded significantly positive *GCA* effects.

4.3.1.2 Days to 50 per cent silking

During *Kharif* at Rajendranagar of the ten parents, the inbred lines P3, P4 and P10 exhibited significantly negative *GCA* effects whereas P5, P6, P8 and P9 recorded significantly positive *GCA* effects. The estimates of *GCA* effects ranged between -2.27 (P4) to 1.26(P9) while at Palem the *GCA* effects for the character ranged between -2.18 days (P4) and 21.57days (P8). Parental lines P4 exhibited significantly negative *GCA* effects. In contrast, P6, P8 and P9 recorded significantly positive *GCA* effects.

During *Rabi* at Rajendranagar, the inbred lines P1, P4 exhibited significantly negative *GCA* effects whereas P5, P6 and P9 recorded significantly positive *GCA* effects. The estimates of *GCA* effects ranged between -3.00 (P4) to 2.17 (P6) while, at Palem the inbred lines P4 exhibited significantly negative *GCA* effects whereas P7, P8 and P9 recorded significantly positive *GCA* effects. The estimates of *GCA* effects ranged between -2.36 (P4) to 1.22 (P7).

4.3.1.3 Anthesis silking interval (days)

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During *Kharif* at Rajendranagar and Palem all the *GCA* effects were non significant except P1 which have significant positive *GCA* effect at Rajendranagar.

During *Rabi* at Rajendranagar *GCA* effects ranged from -0.35 (P4) to 0.19 (P4). One of the parents has significant negative *GCA* effect (P4). While at Palem *GCA* effects ranged from -0.34 (P9) to 0.41 (P10). P6 and P10 exhibited significant positive *GCA* effects. P9 parent has significant negative *GCA* effects

4.3.1.4 Days to maturity

During *Kharif* at Rajendranagar the *GCA* effects ranged from -2.12 (P4) to 1.13 days (P5). However, the lines, P5, P6, P8 and P9 showed significantly positive effects, while the lines P3, P4 and P7 showed negatively significant *GCA* effects while at Palem the range of *GCA* effects for this character was from -2.50 (P4) to 1.92 days (P8). However, the lines, P2 and P4 showed significantly negative effects, while the lines P6, P8 and P9 showed positively significant *GCA* effects.

At Rajendranagar during *Rabi* the range of *GCA* effects was from -2.67 (P4) to 1.75 days (P6). However, there were only three lines, P5, P6 and P9 which showed significantly positive effects, while the lines P1, P3 and P4 showed negatively significant *GCA* effects and at Palem the range of *GCA* effects for this character was from -2.27 (P4) to 1.23 days (P7). However, there was only one line, P7 that showed significantly positive effects, while the line P4 showed negatively significant *GCA* effects.

4.3.1.5 Plant height (cm)

During *Kharif* at Rajendranagar plant height exhibited *GCA* effects from -15.33 (P6) to 19.53 cm (P3). The parental lines P5, P6, P7, P8 and P10 showed

negative significant *GCA* effects, whereas, lines P1, P2, P3 and P4 recorded significant positive *GCA* effects while at Palem Plant height exhibited *GCA* effects from -9.54 (P9) to 11.32cm (P10). The parental lines P1, P2, P5, P6, P7 and P9 showed negative significant *GCA* effects, whereas, lines P3, P8 and P10 recorded significant positive *GCA* effects.

Plant height exhibited *GCA* effects from -8.45 (P6) to 12.61cm (P3) at Rajendranagar during *Rabi*. The parental lines P2, P6 and P7 showed significant negative *GCA* effects, whereas, lines P3, P9 and P10 recorded significant positive *GCA* effects and at Palem Plant height exhibited *GCA* effects from -8.97 (P9) to 10.26 cm (P10). The parental lines P1, P6, P7 and P9 showed significant negative *GCA* effects, whereas, lines P3, P8 and P10 recorded significant positive *GCA* effects.

4.3.1.6 Ear height (cm)

During *Kharif* at Rajendranagar the *GCA* effects ranged from -4.82 (P6) to 11.18 (P3). Three inbred lines *Viz.*, P2, P3 and P4 recorded positive *GCA* effects while, P5, P6, P7 and P10 recorded negative *GCA* effects. At Palem the *GCA* effects ranged from -5.06 (P9) to 7.35 (P10). Three inbred lines *Viz.*, P1, P3 and P10 recorded positive *GCA* effects while; P4, P6, P7 and P9 recorded negative *GCA* effects.

During *Rabi* at Rajendranagar, the *GCA* effects ranged from -4.82 (P6) to 10.98 (P3). Two inbred lines *Viz.*, P3 and P4 recorded positive *GCA* effects while, P2, P5, P6 and P7 recorded negative *GCA* effects and at Palem the *GCA* effects ranged from -4.57 (P9) to 6.85 (P10). Two inbred lines *Viz.*, P1, P3 P8 and P10 recorded positive *GCA* effects while; P4, P6 P7 and P9 recorded negative *GCA* effects.

4.3.1.7 Leaf Area Index (LAI)

During *Kharif* at Rajendranagar significant negative *GCA* effects were exhibited by parental lines, P3, P6, P7, P9 and P10 whereas, the lines P1, P2, P4 and

P5 exhibited positively significant *GCA* effects. The estimates ranged from -0.38 (P3) to 0.48(P4) while, at Palem significant negative *GCA* effects were exhibited by parental lines P1, P3, P6 and P7 whereas, the lines P2, P4, P5, P8, P9 and P10 exhibited positively significant *GCA* effects. The estimates ranged from -0.34 (P7) to 0.36 (P5).

During *Rabi* at Rajendranagar significant negative *GCA* effects were exhibited by parental lines, P3, P6, P7 and P9, whereas, the lines P2, P4, P5, P8 and P10 exhibited positively significant *GCA* effects. The estimates ranged from -0.45(P7) to 0.44 (P4) and at Palem significant negative *GCA* effects were exhibited by parental lines, P1 P3, P6, and, P7 whereas, the lines P2, P4, P5, P9 and P10 exhibited positively significant *GCA* effects. The estimates ranged from -0.23 (P7) to 0.32 (P4).

4.3.1.8 Leaf Dry Weight (LDW) (gm-2)

During *Kharif* at Rajendranagar the *GCA* effects for this character ranged between -17.41 (P3) to 14.83(P4). Parental lines P3, P5, P6, and P7 exhibited significantly negative *GCA* effects. In contrast, P2, P4, P8 and P9 recorded significantly positive *GCA* effects while, at Palem the *GCA* effects for this character ranged between -20.07 (P3) to 10.59 (P9). Parental lines P1, P2, P3 and P6 exhibited significantly negative *GCA* effects. In contrast, P4, P7, P9 and P10 recorded significantly positive *GCA* effects.

During *Rabi* at Rajendranagar the *GCA* effects for this character ranged between -19.39 (P7) to 16.41 (P4). Parental lines P5, P6, and P7 exhibited significantly negative *GCA* effects. In contrast, P1, P2 and P4 recorded significantly positive *GCA* effects and at Palem the *GCA* effects for this character ranged between -12.69 (P6) to 13.30 (P4). Parental lines P2, P3, P6, and P7 exhibited significantly negative *GCA* effects. In contrast, P1, P4 and P8 recorded significantly positive *GCA* effects.

4.3.1.9 Crop Growth Rate (CGR) ($\text{gm}^{-2}\text{d}^{-1}$)

During *Kharif* at Rajendranagar, the *GCA* effects ranged from -1.73 (P8) to 2.33 (P5). Three inbred lines *Viz.*, P7, P8 and P9 recorded negative *GCA* effects while, P1, P2, P5, P6 and P10 recorded positive *GCA* effects while, at Palem the *GCA* effects ranged from -1.56 (P8) to 2.31 (P5). Four inbred lines *Viz.*, P7, P8 and P9 recorded negative *GCA* effects while; P1, P2, P5 and P10 recorded positive *GCA* effects.

For this character, the *GCA* effects ranged from -2.42 (P7) to 2.26 (P5). Three inbred lines *Viz.*, P7, P8 and P9 recorded negative *GCA* effects while; P1, P2, P5, P6 and P10 recorded positive *GCA* effects. During *Rabi* at Rajendranagar and at Palem, the *GCA* effects ranged from -1.64 (P8) to 2.29 (P5). Three inbred lines *Viz.*, P7, P8 and P9 recorded negative *GCA* effects while, P1, P2, P5, P6 and P10 recorded positive *GCA* effects.

4.3.1.10 Relative Growth Rate (RGR) ($\text{gg}^{-1}\text{d}^{-1}$)

During *Kharif* at Rajendranagar the *GCA* effects for this character ranged between -0.0028 (P1) to 0.0033 (P6) while, at Palem the *GCA* effects for this character ranged between -0.0033 (P1) to 0.0029 (P6).

During *Rabi* at Rajendranagar the *GCA* effects for this character ranged between -0.0024 (P1) to 0.0026 (P2) and at Palem the *GCA* effects for this character ranged between -0.0029 (P8) to 0.0021 (P9).

4.3.1.11 Net Assimilation Rate (NAR) ($\text{gm}^{-2}\text{d}^{-1}$)

During *Kharif* at Rajendranagar, the inbred lines P7, P8 and P9 exhibited significantly negative *GCA* effects whereas P1, P6 and P10 recorded significantly positive *GCA* effects. The estimates of *GCA* effects ranged between -0.29 (P9) to 0.29 (P1) while at Palem the inbred lines P2, P7, and P9 exhibited significantly negative

GCA effects whereas P3, P5, P6 and P10 recorded significantly positive *GCA* effects. The estimates of *GCA* effects ranged between -0.40 (P9) to 0.44 (P3).

Of the ten parents, the inbred lines P4, P7, P8 and P9 exhibited significantly negative *GCA* effects whereas P1, P3 and P6 recorded significantly positive *GCA* effects. The estimates of *GCA* effects ranged between -0.33 (P7) to 0.39 (P6) during *Rabi* at Rajendranagar and at Palem, the inbred lines P2, P5 and P9 exhibited significantly negative *GCA* effects whereas P3, P4 and P6 recorded significantly positive *GCA* effects. The estimates of *GCA* effects ranged between -0.30 (P2) to 0.39 (P6).

4.3.1.12 Specific Leaf Weight (SLW) (mgcm^{-2})

During *Kharif* at Rajendranagar, *GCA* effects ranged between -0.36 (P8) to 0.28 (P4). Out of ten inbred lines, six parental inbred lines exhibited significant *GCA* effects. However, among the six inbred lines three inbreds namely P2, P4 P5 and P10 recorded significantly positive *GCA* effects, while inbred lines P3, P8 and P9 exhibited significantly negative *GCA* effects while at Palem *GCA* effects ranged between -0.42 (P6) to 0.46 (P5). Out of ten inbred lines, seven parental inbred lines exhibited significant *GCA* effects. However, among the seven inbred lines three inbreds namely P1, P2, P4 P5 and P10 recorded significantly positive *GCA* effects, while inbred lines P3, P6, P7 and P9 exhibited significantly negative *GCA* effects.

Among the ten inbred lines, *GCA* effects ranged between -0.33 (P9) to 0.51 (P5). Out of ten inbred lines six parental inbred lines exhibited significant *GCA* effects. However, among the six inbred lines three inbreds namely P1, P5 and P8 recorded significantly positive *GCA* effects, while inbred lines P6, P7 and P9 exhibited significantly negative *GCA* effects during *Rabi* at Rajendranagar and at Palem, *GCA* effects ranged between -0.55 (P3) to 0.40 (P1). Eight parental inbred lines exhibited significant *GCA* effects. However, among the eight inbred lines four

inbreds namely P1, P4, P5, P9 and P10 recorded significantly positive *GCA* effects, while inbred lines P3, P6, P7 and P8 exhibited significantly negative *GCA* effects.

4.3.1.13 Total biomass (kg/plot)

During *Kharif* at Rajendranagar for total biomass the *GCA* effects ranged from -0.34 (P1) to 0.17 (P4). Two inbred lines *Viz.*, P4, P8 and P9 recorded positive and significant *GCA* effect while P1 and P3 showed negatively significant *GCA* effects while at Palem the *GCA* effects ranged from -0.12 (P1) to 0.15 (P4). Two inbred lines *Viz.*, P4 and P5 recorded positive and significant *GCA* effect while P1 and P3 showed negatively significant *GCA* effects.

During *Rabi* at Rajendranagar for total biomass the *GCA* effects ranged from -0.20 (P1) to 0.17 (P9). Two inbred lines *Viz.*, P8 and P9 recorded positive and significant *GCA* effect while P1 and P3 showed negatively significant *GCA* effects and at Palem the *GCA* effects ranged from -0.14 (P7) to 0.14 (P8). Two inbred lines *Viz.*, P8 recorded positive and significant *GCA* effect while P7 showed negatively significant *GCA* effects.

4.3.1.14 Total Chlorophyll content (mg/g)

During *Kharif* at Rajendranagar the character chlorophyll content exhibited *GCA* effects in the range from -0.05mg/g (P8) to 0.04 mg/g (P2). However, the inbred lines P2 and P10 recorded significantly positive *GCA* effects, while line P4, P6 and P8 exhibited significant negative *GCA* effects while at Palem, *GCA* effects in the range from -0.05mg/g (P8) to 0.05 mg/g (P10). However, the inbred lines P2 and P10 recorded significantly positive *GCA* effects, while line P4, P6 and P8 exhibited significant negative *GCA* effects.

The character chlorophyll content exhibited *GCA* effects in the range from -0.05 mg/g (P8) to 0.05 mg/g (P10). However, the inbred lines P2, P3, P5

and P10 recorded significantly positive *GCA* effects, while line P4, P6, P8 and P9 exhibited significant negative *GCA* effects During *Rabi* at Rajendranagar and at Palem the character chlorophyll content exhibited *GCA* effects in the range from -0.04mg/g (P8) to 0.03 mg/g (P1). However, the inbred lines P1, P2 and P10 recorded significantly positive *GCA* effects, while line P4, P6 and P8 exhibited significant negative *GCA* effects.

4.3.1.15 Harvest index (•/•)

At Rajendranagar during *Kharif* the *GCA* effects for this character ranged between -1.33 (P3) and 1.58 (P2). Parental lines P3, P6, P7, P9 and P10 exhibited significantly negative *GCA* effects. In contrast, P1, P2, P5 and P8 recorded significantly positive *GCA* effects while at Palem the *GCA* effects for this character ranged between -2.37 (P9) and 1.40 (P5). Parental lines P4, P9 and P10 exhibited significantly negative *GCA* effects. In contrast, P1, P2, P3, P5 and P6 recorded significantly positive *GCA* effects.

The *GCA* effects for this character ranged between -2.28 (P3) and 1.80 (P2). Parental lines P3, P8, P9, and P10 exhibited significantly negative *GCA* effects. In contrast, P2, P5 and P6 recorded significantly positive *GCA* effects during *Rabi* at Rajendranagar and at Palem the *GCA* effects for this character ranged between -2.38 (P4) and 1.96 (P1). Parental lines P4, P6, P7, and P9 exhibited significantly negative *GCA* effects. In contrast, P1, P2 and P3 recorded significantly positive *GCA* effects.

4.3.1.16 Seed Protein content (%)

During *Kharif* at Rajendranagar significant negative *GCA* effects were exhibited by parental lines P1, P7, P8 and P10, whereas, the lines P4, P5, and P9 exhibited positively significant *GCA* effects. The estimates ranged from -0.26 (P8) to 0.31 (P4) while at Palem Significantly negative *GCA* effects were exhibited by

parental lines, P2, P3, P7, P8 and P10, whereas, the lines P4, P5, and P9 exhibited positively significant *GCA* effects. The estimates ranged from -0.25(P10) to 0.34 (P4).

During *Rabi* at Rajendranagar significantly negative *GCA* effects were exhibited by parental lines, P1, P2, P3, P7, P8 and P10, whereas, the lines P4, P5, and P9 exhibited positively significant *GCA* effects. The estimates ranged from -0.24 (P10) to 0.35 (P4) and at Palem Significantly negative *GCA* effects were exhibited by parental lines, P1, P2, P7, P8 and P10, whereas, the lines P4, P5, and P9 exhibited positively significant *GCA* effects. The estimates ranged from -0.22 (P10) to 0.34 (P4).

4.3.1.17 Seed protein yield (kg/ha)

During *Kharif* at Rajendranagar significant negative *GCA* effects were exhibited by parental lines, P1, P3, P7, P8 and P10, whereas, the lines P2, P4, P5, P6 and P9 exhibited positively significant *GCA* effects. The estimates ranged from -52.72 (P1) to 79.92 (P5) while at Palem significant negative *GCA* effects were exhibited by parental lines, P7, P9 and P10, whereas, the lines P2 and P5 exhibited positively significant *GCA* effects. The estimates ranged from -40.83 (P7) to 59.21 (P5).

During *Rabi* at Rajendranagar, significant negative *GCA* effects were exhibited by parental lines, P1, P3, P7 and P10, whereas, the lines P2, P4, P5, and P9 exhibited positively significant *GCA* effects. The estimates ranged from -48.91 (P1) to 73.45 (P5) and at Palem significant negative *GCA* effects were exhibited by parental lines, P7, P9 and P10, whereas, the lines P2, P3, P4, P5 and P8 exhibited positively significant *GCA* effects. The estimates ranged from -61.64 (P9) to 62.65 (P5).

4.3.1.18 Oil per cent

At Rajendranagar during *Kharif*, the inbred line P6 exhibited significantly negative *GCA* effects whereas P1 and P10 recorded significant positive *GCA* effects. The estimates of *GCA* effects ranged between -0.28 (P6) to 0.23(P1) while at Palem

the inbred lines P6 and P7 exhibited significantly negative *GCA* effects whereas P1, P4, P8 and P10 recorded significantly positive *GCA* effects. The estimates of *GCA* effects ranged between -0.42 (P6) to 0.19 (P4).

During *Rabi* at Rajendranagar, the inbred lines P2, P3, P5, and P6 exhibited significantly negative *GCA* effects whereas P1, P4, P8 and P10 recorded significantly positive *GCA* effects. The estimates of *GCA* effects ranged between -0.26(P6) to 0.17 (P1) while at Palem the inbred line P6 exhibited significantly negative *GCA* effects whereas P1, P4, P8 and P10 recorded significantly positive *GCA* effects. The estimates of *GCA* effects ranged between -0.31 (P6) to 0.14 (P1).

4.3.1.19 Oil yield per hectare (kg/ha)

During *Kharif* at Rajendranagar, the *GCA* effects ranged from -19.69 (P3) to 35.67 (P5). Three inbred lines *Viz.*, P2, P4, P5 and P8 recorded positive *GCA* effects while, P1, P3, P6 and P7 recorded negative *GCA* effects while at Palem the *GCA* effects ranged from -41.08 (P9) to 25.36 (P2). Five inbred lines *Viz.*, P1, P2, P3, P5, P8 and P10 recorded positive *GCA* effects while, P6, P7 and P9 recorded negative *GCA* effects.

During *Rabi* at Rajendranagar, the *GCA* effects ranged from -20.45 (P3) to 38.16 (P5). Three inbred lines *Viz.*, P2, P4 and P5 recorded positive *GCA* effects while, P1, P3, P6 and P10 recorded negative *GCA* effects while at Palem, the *GCA* effects ranged from -57.17(P9) to 33.29 (P1). Five inbred lines *Viz.*, P1, P2, P4, P5 and P8 recorded positive *GCA* effects while, P6, P7 and P9 recorded negative *GCA* effects.

4.3.1.20 Tryptophan content

During *Kharif* at Rajendranagar and Palem the range of *GCA* effects for this character was from -0.09 (P8) to 0.10 (P9). However, there were five lines, P1, P2, P3,

P4 and P9 which showed significant positive effects, while the lines P5, P6, P7, P8 and P10 showed negatively significant *GCA* effects.

The range of *GCA* effects for this character was from -0.10 (P8) to 0.10 (P9). However, there were five lines, P1, P2, P3, P4 and P9 which showed significantly positive effects, while the lines P5, P6, P7, P8 and P10 showed negatively significant *GCA* effects during *Rabi* at Rajendranagar and Palem.

4.3.1.21 Grain yield (kg/plot)

During *Kharif* at Rajendranagar, *GCA* effects ranged between -0.20 (P3) to 0.28 (P5). Out of ten inbred lines three parental inbred lines exhibited significant *GCA* effects. However, among the three inbred lines only one inbred namely P2 and P5 recorded significantly positive *GCA* effects, while two inbred lines P1 and P3 exhibited significantly negative *GCA* effects while at Palem *GCA* effects ranged between -0.24 (P9) to 0.22 (P2). Out of ten inbred lines five parental inbred lines exhibited significant *GCA* effects. However, among the five inbred lines three inbred namely P2, P3 and P5 recorded significantly positive *GCA* effects, while two inbred lines P7 and P9 exhibited significantly negative *GCA* effects.

During *Rabi* at Rajendranagar among the ten inbred lines, *GCA* effects ranged between -0.19 (P1) to 0.31 (P5). Out of ten inbred lines five parental inbred lines exhibited significant *GCA* effects. However, among the five inbred lines two inbreds namely P2 and P5 recorded significantly positive *GCA* effects, while inbred lines P1, P3 and P10 exhibited significantly negative *GCA* effects. At Palem among the ten inbred lines, *GCA* effects ranged between -0.38 (P9) to 0.22 (P5). Out of ten inbred lines five parental inbred lines exhibited significant *GCA* effects. However, among the five inbred lines two inbreds namely P2, P3, P5 and P8 recorded significantly positive *GCA* effects, while inbred lines P7 and P9 exhibited significantly negative *GCA* effects.

4.3.2 SPECIFIC COMBINING ABILITY EFFECTS

The estimates of specific combining ability effects with respect to the 21 characters are presented in the Table 11. The character wise details of specific combining ability effects are summarized below.

4.3.2.1 Days to 50% tasseling

During *Kharif* at Rajendranagar the *SCA* effects ranged -6.22 (P1 X P9) to 5.34(P3 X P4). Among the 55 hybrids tested, 19 crosses exhibited significantly positive *SCA* effects while, 23 crosses showed significantly negative *SCA* effects and at Palem the range between lowest and highest *SCA* effects was from -6.48 (P4 X P9) to 6.19 (P2 X P10). Significant positive and negative effects were recorded in 13 and 15 hybrids, respectively.

During *Rabi* at Rajendranagar, *SCA* effects for days to 50 per cent tasseling ranged between -6.96(P1 X P9) to 7.04(P3 X P4). Out of thirty-three significant *SCA* effects 14 hybrids exhibited positive *SCA* effects while 19 hybrids had significant negative *SCA* effects. At Palem a total of 18 hybrids exhibited significantly negative and 15 hybrids exhibited significant positive *SCA* effects out of 45 hybrids. The range of *SCA* effects for days to 50 per cent tasseling was from -7.35 days (P2 X P5) to 7.40 days (P3 X P4).

4.3.2.2 Day to 50% silking

During *Kharif* at Rajendranagar the range of *SCA* effects was from to-6.30 (P1X P9) to 5.48(P2 X P10). Out of 41 significant crosses, 18 were positively and were 23 negatively significant and at Palem *SCA* effects ranged between -6.58(P4 X P9) to 5.59(P2 X P10). 16 hybrids exhibited significant negative *SCA* effects while 14 hybrids had significant positive *SCA* effects.

Table 11: Estimates of SCA effects of the 45 crosses for morphological, physiological, biochemical parameters and grain yield at four locations

Crosses	Days to 50% tasseling				Days to 50% silking			
	Rajendranagar		Palem		Rajendranagar		Palem	
	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
P1 X P2	-1.28**	-0.80	-0.81	0.73	-1.16**	-0.06	-0.24	1.09
P1 X P3	-1.05**	-0.46	-0.23	-1.60	-1.27**	-1.06	-0.49	-1.82
P1 X P4	2.81**	4.45**	3.69**	2.65*	2.56**	3.44**	3.42**	2.34*
P1 X P5	-1.66**	-1.46	-3.56**	-4.43**	-1.74**	-1.64	-2.74**	-3.91**
P1 X P6	-0.64	3.62**	-0.39	1.65	-0.30	3.27**	-0.91	2.84**
P1 X P7	-0.72*	-3.96**	0.52	-1.02	-0.86*	-3.56**	1.09	-1.24
P1 X P8	2.81**	-3.38**	1.19	3.65**	2.42**	-2.98**	0.67	3.26**
P1 X P9	-6.22**	-6.96**	-5.23**	-5.60**	-6.30**	-7.31**	-5.41**	-5.71**
P1 X P10	-2.22**	-2.96**	-3.06**	-3.35**	-2.24**	-3.31**	-2.58**	-3.21**
P2 X P3	-5.41**	-6.21**	-4.98**	-6.52**	-5.55**	-6.73**	-4.33**	-6.91**
P2 X P4	-2.55**	-2.30*	-1.06	-2.27*	-2.38**	-2.23*	-1.41	-1.74
P2 X P5	-5.03**	-5.21**	-5.31**	-7.35**	-5.36**	-5.31**	-5.58**	-6.99**
P2 X P6	2.34**	0.87	2.86**	5.73**	1.76**	1.61	2.26*	5.76**
P2 X P7	2.25**	2.29*	2.77**	3.07**	2.53**	2.77**	2.26*	2.68**
P2 X P8	-4.89**	-4.13**	-3.56**	-3.27**	-5.19**	-4.64**	-3.16**	-3.82**
P2 X P9	2.09**	2.29*	1.02	-0.52	2.76**	2.02*	0.76	-0.80
P2 X P10	5.09**	6.29**	6.19**	6.73**	5.48**	6.02**	5.59**	6.70**
P3 X P4	5.34**	7.04**	5.52**	7.40**	4.84**	6.77**	4.34**	7.34**
P3 X P5	2.20**	3.12**	3.27**	5.32**	2.87**	3.69**	3.17**	6.09**
P3 X P6	-1.11**	-0.80	-0.56	0.40	-1.36**	0.61	-0.99	-0.16
P3 X P7	-2.19**	-3.38**	-2.64**	-4.27**	-2.24**	-3.23**	-2.99**	-4.24**
P3 X P8	2.67**	4.20**	3.02**	4.40**	2.70**	3.36**	2.59**	4.26**
P3 X P9	3.31**	1.62	1.61	-0.85	3.31**	1.02	2.51*	-0.71
P3 X P10	-2.03**	-3.38**	-2.23*	-2.60*	-1.97**	-2.98**	-2.66**	-2.21*
P4 X P5	0.39	-0.96	1.19	2.57*	0.37	-0.81	2.09*	2.26*
P4 X P6	-1.91**	-3.88**	-1.64	0.65	-1.86**	-3.89**	-0.08	0.01
P4 X P7	0.00	1.54	-1.73	-4.02**	-0.08	1.27	-2.08*	-4.07**
P4 X P8	-1.80**	-1.88*	-2.06*	-1.35	-1.80**	-1.14	-2.49*	-1.57
P4 X P9	-4.83**	-4.46**	-6.48**	-2.60*	-4.52**	-4.48**	-6.58**	-1.55
P4 X P10	-1.16**	-1.46	-0.31	-6.35**	-1.13**	-1.48	0.26	-6.05**
P5 X P6	1.28**	0.20	3.11**	-3.43**	1.17**	0.02	2.76**	-3.24**
P5 X P7	-5.80**	-6.38**	-3.98**	3.90**	-6.05**	-5.81**	-4.24**	3.68**
P5 X P8	1.72**	3.20**	0.69	-5.43**	1.56**	2.77**	0.34	-5.82**
P5 X P9	1.36**	2.62**	3.27**	1.32	1.51**	2.44*	3.26**	1.20
P5 X P10	2.36**	2.62**	1.44	6.57**	2.23**	2.44*	1.09	6.70**
P6 X P7	-3.44**	-2.30*	-2.81**	-0.02	-2.94**	-1.89	-2.41*	0.43
P6 X P8	1.09**	1.29	0.86	-4.35**	1.34**	0.69	1.17	-4.07**
P6 X P9	1.06**	2.70**	2.44**	2.40*	0.95*	3.36**	3.09**	1.95
P6 X P10	-2.61**	-2.30*	-2.39*	-2.35*	-2.66**	-3.64**	-2.08*	-2.55*
P7 X P8	2.34**	3.70**	2.77**	0.98	2.45**	2.86**	2.17*	0.84
P7 X P9	2.31**	2.12*	4.36**	1.73	2.06**	2.52*	4.09**	1.87
P7 X P10	-1.03**	-1.88*	0.52	-1.02	-1.22**	-1.48	0.92	-0.63
P8 X P9	0.84*	0.70	2.02*	3.40**	0.67	1.11	1.67	3.37**
P8 X P10	-4.50**	-4.30**	-3.81**	-3.35**	-4.27**	-4.89**	-4.49**	-3.13**
P9 X P10	-4.86**	-4.88**	-4.23**	-5.60**	-4.99**	-4.23**	-4.58**	-6.43**
SE sij	0.1438	0.9977	0.9891	1.382	0.2122	1.1713	1.0734	1.1448

Crosses	Anthesis silking interval				Days to maturity			
	Rajendranagar		Palem		Rajendranagar		Palem	
	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
P1 X P2	0.11	0.73	0.57	0.36	-1.55*	0.41	-0.64	1.85
P1 X P3	-0.22	-0.60	-0.27	-0.22	0.45	-1.34	-2.06	-1.32
P1 X P4	-0.25	-1.02*	-0.27	-0.31	2.98**	2.66*	4.02**	2.85
P1 X P5	-0.08	-0.18	0.82	0.53	-1.27	-2.17	-2.39	-3.32*
P1 X P6	0.34	-0.35	-0.52	1.19**	-0.52	3.24**	0.36	1.35
P1 X P7	-0.14	0.40	0.57	-0.22	0.98	-3.26**	2.11	-1.65
P1 X P8	-0.39	0.40	-0.52	-0.39	3.04**	-2.09	0.61	2.85
P1 X P9	-0.08	-0.35	-0.18	-0.11	-6.44**	-6.67**	-5.48**	-5.32**
P1 X P10	-0.03	-0.35	0.48	0.14	-4.41**	-2.92**	-2.06	-3.65*
P2 X P3	-0.14	-0.52	0.65	-0.39	-5.13**	-6.01**	-5.48**	-5.65**
P2 X P4	0.17	0.07	-0.35	0.53	-1.60*	-3.01**	-0.39	-1.48
P2 X P5	-0.33	-0.10	-0.27	0.36	-6.85**	-4.84**	-6.81**	-6.65**
P2 X P6	-0.58*	0.73	-0.60	0.03	1.23	1.58	2.94*	6.02**
P2 X P7	0.28	0.48	-0.52	-0.39	3.40**	2.08	1.69	2.02
P2 X P8	-0.30	-0.52	0.40	-0.56	-5.21**	-3.76**	-3.81**	-3.48*
P2 X P9	0.67*	-0.27	-0.27	-0.28	2.31**	1.66	1.11	-1.65
P2 X P10	0.39	-0.27	-0.60	-0.03	5.67**	6.41**	5.52**	6.02**
P3 X P4	-0.50	-0.27	-1.18*	-0.06	2.73**	6.24**	4.19**	6.35**
P3 X P5	0.67*	0.57	-0.10	0.78*	1.48*	4.41**	2.77*	6.18**
P3 X P6	-0.25	1.40**	-0.43	-0.56	-2.44**	-0.17	-1.48	-0.15
P3 X P7	-0.05	0.15	-0.35	0.03	-0.94	-3.67**	-2.73*	-4.15**
P3 X P8	0.03	-0.85	-0.43	-0.14	1.45	3.49**	4.77**	4.35**
P3 X P9	0.00	-0.60	0.90	0.14	3.65**	0.91	2.69*	-0.82
P3 X P10	0.06	0.40	-0.43	0.39	-1.66*	-2.34*	-2.89*	-3.15*
P4 X P5	-0.03	0.15	0.90	-0.31	-0.33	-0.59	1.86	1.35
P4 X P6	0.06	-0.02	1.57**	-0.64	1.09	-3.17**	-0.39	-0.98
P4 X P7	-0.08	-0.27	-0.35	-0.06	-1.08	1.33	-2.64*	-2.98
P4 X P8	0.00	0.73	-0.43	-0.22	-1.35	-1.51	-3.14*	-0.48
P4 X P9	0.31	-0.02	-0.10	1.05**	-4.16**	-4.09**	-6.23**	-1.65
P4 X P10	0.03	-0.02	0.57	0.30	1.20	-0.34	0.19	-5.98**
P5 X P6	-0.11	-0.18	-0.35	0.19	1.17	-0.01	3.19**	-3.15*
P5 X P7	-0.25	0.57	-0.27	-0.22	-3.33**	-5.51**	-3.06*	2.85
P5 X P8	-0.16	-0.43	-0.35	-0.39	3.06**	2.66*	0.44	-5.65**
P5 X P9	0.14	-0.18	-0.02	-0.11	0.92	3.08**	4.36**	1.18
P5 X P10	-0.14	-0.18	-0.35	0.14	1.62*	1.83	0.77	6.85**
P6 X P7	0.50	0.40	0.40	0.44	-3.24**	-2.09	-2.31	0.52
P6 X P8	0.25	-0.60	0.32	0.28	0.81	0.08	1.19	-3.98*
P6 X P9	-0.11	0.65	0.65	-0.45	-0.99	3.49**	3.11*	1.85
P6 X P10	-0.05	-1.35**	0.32	-0.20	-1.63*	-3.76**	-2.48*	-2.48
P7 X P8	0.11	-0.85	-0.60	-0.14	2.65**	1.58	2.94*	1.02
P7 X P9	-0.25	0.40	-0.27	0.14	1.84*	0.99	2.86*	1.85
P7 X P10	-0.19	0.40	0.40	0.39	-1.46*	-2.26*	0.27	-0.48
P8 X P9	-0.16	0.40	-0.35	-0.03	-0.10	1.16	2.36	2.35
P8 X P10	0.22	-0.60	-0.68	0.22	-5.08**	-5.09**	-4.23**	-3.98*
P9 X P10	-0.14	0.65	-0.35	-0.84*	-3.21**	-3.67**	-5.31**	-6.15**
SE sij	0.08	0.29	0.30	0.17	0.62	1.44	1.68	1.76

Table contd.....

Crosses	Plant height				Ear height			
	Rajendranagar		Palem		Rajendranagar		Palem	
	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
P1 X P2	10.58**	23.42**	26.33**	25.67**	19.37**	18.81**	10.46**	10.85**
P1 X P3	-14.08**	6.14	0.24	1.75	10.62**	10.08**	3.05	3.32
P1 X P4	-20.03**	-45.38**	12.90**	14.42**	-28.02**	-25.08**	5.09*	1.80
P1 X P5	-0.56	-53.69**	11.03**	10.27**	-10.96**	-10.50**	5.87*	6.13**
P1 X P6	19.78**	-6.47	14.45**	9.72**	-6.04**	-8.11**	7.24**	-8.06**
P1 X P7	8.56**	4.20	22.79**	24.39**	-4.10**	-4.75**	11.65**	12.48**
P1 X P8	-18.11**	16.39**	12.66**	9.11**	1.01	-2.47	10.41**	9.53**
P1 X P9	24.08**	22.76**	-12.74**	-11.42**	13.96**	17.39**	-8.93**	-9.40**
P1 X P10	10.67**	26.95**	10.79**	6.86**	13.51**	8.64**	6.26**	6.08**
P2 X P3	43.94**	16.39**	4.90*	2.89	3.68**	6.89**	0.62	0.59
P2 X P4	-16.00**	27.87**	30.76**	30.66**	6.71**	6.72**	17.74**	16.98**
P2 X P5	-0.53	-0.11	10.79**	24.41**	4.10**	4.97**	8.38**	8.30**
P2 X P6	-10.86**	-10.55*	-24.49**	-27.54**	-16.99**	-16.97**	-10.52**	-11.87**
P2 X P7	6.92**	-12.22*	14.42**	13.13**	2.96**	-0.61	9.99**	10.46**
P2 X P8	-3.42	19.64**	-0.31	-1.55	13.07**	15.67**	0.42	1.10
P2 X P9	10.44**	18.67**	-43.48**	-45.18**	0.68	-3.81*	-20.49**	-19.22**
P2 X P10	19.03**	-7.13	21.62**	20.70**	6.90**	6.44**	12.30**	12.56**
P3 X P4	-1.00	-25.41**	6.77**	7.64**	1.96**	-4.00*	2.09	0.44
P3 X P5	6.14*	7.95	19.00**	15.79**	-6.65**	-8.42**	-1.41	-0.33
P3 X P6	4.14	-16.16**	48.82**	47.14**	-6.40**	-2.36	23.63**	22.60**
P3 X P7	1.58	10.84*	-1.77	1.32	12.54**	10.33**	-6.79**	-5.07**
P3 X P8	16.58**	-28.97**	7.63**	8.63**	-1.02	-2.72	12.97**	13.57**
P3 X P9	19.78**	-11.27*	10.53**	11.31**	8.60**	7.81**	16.00**	16.14**
P3 X P10	15.03**	4.92	-6.37**	-11.02**	6.15**	-1.28	-2.38	-1.97
P4 X P5	43.53**	24.42**	-37.37**	-46.44**	17.04**	11.42**	-5.39*	-4.95*
P4 X P6	-12.81**	56.98**	3.65	1.41	27.29**	28.81**	-8.92**	-1.72
P4 X P7	18.97**	25.98**	-0.31	0.38	0.23	-3.50*	-1.78	-2.39
P4 X P8	26.97**	24.17**	-15.54**	-10.00**	16.68**	18.11**	-7.41**	-7.15**
P4 X P9	-13.17**	-13.80**	4.29	5.97*	11.62**	11.97**	5.17*	4.33*
P4 X P10	15.42**	-24.94**	3.99	5.55*	-0.15	13.89**	-0.64	-0.99
P5 X P6	24.67**	17.01**	8.88**	37.26**	21.35**	11.72**	1.35	0.41
P5 X P7	-12.89**	47.01**	11.93**	7.73**	13.29**	19.42**	8.79**	10.33**
P5 X P8	-2.89	14.20**	2.22	1.15	-0.60	12.03**	-9.37**	-9.02**
P5 X P9	-41.36**	11.23*	14.13**	10.02**	-0.65	0.22	11.02**	11.25**
P5 X P10	-28.11**	0.42	-7.07**	-14.60**	-13.77**	-12.19**	3.14	3.53
P6 X P7	17.11**	3.23	29.98**	27.38**	-7.46**	-4.19*	7.37**	5.77**
P6 X P8	-10.22**	-4.91	-12.69**	-20.50**	4.98**	3.75*	7.23**	7.01**
P6 X P9	-34.36**	-9.55	-45.32**	-45.73**	-10.40**	-11.39**	-19.11**	-17.22**
P6 X P10	-4.78*	-9.36	11.28**	11.65**	-12.18**	-13.47**	0.61	0.47
P7 X P8	-14.44**	-36.58**	-11.78**	-14.83**	2.93**	1.78	-12.39**	-11.67**
P7 X P9	-6.92**	-21.55**	18.72**	18.75**	-12.13**	-13.03**	8.03**	6.51**
P7 X P10	-10.00**	-2.02	-11.28**	-7.38**	2.10**	1.56	-12.08**	-11.41**
P8 X P9	-19.25**	-1.36	17.15**	19.67**	-14.68**	-18.75**	3.50	3.65
P8 X P10	-22.33**	22.17**	5.25*	10.34**	-21.79**	-20.83**	6.95**	7.83**
P9 X P10	22.19**	-3.13	4.89*	6.12*	-16.85**	-19.31**	-9.09**	-9.09**
SE sij	0.00	5.39	2.34	2.52	0.57	1.82	2.41	2.03

Crosses	Leaf area index (60 DAS)				Leaf dry weight (90 DAS)			
	Rajendranagar		Palem		Rajendranagar		Palem	
	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
P1 X P2	-0.37**	-0.33**	-0.97**	-1.02**	4.32	-81.31**	10.75*	2.20
P1 X P3	1.00**	1.07**	0.63**	0.60**	6.59	-16.63**	80.02**	79.46**
P1 X P4	-0.74**	-0.55**	0.18**	-0.04	60.65**	61.62**	70.19**	49.93**
P1 X P5	0.11*	0.12*	-1.49**	-1.46**	-8.28	87.67**	-20.27**	-18.07**
P1 X P6	1.31**	0.88**	-0.36**	-0.47**	-7.72	-25.65**	-34.85**	-26.48**
P1 X P7	0.07	-0.45**	-0.13**	-0.35**	5.54	19.62**	0.26	19.66**
P1 X P8	-0.93**	-0.80**	0.27**	0.26**	5.13	20.62**	1.17	-4.68
P1 X P9	0.89**	1.22**	0.49**	1.41**	17.72**	27.35**	-4.89	15.48**
P1 X P10	0.87**	0.83**	1.86**	1.77**	10.47*	18.48**	-7.04	3.99
P2 X P3	-0.95**	-0.82**	-1.28**	-1.25**	-2.75	70.05**	-11.46*	-18.60**
P2 X P4	0.13**	0.09	0.80**	0.87**	-2.59	-7.10	2.40	3.07
P2 X P5	0.99**	1.12**	1.48**	1.50**	24.69**	-14.65**	16.75**	37.38**
P2 X P6	-0.21**	-0.21**	-0.80**	-0.86**	-14.35**	83.63**	-28.33**	-21.34**
P2 X P7	1.43**	1.65**	1.53**	1.40**	19.60**	30.70**	-1.82	24.10**
P2 X P8	1.02**	0.94**	0.54**	0.63**	-2.90	-2.90	9.89*	5.76
P2 X P9	-0.83**	-0.69**	-1.53**	-1.54**	64.59**	-9.77*	71.83**	4.92
P2 X P10	0.52**	0.36**	0.59**	0.57**	28.24**	29.45**	14.28**	30.23**
P3 X P4	-0.05	-0.05	0.28**	0.07*	-0.41	-17.52**	-8.02	-19.77**
P3 X P5	1.32**	1.28**	0.81**	1.00**	11.06*	4.53	16.92**	60.03**
P3 X P6	0.53**	0.56**	0.88**	0.82**	-10.48*	-35.99**	-23.45**	-18.88**
P3 X P7	0.17**	-0.04	-0.37**	-0.49**	-6.62	83.88**	-32.05**	-30.24**
P3 X P8	0.20**	0.43**	0.50**	0.57**	20.47**	-6.82	24.76**	4.82
P3 X P9	0.37**	0.47**	0.56**	0.61**	18.46**	16.01**	7.70	20.48**
P3 X P10	-0.59**	-0.84**	-0.45**	-0.45**	-10.39*	-35.96**	-35.05**	-33.61**
P4 X P5	0.00	0.27**	0.61**	0.57**	5.92	23.38**	5.59	9.90*
P4 X P6	1.52**	1.58**	0.97**	1.54**	32.18**	29.56**	15.21**	28.98**
P4 X P7	0.07	-0.77**	-0.65**	-0.99**	20.14**	16.83**	-8.18	22.43**
P4 X P8	-0.48**	-0.29**	-0.72**	-0.77**	-14.57**	3.03	1.33	-3.52
P4 X P9	0.31**	0.45**	-0.09**	0.81**	-17.38**	-10.14*	-14.03**	0.94
P4 X P10	0.37**	0.27**	1.26**	1.14**	-50.43**	-52.31**	-55.98**	-55.14**
P5 X P6	1.44**	1.59**	1.87**	1.65**	14.35**	30.31**	-3.05	15.69**
P5 X P7	-0.68**	-0.85**	-0.43**	1.58**	-22.89**	-0.52	-47.74**	-24.57**
P5 X P8	1.16**	1.18**	1.20**	0.42**	34.60**	30.68**	13.67**	19.39**
P5 X P9	-0.15**	-0.03	0.25**	-1.60**	-24.40**	-16.49**	-53.59**	-33.65**
P5 X P10	-1.14**	-1.48**	-1.24**	-1.11**	7.95	24.24**	93.86**	-0.93
P6 X P7	-0.50**	-0.35**	-0.64**	-0.81**	2.77	-65.34**	59.09**	-6.48
P6 X P8	-0.72**	-0.66**	-0.34**	-0.08*	11.36*	5.16	7.90	12.38**
P6 X P9	-0.92**	-0.85**	-0.23**	-0.27**	2.85	8.50*	-16.16**	7.73
P6 X P10	-1.34**	-1.55**	-1.05**	-0.99**	-27.00**	-28.18**	48.09**	-24.35**
P7 X P8	-1.02**	-1.06**	-1.18**	-1.21**	-24.38**	-16.67**	-51.30**	-32.48**
P7 X P9	1.89**	0.49**	2.17**	1.88**	17.31**	23.16**	-13.15**	23.08**
P7 X P10	-0.42**	1.83**	-0.04	-0.29**	9.06	23.29**	-18.30**	18.59**
P8 X P9	0.66**	0.67**	0.67**	0.77**	-27.30**	-24.74**	-31.55**	-19.77**
P8 X P10	-1.25**	-1.63**	-1.09**	-1.01**	-9.05	-14.21**	-7.10	-0.85
P9 X P10	0.01	0.15**	0.06	0.26**	5.15	11.92**	-9.55*	27.01**
SE sij	0.0022	0.0028	0.001	0.0015	14.31	4.18	4.99	4.79

Crosses	Crop growth rate (60-75 DAS)				Relative Growth rate (60-75 DAS)			
	Rajendranagar		Palem		Rajendranagar		Palem	
	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
P1 X P2	1.73**	1.50**	1.89**	1.60**	0.003652*	0.004215*	0.003742*	0.003106*
P1 X P3	2.20**	2.05**	2.24**	2.45**	-0.002818	-0.00236	0.003409*	0.004227*
P1 X P4	-0.58	-0.56	-0.36	-0.39	0.004902*	0.003693*	0.004826*	0.005477*
P1 X P5	-3.18**	-2.78**	-3.41**	-2.33**	0.005318*	0.005610*	0.004326*	0.004311*
P1 X P6	-1.42**	-1.75**	-0.53	-1.18*	0.004902*	-0.002943	0.005492*	0.007477*
P1 X P7	3.97**	5.10**	3.64**	3.90**	0.000598	-0.00069	0.000008	-0.00092
P1 X P8	1.19*	0.35	1.17*	1.20*	0.004985*	0.005132*	-0.002992	-0.00178
P1 X P9	3.10**	4.00**	3.04**	2.68**	0.012098*	0.013474*	0.012424*	0.011189*
P1 X P10	6.05**	4.85**	5.44**	5.18**	0.017515*	0.015557*	0.014841*	0.014023*
P2 X P3	0.05	0.14	-0.11	-0.70	0.007652*	0.009382*	0.008909*	0.009061*
P2 X P4	-0.93	-0.78	-0.81	-0.44	0.004265*	0.006285*	0.005674*	0.002689*
P2 X P5	-2.93**	-2.90**	-2.76**	-2.98**	0.000848	-0.00163	0.007826*	0.007144*
P2 X P6	-1.97**	-2.66**	-1.28*	-2.03**	0.008735*	0.005965*	0.007992*	0.008311*
P2 X P7	-0.18	0.69	-0.21	-0.35	0.005235*	0.005285*	0.006508*	0.006245*
P2 X P8	8.64**	7.74**	8.32**	7.95**	0.008182*	0.002113	0.002508*	0.005384*
P2 X P9	0.85	1.19*	0.59	0.63	0.006265*	0.004452*	0.005924*	0.003356*
P2 X P10	9.79**	9.54**	9.29**	9.63**	0.002682*	0.005535*	0.006341*	0.003189*
P3 X P4	-0.36	-0.22	-0.37	0.11	-0.002902	-0.00086	-0.00199	-0.00164
P3 X P5	-3.06**	-3.04**	-3.41**	-3.03**	0.005682*	0.005224*	0.004508*	0.005523*
P3 X P6	-0.50	-1.50**	-0.14	-0.88	0.003098*	-0.00111	0.002341	0.002356
P3 X P7	1.49**	2.95**	1.64**	2.20**	0.003402*	0.003860*	0.005159*	0.005088*
P3 X P8	1.51**	0.50	1.46**	1.60**	-0.00199	-0.0013	-0.00216	-0.00095
P3 X P9	1.23*	2.45**	1.03*	1.38**	0.006902*	0.006693*	0.006742*	0.008977*
P3 X P10	6.97**	5.90**	6.43**	5.97**	0.005485*	-0.002610	0.006674*	0.006856*
P4 X P5	5.16**	4.85**	4.19**	4.82**	0.002598*	0.004890*	0.003091*	0.004273*
P4 X P6	10.82**	10.18**	11.36**	10.58**	0.016015*	0.000557	0.016924*	0.016106*
P4 X P7	-3.19**	-1.97**	-3.16**	-3.34**	0.007485*	0.007193*	0.007576*	0.006338*
P4 X P8	-2.27**	-2.92**	-1.84**	-2.34**	-0.00207	-0.00063	-0.00158	-0.0002
P4 X P9	-3.46**	-2.47**	-3.77**	-3.56**	0.007985*	0.007026*	0.008159*	0.010227*
P4 X P10	6.69**	5.58**	5.93**	5.83**	0.005568*	0.005943*	0.008742*	0.007394*
P5 X P6	6.52**	-0.24	6.62**	6.23**	0.004402*	0.008360*	-0.00058	0.003273*
P5 X P7	5.81**	6.31**	5.99**	4.32**	0.001098	0.00089	0.000924	0.001162
P5 X P8	6.73**	3.56**	6.22**	6.62**	0.003485*	-0.00255	-0.00208	0.001634
P5 X P9	3.64**	6.91**	4.29**	3.30**	0.009402*	0.008943*	0.008659*	0.010061*
P5 X P10	0.79	6.46**	0.79	0.69	0.000015	0.00014	-0.00024	0.000773
P6 X P7	-4.33**	-3.65**	-3.33**	-4.13**	0.001515	0.002557	-0.00024	0.000662
P6 X P8	-4.11**	6.30**	-3.91**	-4.23**	0.011068*	0.007882*	0.010242*	0.009199*
P6 X P9	-3.00**	-2.85**	-2.64**	-2.95**	0.007015*	0.008724*	0.006174*	0.002773*
P6 X P10	-6.36**	-6.80**	-5.14**	-5.36**	0.003432*	0.005807*	0.002591*	0.003606*
P7 X P8	-1.92**	-1.65**	-1.83**	-1.55**	0.012432*	0.011368*	0.012258*	0.013356*
P7 X P9	9.59**	-0.90	8.34**	8.93**	0.011515*	0.009974*	0.011674*	0.009328*
P7 X P10	-3.96**	-3.65**	-3.76**	-3.88**	0.000932	-0.00194	-0.002909	-0.002838
P8 X P9	-1.59**	-1.95**	-1.44**	-2.17**	0.006068*	0.004465*	0.007326*	0.007533*
P8 X P10	-3.15**	-4.50**	-3.14**	-2.98**	0.006652*	0.005382*	0.004909*	-0.0017
P9 X P10	-3.23**	-2.75**	-3.07**	-2.89**	-0.00057	-0.00178	0.000508	-0.002727
SE sij	0.2707	0.2794	0.2989	0.249	0.0000	0.0000	0.0000	0.0000

Table contd....

Crosses	Net assimilation rate (60-75 DAS)				Specific leaf weight (90 DAS)			
	Rajendranagar		Palem		Rajendranagar		Palem	
	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
P1 X P2	-1.43**	-1.16**	-1.47**	-1.50**	0.17	-0.10	-0.74**	0.94**
P1 X P3	-0.12	0.59**	-0.31	-0.63**	-0.92**	0.79**	0.84**	-0.58**
P1 X P4	-0.62**	-0.36	-0.57**	0.60**	0.37	-0.74**	1.18**	-0.29
P1 X P5	-0.06	-0.38	-0.45*	-0.33	0.07	-0.16	-0.22	-0.03
P1 X P6	0.08	-0.29	-0.07	0.62**	0.33	1.18**	-0.68**	0.19
P1 X P7	1.74**	-0.09	1.56**	1.17**	1.73**	-0.67**	0.54**	0.89**
P1 X P8	0.32	0.82**	0.79**	1.21**	-0.32	0.47*	0.55**	1.20**
P1 X P9	1.05**	1.42**	0.74**	1.03**	1.39**	1.60**	2.16**	1.50**
P1 X P10	2.33**	2.16**	1.62**	-0.01	0.88**	0.52*	-0.62**	0.43
P2 X P3	0.04	-0.26	-0.50**	-0.17	2.29**	1.85**	1.29**	1.06**
P2 X P4	0.81**	1.40**	0.85**	0.48**	1.58**	1.00**	0.20	1.14**
P2 X P5	0.17	-1.13**	1.26**	-0.22	0.80**	1.04**	1.75**	1.05**
P2 X P6	0.24	-0.16	0.35*	0.54**	-1.74**	-1.06**	0.83**	-0.65**
P2 X P7	0.95**	1.11**	0.62**	1.29**	2.05**	1.30**	1.45**	0.43
P2 X P8	0.18	0.33	-0.63**	-0.62**	2.21**	1.20**	0.50*	1.56**
P2 X P9	0.23	0.23	-0.60**	0.55**	0.52*	0.81**	-0.07	1.19**
P2 X P10	0.45*	1.26**	0.84**	1.20**	0.10	0.17	0.83**	-0.24
P3 X P4	-1.08**	-0.44*	1.01**	1.29**	-0.63**	-0.29	-0.66**	-0.62**
P3 X P5	1.62**	2.41**	0.03	0.62**	1.59**	1.79**	0.53**	-0.30
P3 X P6	0.36	0.67**	0.95**	1.16**	0.22	1.00**	-0.45*	0.81**
P3 X P7	0.29	-0.36	-0.09	1.00**	-1.35**	-1.91**	-0.86**	-0.83**
P3 X P8	1.43**	1.10**	2.05**	0.65**	1.21**	0.31	0.85**	-0.67**
P3 X P9	0.62**	0.37	-0.35*	-1.17**	0.61**	0.11	1.12**	1.44**
P3 X P10	1.10**	0.63**	0.89**	0.45*	1.00**	0.78**	0.78**	2.01**
P4 X P5	0.41*	-0.19	1.12**	1.02**	0.97**	1.33**	0.73**	0.94**
P4 X P6	1.49**	1.33**	0.66**	1.28**	1.81**	1.07**	0.94**	0.70**
P4 X P7	-0.19	0.17	-0.98**	-0.20	0.23	0.14	1.76**	2.48**
P4 X P8	0.28	-0.13	0.11	0.02	0.39	0.49*	1.02**	0.37
P4 X P9	-0.46*	-0.42*	-0.88**	-1.11**	1.80**	0.87**	0.17	0.93**
P4 X P10	0.77**	0.03	0.48**	-0.28	-2.02**	-1.24**	-1.83**	-1.92**
P5 X P6	1.45**	2.46**	1.58**	1.40**	1.92**	1.24**	0.30	0.46*
P5 X P7	0.07	-1.56**	0.12	0.23	-1.16**	-1.37**	-1.89**	-1.67**
P5 X P8	0.98**	1.09**	1.03**	1.19**	2.01**	1.13**	0.35	0.57**
P5 X P9	-0.86**	-0.31	-0.19	0.41*	-1.49**	-1.62**	-1.74**	-0.10
P5 X P10	-0.96**	-1.48**	-0.04	-0.86**	-0.71**	-0.61**	-0.13	-0.43*
P6 X P7	-1.49**	-1.37**	-0.65**	-1.22**	-0.52*	0.75**	1.09**	0.56*
P6 X P8	0.27	-0.25	0.15	-0.37*	1.55**	0.26	0.79**	0.87**
P6 X P9	-0.48**	-0.61**	-0.37*	-0.99**	0.18	0.18	-0.50*	-0.44*
P6 X P10	-1.12**	-0.67**	-1.39**	-0.70**	-1.15**	-1.55**	-1.07**	-0.42
P7 X P8	-0.67**	0.29	-0.85**	0.06	-0.11	-0.21	-1.06**	0.75**
P7 X P9	1.04**	1.76**	1.99**	1.31**	1.19**	1.44**	1.03**	0.40
P7 X P10	1.04**	1.49**	0.26	-0.08	0.95**	1.00**	2.16**	0.00
P8 X P9	0.21	0.48*	-0.25	-0.49**	-3.15**	-1.35**	-1.69**	-1.77**
P8 X P10	-1.01**	-0.68**	-0.57**	-0.26	-1.48**	-1.19**	-0.22	-1.60**
P9 X P10	-0.16	-0.90**	0.21	1.30**	1.62**	0.83**	-0.38*	0.42
SE sij	0.0388	0.0456	0.04	0.04	0.07	0.05	0.04	0.05

Crosses	Total biomass				Total chlorophyll content			
	Rajendranagar		Palem		Rajendranagar		Palem	
	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
P1 X P2	-0.93**	-1.15**	0.34**	0.57**	0.20**	0.21**	0.22**	0.20**
P1 X P3	-0.29	0.31*	0.25*	-0.07	0.00	0.01	-0.01	0.00
P1 X P4	0.14	0.41**	0.56**	0.35	-0.11**	-0.11**	-0.12**	-0.06*
P1 X P5	-0.92**	-0.59**	-0.18	0.40	-0.01	-0.03	-0.02	0.01
P1 X P6	0.15	0.48**	0.71**	0.37	0.10**	0.11**	0.07*	0.12**
P1 X P7	0.14	0.39**	0.46**	0.87**	0.09**	0.11**	0.11**	0.13**
P1 X P8	0.90**	0.55**	0.19	0.30	-0.05*	-0.04	-0.04	-0.04
P1 X P9	0.68**	0.66**	0.01	0.31	-0.07**	-0.08**	-0.07*	-0.04
P1 X P10	1.34**	1.20**	0.70**	0.78**	-0.08**	-0.09**	-0.09**	-0.17**
P2 X P3	-0.85**	-0.32*	0.01	0.29	0.16**	0.16**	0.16**	0.13**
P2 X P4	0.54**	0.50**	0.38**	-0.50*	0.17**	0.16**	0.17**	0.13**
P2 X P5	0.57**	0.56**	0.17	0.11	0.09**	0.05*	0.09**	0.06*
P2 X P6	0.43*	0.42**	0.50**	0.61**	0.07**	0.08**	0.05*	0.05*
P2 X P7	1.01**	1.12**	0.50**	0.52**	0.01	0.02	0.01	0.03
P2 X P8	0.72**	0.94**	0.52**	0.34	0.02	0.03	0.01	0.05*
P2 X P9	0.30	0.22	0.56**	0.73**	-0.09**	-0.06**	-0.10**	-0.10**
P2 X P10	1.15**	1.01**	0.26*	0.51*	-0.05*	-0.05	-0.08**	-0.03
P3 X P4	0.83**	0.26*	0.43**	-0.19	0.06*	0.07**	0.05	0.05*
P3 X P5	-0.82**	-0.37**	0.42**	0.63**	-0.11**	-0.12**	-0.11**	-0.13**
P3 X P6	0.52**	0.46**	0.25*	0.55**	-0.05*	-0.04	-0.03	-0.06*
P3 X P7	1.02**	0.71**	0.25*	0.48*	0.17**	0.18**	0.20**	0.22**
P3 X P8	0.03	0.25	0.35**	0.30	0.12**	0.11**	0.11**	0.15**
P3 X P9	1.02**	0.64**	0.49**	0.15	0.11**	0.11**	0.10**	0.08**
P3 X P10	-0.38*	-0.17	0.15	0.51*	0.11**	0.11**	0.10**	0.08**
P4 X P5	0.99**	0.85**	0.24*	0.78**	-0.15**	-0.15**	-0.14**	-0.16**
P4 X P6	0.96**	1.05**	0.10	0.46*	-0.10**	-0.09**	-0.07*	-0.12**
P4 X P7	0.26	0.51**	0.55**	0.06	-0.05	-0.03	-0.03	-0.10**
P4 X P8	-0.21	-0.29*	-0.12	-0.33	-0.03	-0.05	-0.03	-0.02
P4 X P9	-0.13	0.02	0.32**	0.82**	0.05	0.05*	0.03	0.06*
P4 X P10	-0.17	-0.05	0.11	0.13	0.01	0.01	0.01	0.03
P5 X P6	0.62**	0.53**	0.24*	-0.10	-0.11**	-0.11**	-0.12**	-0.10**
P5 X P7	-0.83**	-0.63**	-0.01	-0.06	0.04	0.04	0.04	0.02
P5 X P8	0.84**	0.71**	0.34**	0.69**	0.17**	0.17**	0.17**	0.14**
P5 X P9	0.58**	0.47**	-0.09	0.26	0.17**	0.17**	0.18**	0.17**
P5 X P10	0.51**	0.53**	0.55**	0.43*	0.16**	0.16**	0.15**	0.19**
P6 X P7	0.05	0.42**	-0.01	0.65**	-0.08**	-0.08**	-0.07*	-0.11**
P6 X P8	0.16	0.29*	-0.14	0.58**	0.06*	0.07**	0.04	0.06*
P6 X P9	-0.32	-0.22	-0.44**	-0.51*	0.00	0.02	0.01	-0.01
P6 X P10	-0.61**	-1.12**	0.32**	0.08	0.11**	0.07**	0.12**	0.12**
P7 X P8	-0.30	-1.05**	0.03	-0.19	0.04	0.04	0.05	0.01
P7 X P9	0.86**	0.82**	0.60**	-0.37	-0.08**	-0.07**	-0.04	-0.09**
P7 X P10	-0.16	-0.25	-0.70**	-0.66**	0.00	0.01	0.04	0.03
P8 X P9	-0.39*	0.70**	0.07	0.21	-0.12**	-0.13**	-0.11**	-0.13**
P8 X P10	-0.26	0.39**	0.80**	0.47*	-0.14**	-0.14**	-0.13**	-0.12**
P9 X P10	0.53**	0.33*	0.41**	0.15	-0.02	-0.01	-0.03	-0.03
SE sij	0.04	0.02	0.02	0.05	0.00	0.00	0.00	0.00

Crosses	Harvest index				Protein content			
	Rajendranagar		Palem		Rajendranagar		Palem	
	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
P1 X P2	-0.54	1.48*	-2.31*	-2.88**	-0.60**	-0.56**	-0.60**	-0.55**
P1 X P3	-0.71	-5.90**	-5.79**	-7.34**	-0.43*	-0.36**	-0.48**	-0.42**
P1 X P4	1.93**	1.19	-0.96	-3.05**	0.82**	0.83**	0.72**	0.82**
P1 X P5	-3.44**	-7.49**	-1.35	1.80*	0.57**	0.53**	0.46**	0.56**
P1 X P6	0.37	-1.63**	1.15	-0.30	0.49**	0.56**	0.41**	0.56**
P1 X P7	1.71**	0.56	-0.34	2.60**	0.01	0.05	-0.04	0.02
P1 X P8	-2.47**	0.07	-0.53	-1.14	-0.81**	-0.82**	-0.90**	-0.84**
P1 X P9	2.62**	2.56**	4.88**	4.60**	-0.90**	-0.91**	-1.05**	-0.96**
P1 X P10	3.95**	3.83**	0.86	0.13	-0.12	-0.16	-0.27**	-0.13
P2 X P3	-3.91**	-6.91**	-1.64	-2.18*	-0.23	-0.23*	-0.16	-0.22*
P2 X P4	2.13**	3.32**	3.59**	4.41**	-0.48**	-0.54**	-0.46**	-0.54**
P2 X P5	0.62	0.88	1.47	2.80**	-0.33	-0.26**	-0.27**	-0.34**
P2 X P6	0.03	-1.13	-3.85**	-3.01**	0.09	0.10	0.11	0.15
P2 X P7	2.49**	0.66	-1.69	1.84*	0.11	0.09	0.15	0.07
P2 X P8	2.32**	2.28**	4.01**	2.20*	-0.01	-0.05	0.02	-0.06
P2 X P9	1.42**	0.83	-1.54	-4.09**	0.40*	0.36**	0.44**	0.39**
P2 X P10	2.78**	2.78**	2.67**	1.25	-0.72**	-0.65**	-0.60**	-0.63**
P3 X P4	-1.89**	1.14	3.81**	1.71	0.79**	0.77**	0.75**	0.75**
P3 X P5	-15.78**	-14.89**	-0.29	1.47	0.64**	0.75**	0.75**	0.68**
P3 X P6	-0.62	-0.13	-0.80	0.30	-0.64**	-0.51**	-0.57**	-0.59**
P3 X P7	2.21**	3.78**	0.56	0.31	-0.82**	-0.82**	-0.82**	-0.89**
P3 X P8	4.32**	3.06**	1.21	-0.40	-0.94**	-1.06**	-1.07**	-0.55**
P3 X P9	2.42**	5.27**	1.51	2.04*	0.97**	1.04**	0.97**	0.97**
P3 X P10	-4.06**	-5.28**	-2.50*	-0.99	-0.05	-0.04	-0.04	-0.07
P4 X P5	2.46**	5.27**	0.45	5.11**	-0.71**	-0.67**	-0.72**	-0.69**
P4 X P6	4.06**	3.24**	6.16**	9.05**	-0.39*	-0.33**	-0.37**	-0.36**
P4 X P7	2.26**	1.43*	5.13**	-2.58**	-0.67**	-0.73**	-0.72**	-0.67**
P4 X P8	-2.64**	-3.94**	-6.26**	-0.87	1.61**	1.89**	1.81**	1.71**
P4 X P9	0.07	-1.96**	4.90**	-3.20**	-0.42*	-0.46**	-0.45**	-0.47**
P4 X P10	-1.35**	-2.74**	3.52**	2.19*	-0.80**	-0.86**	-0.85**	-0.85**
P5 X P6	2.24**	1.75**	1.67	2.18*	0.66**	0.17	0.75**	0.75**
P5 X P7	-3.51**	-5.47**	-5.08**	-6.37**	-1.27**	-1.16**	-1.21**	-1.23**
P5 X P8	1.63**	2.22**	-0.26	1.29	1.06**	1.07**	1.05**	1.04**
P5 X P9	2.17**	1.68**	-4.29**	-3.90**	-0.93**	-0.85**	-0.89**	-0.93**
P5 X P10	1.20**	1.57**	-3.79**	-0.59	1.45**	1.62**	1.54**	1.50**
P6 X P7	-1.55**	-5.31**	-2.92**	0.57	0.10	0.19	0.16	0.17
P6 X P8	0.78	-0.42	-1.84	2.59**	-0.02	0.04	0.01	-0.05
P6 X P9	-2.25**	-3.48**	-6.75**	-8.17**	-0.01	0.16	0.04	0.06
P6 X P10	-7.21**	-1.19*	-0.24	-2.93**	-0.63**	-0.54**	-0.59**	-0.60**
P7 X P8	-8.47**	-1.03	-2.42*	-6.16**	-0.10	-0.18	-0.14	-0.15
P7 X P9	1.70**	2.06**	10.48**	2.98**	1.11**	1.13**	1.10**	1.15**
P7 X P10	-1.79**	-1.15	-7.18**	-6.02**	0.29	0.26*	0.27**	0.39**
P8 X P9	0.88*	-4.25**	-1.50	-1.92*	-0.01	-0.05	-0.07	-0.07
P8 X P10	-5.89**	-8.12**	0.85	-1.03	0.67**	0.68**	0.70**	0.67**
P9 X P10	-0.18	1.04	1.73	1.05	-0.42*	-0.37**	-0.41**	-0.40**
SE sij	0.22	0.41	1.05	0.93	0.03	0.01	0.01	0.00

Crosses	Seed protein yield				Oil per cent			
	Rajendranagar		Palem		Rajendranagar		Palem	
	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
P1 X P2	-198.09**	-209.07**	-0.68	-3.58	0.43	0.53**	0.61**	0.57**
P1 X P3	-101.14**	-102.89**	-109.57**	-126.90**	0.51*	0.47**	0.35	0.37*
P1 X P4	137.49**	160.33**	91.51*	58.49**	-0.62**	-0.61**	-0.58**	-0.63**
P1 X P5	-266.72**	-250.27**	75.38	69.32**	0.40	0.19**	0.24	0.14
P1 X P6	68.35**	67.96**	-62.38	182.02**	-0.08	-0.06	0.15	0.02
P1 X P7	62.35**	64.62*	212.82**	140.56**	-0.21	-0.21**	-0.14	-0.11
P1 X P8	64.60**	69.26**	-31.24	-32.07**	0.61**	0.86**	0.85**	0.87**
P1 X P9	132.78**	135.47**	124.91**	112.28**	-0.81**	-0.89**	-0.72**	-0.73**
P1 X P10	314.49**	312.13**	179.62**	176.60**	0.22	0.44**	0.45*	0.48**
P2 X P3	-245.18**	-227.33**	-43.31	-2.40	-1.22**	-1.54**	-1.50**	-1.35**
P2 X P4	133.86**	147.43**	145.36**	118.42**	-0.42	-0.70**	-0.66**	-0.60**
P2 X P5	41.25**	64.43*	35.92	52.74**	0.15	0.30**	0.38	0.22
P2 X P6	71.50**	59.93*	83.13*	23.13**	0.08	0.18**	0.23	0.41**
P2 X P7	270.71**	228.06**	168.34**	34.41**	0.06	0.12	0.38	0.09
P2 X P8	214.87**	235.82**	159.75**	175.39**	-0.07	-0.01	-0.19	-0.06
P2 X P9	110.75**	121.84**	61.47	115.32**	0.08	0.28**	0.32	0.21
P2 X P10	210.95**	206.43**	77.68*	112.69**	0.60*	0.58**	0.46*	0.55**
P3 X P4	61.40**	79.18**	189.03**	157.86**	0.14	0.27**	0.10	0.19
P3 X P5	144.27**	40.54	188.30**	191.24**	0.65**	0.64**	0.68**	0.66**
P3 X P6	-2.04	16.57	36.89	16.24*	0.20	-0.09	-0.11	-0.15
P3 X P7	112.06**	117.97**	20.14	25.36**	0.03	0.17*	0.17	0.20
P3 X P8	11.81*	19.89	-20.66	-4.37	0.20	0.02	0.53**	0.26
P3 X P9	247.69**	260.76**	269.08**	136.66**	-0.06	0.16*	0.00	0.11
P3 X P10	-154.40**	-149.34**	-165.98**	11.37	-0.03	0.13	0.15	0.11
P4 X P5	142.83**	152.21**	95.18*	82.31**	0.39	0.32**	0.24	0.51**
P4 X P6	278.73**	280.73**	244.34**	218.17**	0.79**	0.51**	0.65**	0.51**
P4 X P7	70.89**	63.61*	-36.18	106.71**	-0.13	-0.02	0.23	-0.04
P4 X P8	-77.02**	-49.77*	3.70	17.67*	-1.35**	-0.27**	-0.29	-0.27
P4 X P9	-35.14**	-52.04*	-30.08	-21.54**	0.49*	0.38**	0.21	0.42**
P4 X P10	-100.74**	-116.53**	11.52	28.79**	0.14	0.01	0.11	0.02
P5 X P6	160.79**	166.66**	121.08**	98.79**	-0.03	-0.05	0.15	-0.03
P5 X P7	-293.05**	-292.07**	-234.02**	-215.99**	-0.10	-0.09	-0.30	-0.21
P5 X P8	213.24**	231.73**	134.09**	203.95**	0.02	0.10	0.22	0.20
P5 X P9	28.12**	26.74	-162.72**	-121.43**	-0.28	-0.21**	-0.32	-0.22
P5 X P10	155.02**	176.63**	180.69**	68.09**	-0.30	-0.24**	-0.35	-0.39*
P6 X P7	-30.75**	-33.58	17.49	29.83**	0.00	0.01	-0.69**	0.25
P6 X P8	60.93**	59.92*	120.48**	17.50*	-0.17	-0.34**	-0.16	-0.19
P6 X P9	-113.99**	-117.93**	-220.58**	-186.63**	-0.47*	-0.55**	-0.45*	-0.45**
P6 X P10	-231.41**	-229.14**	-46.12	-34.08**	-0.35	-0.32**	-0.05	-0.24
P7 X P8	-191.70**	-189.75**	-67.87	-139.37**	0.65**	0.41**	0.41*	0.39*
P7 X P9	270.31**	285.98**	317.93**	335.45**	0.17	0.21**	0.21	0.26
P7 X P10	-45.91**	-46.61	-212.87**	-192.87**	-0.06	-0.09	-0.08	-0.13
P8 X P9	-12.27*	-12.16	-34.99	15.01*	-0.12	-0.09	-0.31	-0.26
P8 X P10	-104.36**	-109.11**	154.03**	153.52**	0.26	0.18**	0.02	0.24
P9 X P10	45.52**	53.24*	165.17**	17.74*	0.47*	0.34**	0.56**	0.44**
SE sij	5.71	26.76	41.82	7.77	0.60	0.00	0.05	0.03

Crosses	Oil yield/ha				Tryptophan content			
	Rajendranagar		Palem		Rajendranagar		Palem	
	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
P1 X P2	-100.34**	-109.50**	55.92**	47.11**	0.01	0.00	0.01	0.00
P1 X P3	-36.55**	-53.41**	-58.98**	-63.11**	0.06**	0.05**	0.04*	0.06**
P1 X P4	9.82	12.75	-21.28*	95.23**	0.01	0.01	0.01	0.01
P1 X P5	-168.41**	-176.86**	28.89**	15.89	-0.06**	-0.06**	-0.06**	-0.06*
P1 X P6	27.79*	23.19*	80.27**	73.66**	-0.05**	-0.05*	-0.05*	-0.05*
P1 X P7	32.00**	74.52**	35.14**	78.85**	-0.02	-0.02	-0.02	-0.02
P1 X P8	117.38**	138.89**	74.94**	63.22**	-0.05*	-0.05*	-0.05*	-0.05*
P1 X P9	69.09**	70.24**	61.41**	48.53**	0.04*	0.04	0.04	0.04
P1 X P10	239.90**	262.59**	150.67**	163.86**	0.07**	0.08**	0.07**	0.07**
P2 X P3	-191.87**	-204.96**	-114.74**	-115.60**	0.05*	0.05*	0.05**	0.05*
P2 X P4	53.69**	54.48**	67.11**	43.94**	-0.02	-0.02	-0.02	-0.02
P2 X P5	48.76**	68.61**	62.88**	67.87**	0.00	0.00	0.00	0.00
P2 X P6	42.56**	49.02**	8.19	29.55**	0.02	0.03	0.02	0.02
P2 X P7	162.47**	134.97**	141.23**	36.69**	-0.02	-0.01	-0.02	-0.02
P2 X P8	126.35**	168.06**	111.28**	119.25**	-0.04	-0.04	-0.03	-0.04
P2 X P9	53.16**	82.05**	43.65**	73.97**	0.00	0.00	0.00	0.00
P2 X P10	217.71**	228.16**	112.46**	161.34**	-0.03	-0.02	-0.03	-0.02
P3 X P4	19.64	7.84	86.16**	67.32**	0.03	0.03	0.03	0.03
P3 X P5	111.86**	160.20**	131.19**	144.90**	-0.02	-0.01	-0.02	-0.02
P3 X P6	11.15	19.85*	15.82	25.42*	-0.01	-0.01	-0.01	-0.01
P3 X P7	110.60**	100.32**	61.93**	76.32**	0.00	0.00	0.00	0.00
P3 X P8	52.55**	54.13**	50.08**	77.83**	-0.01	-0.01	0.00	-0.01
P3 X P9	108.86**	119.28**	116.95**	55.35**	0.03	0.03	0.03	0.03
P3 X P10	-104.07**	-107.98**	16.46	19.37	0.01	0.01	0.01	0.01
P4 X P5	147.52**	136.50**	115.78**	103.82**	0.05*	0.04*	0.04*	0.04
P4 X P6	239.17**	220.71**	219.35**	185.16**	0.05*	0.04*	0.04*	0.04
P4 X P7	59.88**	239.30**	24.53*	-5.46	-0.02	-0.02	-0.01	-0.02
P4 X P8	-118.03**	-114.76**	-72.36**	-84.86**	-0.03	-0.04	-0.03	-0.03
P4 X P9	17.02	-8.15	12.67	11.45	-0.02	-0.02	-0.02	-0.02
P4 X P10	-41.58**	-66.36**	32.26**	47.34**	-0.02	-0.03	-0.03	-0.03
P5 X P6	62.59**	59.56**	39.96**	25.50*	0.02	0.01	0.02	0.02
P5 X P7	-149.10**	-183.38**	-113.19**	-99.18**	0.00	-0.01	0.00	0.00
P5 X P8	90.93**	105.30**	63.46**	93.33**	0.02	0.02	0.01	0.02
P5 X P9	39.49**	34.82**	-80.73**	-51.15**	-0.01	-0.01	-0.01	-0.01
P5 X P10	21.61*	27.70**	15.34	-33.18**	0.00	0.00	0.00	0.00
P6 X P7	-16.60	-40.84**	24.23*	35.83**	0.01	0.01	0.02	0.02
P6 X P8	22.78*	23.71*	-8.67	3.84	0.03	0.02	0.02	0.02
P6 X P9	-86.86**	-93.55**	-148.27**	-134.14**	-0.06**	-0.06**	-0.06**	-0.06*
P6 X P10	-146.74**	-142.60**	-30.53**	-15.09	-0.03	-0.03	-0.04	-0.04
P7 X P8	-104.46**	-125.64**	-69.22**	-59.96**	0.00	0.00	0.00	0.01
P7 X P9	133.90**	127.41**	178.78**	183.86**	0.01	0.01	0.01	0.01
P7 X P10	-43.28**	-64.20**	-152.03**	-139.43**	0.01	0.00	0.00	0.01
P8 X P9	-18.47	-6.64	-25.44*	-0.43	0.02	0.02	0.02	0.02
P8 X P10	-86.35**	-85.89**	83.23**	90.84**	-0.02	-0.02	-0.02	-0.02
P9 X P10	70.66**	77.35**	113.80**	51.36**	0.01	0.01	0.01	0.01
SE sij	9.85	9.04	10.59	11.19	0.00	0.00	0.00	0.00

Table contd..

Crosses	Grain yield/ plot			
	Rajendranagar		Palem	
	Kharif	Rabi	Kharif	Rabi
P1 X P2	-0.85**	-0.87**	0.06	0.16
P1 X P3	-0.2	-0.43**	-0.60**	-0.55**
P1 X P4	0.48*	0.51**	0.07	0.11
P1 X P5	-1.34**	-1.38**	0.10	0.14
P1 X P6	0.41*	0.18	0.55**	0.58**
P1 X P7	0.21	0.40**	1.01**	0.69**
P1 X P8	0.56**	0.63**	0.11	0.13
P1 X P9	0.84**	0.95**	0.76**	0.84**
P1 X P10	1.48**	1.66**	0.82**	0.92**
P2 X P3	-1.15**	-1.09**	-0.23	0.02
P2 X P4	0.18	0.92**	0.85**	0.79**
P2 X P5	0.52**	0.32*	0.28*	0.32*
P2 X P6	0.59**	0.36*	-0.06	0.02
P2 X P7	1.29**	1.08**	0.90**	0.22
P2 X P8	1.13**	1.20**	0.91**	0.85**
P2 X P9	0.37	0.26	0.38**	0.37*
P2 X P10	1.27**	1.40**	0.50**	0.73**
P3 X P4	0.17	0.11	0.51**	0.46**
P3 X P5	0.55**	0.70**	0.66**	0.61**
P3 X P6	0.18	0.30*	0.29*	0.46**
P3 X P7	0.88**	0.79**	0.34**	0.42**
P3 X P8	0.43*	0.40**	0.36**	0.34*
P3 X P9	0.88**	0.79**	0.83**	0.38*
P3 X P10	-0.81**	-0.86**	0.02	0.02
P4 X P5	1.05**	0.90**	0.75**	0.76**
P4 X P6	1.41**	1.46**	1.22**	1.17**
P4 X P7	0.61**	0.45**	0.15	0.07
P4 X P8	-0.68**	-0.66**	-0.40**	-0.43**
P4 X P9	-0.10	-0.21	-0.11	0.05
P4 X P10	-0.34	-0.33*	0.27*	0.41**
P5 X P6	0.52**	0.51**	0.30*	0.20
P5 X P7	-1.22**	-1.19**	-0.73**	-0.70**
P5 X P8	0.62**	0.78**	0.42**	0.67**
P5 X P9	0.39*	0.35*	-0.58**	-0.35*
P5 X P10	0.34	0.30*	0.32*	-0.04
P6 X P7	-0.24	-0.12	0.08	0.22
P6 X P8	0.32	0.02	0.13	0.14
P6 X P9	-0.59**	-0.53**	-1.09**	-1.00**
P6 X P10	-1.13**	-1.10**	-0.03	0.01
P7 X P8	-1.00**	-0.85**	-0.64**	-0.60**
P7 X P9	1.05**	0.99**	1.06**	1.22**
P7 X P10	-0.27	-0.26	-1.15**	-0.84**
P8 X P9	-0.11	0.00	-0.12	0.17
P8 X P10	-0.67**	-0.68**	0.56**	0.49**
P9 X P10	0.36	0.41**	0.58**	0.14
SE sij	0.04	0.25	0.02	0.03

At Rajendranagar during *Rabi*, 14 Crosses exhibited positively significant *SCA* effects, while 16 of the crosses exhibited negatively significant *SCA* effects for this character. The *SCA* effects ranged between $-7.31(P1 \times P9)$ to $6.77(P3 \times P4)$ and at Palem the *SCA* effects ranged between $-6.98(P2 \times P5)$ to $7.34(P3 \times P4)$. 13 crosses out of 55 exhibited positively significant and 16 crosses out of 45 exhibited negatively significant *SCA* effects.

4.3.2.3 Anthesis Silking Interval

During *Kharif* at Rajendranagar, *SCA* effects ranged between $-0.39(P1 \times P8)$ to $0.67(P2 \times P9 \text{ and } P3 \times P5)$. Out of three significant *SCA* effects 2 hybrids exhibited positive *SCA* effects while one hybrid had significant negative *SCA* effects and at Palem, the *SCA* effects ranged between $-1.18(P3 \times P4)$ to $0.90(P4 \times P5)$. Only one Cross exhibited positively significant *SCA* effects and one Cross exhibited negatively significant *SCA* effects while rest of the crosses are non significant for this character.

The range of *SCA* effects for anthesis to silking interval was from $-1.35(P6 \times P10)$ to $-0.73(P4 \times P8, P2 \times P6)$. All are non significant while two hybrids showed negatively significant and one hybrid showed positive significant during *Rabi* at Rajendranagar and at Palem the *SCA* effects ranged between $-0.84(P9 \times P10)$ to $1.19(P1 \times P6)$. 3 crosses out of 45 exhibited positively significant and 1 cross out of 45 exhibited negatively significant *SCA* effects.

4.3.2.4 Days to maturity

During *Kharif* at Rajendranagar the *SCA* effects ranged between $-6.44(P1 \times P9)$ to $6.41(P2 \times P10)$. 12 crosses out of 45 exhibited positively significant and 16 crosses out of 45 exhibited negatively significant *SCA* effects and at Palem a total of 13 hybrids exhibited significantly negative and 12 hybrids exhibited significant

positive *SCA* effects out of 45 hybrids. The range of *SCA* effects was from -6.81 days¹⁸⁴ (P2 X P5) to 5.52 days (P2 X P10).

The *SCA* effects for days to maturity ranged between -6.67 (P1X P9) to 6.41 (P2 x P10). 16 hybrids exhibited significant negative *SCA* effects while 9 hybrids had significant positive *SCA* effects at Rajendranagar during *Rabi* and at Palem the range of *SCA* effects for days maturity was from to -6.65 (P2 X P5) to 6.85 (P5X P10). Out of 19 significant crosses, 6 were positively and 13 were negatively significant.

4.3.2.5 Plant height (cm)

The *SCA* effects ranged between -34.36(P6 X P9) to 43.94(P2X P3). 20 crosses out of 55 exhibited positively significant and 18 crosses exhibited negatively significant *SCA* effects during *Kharif* at Rajendranagar and at Palem the range of *SCA* effects were from to -45.32 (P6 X P9) to 48.82 (P3 X P6). Out of 37 significant crosses, 26 were positively and 11 were negatively significant.

During *Rabi* at Rajendranagar, *SCA* effects for plant height ranged between -53.69 (P1XP5) to 56.98 (P4 X P6). Out of thirty significant *SCA* effects 18 hybrids exhibited positive *SCA* effects while 12 hybrids had significant negative *SCA* effects and at Palem a total of 11 hybrids exhibited significantly negative and 27 hybrids exhibited significant positive *SCA* effects out of 45 hybrids. The range of *SCA* effects for days to 50 per cent tasseling was from -46.44 (P4X P5) to 47.14 (P3X P6).

4.3.2.6 Ear height (cm)

The range of *SCA* effects was from to -28.02 (P1X P4) to 27.29 (P4X P6). Out of 38 significant crosses, 23 were positively and were 15 negatively significant at Rajendranagar during *Kharif* and at Palem *SCA* effects ranged between -20.49(P2 X P9) to 23.63(P3 X P6). Out of thirty-three significant *SCA* effects 21 hybrids exhibited positive *SCA* effects while 12 hybrids had significant negative *SCA* effects.

During *Rabi* at Rajendranagar the range between lowest and highest *SCA* effects was from -25.08 (P1 X P4) to 28.81(P4 X P6). Significantly positive and negative effects were recorded in 20 and 17 hybrids, respectively and at Palem, 20 Crosses exhibited positively significant *SCA* effects, while 10 of the crosses exhibited negatively significant *SCA* effects for this character. The *SCA* effects ranged between -19.22 (P2X P9) to 22.60(P3X P6).

4.3.2.7 Leaf Area Index (LAI)

A total of 18 hybrids exhibited significantly negative and 22 hybrids exhibited significant positive *SCA* effects out of 55 hybrids. The range of *SCA* effects was from -1.34 (P6X P10) to 1.89 (P7XP9) at Rajendranagar during *Kharif* and at Palem *SCA* effects ranged between -1.53 (P2 X P9) to 2.17 (P7XP9). Out of forty-three significant *SCA* effects 23 hybrids exhibited positive *SCA* effects while 20 hybrids had significant negative *SCA* effects.

During *Rabi* at Rajendranagar, the *SCA* effects ranged between -1.63 (P8 X P10) to 1.83 (P7 X P10). 23 crosses out of 45 exhibited positively significant and 18 crosses exhibited negatively significant *SCA* effects and at Palem, 23 Crosses exhibited positively significant *SCA* effects, while 20 of the crosses exhibited negatively significant *SCA* effects for this character. The *SCA* effects ranged between -1.60 (P5X P9) to 1.83 (P7X P9)

4.3.2.8 Leaf Dry Weight (LDW) (gm^{-2})

During *Kharif* at Rajendranagar, 16 Crosses exhibited positively significant *SCA* effects, while 11 of the crosses exhibited negatively significant *SCA* effects for this character. The *SCA* effects ranged between -50.43 (P4X P10) to 64.59 (P2XP9) and at Palem the range between lowest and highest *SCA* effects were from -55.98

(P4XP10) to 71.83 (P2 X P9). Significantly positive and negative effects were recorded in 14 and 17 hybrids, respectively.

At Rajendranagar during *Rabi*, the *SCA* effects ranged between -81.31 (P1XP2) to 87.67 (P1X P5). 23 crosses out of 45 exhibited positively significant and 16 crosses out of 45 exhibited negatively significant *SCA* effects and at Palem a total of 15 hybrids exhibited significantly negative and 18 hybrids exhibited significant positive *SCA* effects out of 55 hybrids. The range of *SCA* effects was from -33.65(P5 x P9) to 79.46 (P1XP3).

4.3.2.9 Crop Growth Rate (CGR) ($\text{gm}^{-2}\text{d}^{-1}$)

At Rajendranagar during *Kharif*, 20 Crosses exhibited positive significant *SCA* effects, while 19 of the crosses exhibited negative significant *SCA* effects for this character. The *SCA* effects ranged between -4.33 (P6XP7) to 10.82 (P4 X P6) and at Palem *SCA* effects ranged between -5.14 (P6XP10) to 11.36 (P4 X P6). Out of thirty-five significant *SCA* effects 20 hybrids exhibited positive *SCA* effects while 15 hybrids had significant negative *SCA* effects.

A total of 17 hybrids exhibited significantly negative and 19 hybrids exhibited significant positive *SCA* effects out of 36 hybrids. The range of *SCA* effects for days to 50 per cent tasselling was from -4.50 (P8 X P10) to 10.18(P4 X P6) during *Rabi* at Rajendranagar and at Palem, the *SCA* effects ranged between -5.36 (P6 X P10) to 10.58 (P4 X P6). 20 crosses out of 45 exhibited positively significant and 17 crosses out of 45 exhibited negatively significant *SCA* effects.

4.3.2.10 Relative Growth Rate (RGR) ($\text{gg}^{-1}\text{d}^{-1}$)

The *SCA* effects ranged between -0.0087 (P2 X P6) to 0.0175 (P1 X P10). Out of thirty-six significant *SCA* effects 15 hybrids exhibited positive *SCA* effects while 22 hybrids had significant negative *SCA* effects during *Kharif* at Rajendranagar. At

Palem, a total of 19 hybrids exhibited significantly negative and 16 hybrids exhibited significant positive *SCA* effects out of 45 hybrids. The range of *SCA* effects for days to 50 per cent tasseling was from -0.0089(P2 X P3) to 0.0169 (P4 X P6).

At Rajendranagar during *Rabi*, the *SCA* effects ranged between -0.0094 (P2 X P3) to 0.015(P1X P10). 13 crosses out of 45 exhibited positively significant and 16 crosses out of 45 exhibited negatively significant *SCA* effects and at Palem, 17 Crosses exhibited positively significant *SCA* effects, while 17 of the crosses exhibited negatively significant *SCA* effects for this character. The *SCA* effects ranged between -0.010(P4 X P9) to 0.016(P4 X P6).

4.3.2.11 Net Assimilation Rate (NAR) ($\text{gm}^{-2}\text{d}^{-1}$)

At Rajendranagar during *Kharif*, *SCA* effects ranged between -1.41 (P6 X P7) to 2.33 (P1 X P10). Out of twenty-eight significant *SCA* effects, 17 hybrids exhibited positive *SCA* effects while 11 hybrids had significant negative *SCA* effects and at Palem the range of *SCA* effects were from to -1.37 (P1X P2) to 2.05 (P3 X P8). Out of 33 significant crosses, 19 were positively and 14 were negatively significant.

During *Rabi* at Rajendranagar, the *SCA* effects ranged between -1.56 (P5 X P7) to 2.46 (P5 X P6). 16 crosses out of 27 exhibited positively significant and 11 crosses exhibited negatively significant *SCA* effects whereas at Palem, 23 Crosses exhibited positively significant *SCA* effects, while 11 of the crosses exhibited negatively significant *SCA* effects for this character. The *SCA* effects ranged between -1.50 (P1XP2) to 1.40 (P5 X P6)

4.3.2.12 Specific Leaf Weight (SLW) (mgcm^{-2})

During *Kharif* at Rajendranagar the range between lowest and highest *SCA* effects was from -3.15 (P8 X P9) to 2.29(P2 X P3). Significant positive and negative effects were recorded in 22 and 13 hybrids, respectively. While at Palem, 24 Crosses

exhibited positively significant *SCA* effects, while 14 of the crosses exhibited negatively significant *SCA* effects for this character. The *SCA* effects ranged between -1.81 (P5 X P7) to 2.16 (P1X P9). 188

For SLW, the *SCA* effects ranged between -1.91 (P3 X P6) to 1.85 (P2 X P3). 24 crosses exhibited positively significant and 12 crosses exhibited negatively significant *SCA* effects at Rajendranagar during *Rabi* and at Palem, the *SCA* effects ranged between -1.92 (P4 X P10) to 2.48 (P4 X P7). 22 crosses out of 32 exhibited positively significant and 10 crosses out of 36 exhibited negatively significant *SCA* effects

4.3.2.13 Total biomass (Kg/plot)

At Rajendranagar during *Kharif* the range of *SCA* effects was from -0.92 (P1 X P2) to 1.34 (P1 X P10). Out of 30 significant crosses, 21 were positively and 9 were negatively significant. At Palem, the *SCA* effects ranged between -0.70 (P7 X P10) to 0.80 (P8 X P10). 28 crosses out of 45 exhibited positively significant and 2 crosses exhibited negatively significant *SCA* effects.

During *Rabi* at Rajendranagar *SCA* effects for total biomass ranged between -1.15 (P1 X P2) to 1.20 (P1 X P10). Out of thirty-eight significant *SCA* effects 30 hybrids exhibited positive *SCA* effects while 8 hybrids had significant negative *SCA* effects. At Palem, 19 Crosses exhibited positively significant *SCA* effects, while 3 of the crosses exhibited negatively significant *SCA* effects for this character. The *SCA* effects ranged between days to days -0.66 (P7 X P10) to 0.87 (P1 X P7)

4.3.2.14 Total Chlorophyll content (mg/g)

During *Kharif* at Rajendranagar the range of *SCA* effects was from -0.14 (P4X P5) to 0.20 (P1X P2). Out of 32 significant crosses, 17 were positively and were 15 negatively significant whereas at Palem chlorophyll content exhibited *GCA* effects

in the range from -0.14(P4 X P5) to 0.22(P1 XP2). Out of twenty-seven significant *SCA* effects 15 hybrids exhibited positive *SCA* effects while 12 hybrids had significant negative *SCA* effects.

At Rajendranagar during *Rabi*, the *SCA* effects ranged between -0.15 (P4XP5) to 0.21 (P1 X P2) .18 crosses out of 30 exhibited positively significant and 12 crosses exhibited negatively significant *SCA* effects and at Palem *SCA* effects ranged between -0.17 (P1X P10) to 0.22 (P3 X P7). Out of thirty-one significant *SCA* effects 19 hybrids exhibited positive *SCA* effects while 12 hybrids had significant negative *SCA* effects.

4.3.2.15 Harvest index (%)

The range between lowest and highest *SCA* effects was from -15.78 (P3 X P5) to 4.32 (P3 X P8). Significantly positive and negative effects were recorded in 18 and 15 hybrids, respectively during *Kharif* at Rajendranagar. At Palem, *SCA* effects ranged between -7.18 (P7 X P10) to 10.48 (P7 X P9). Out of twenty-one significant *SCA* effects 10 hybrids exhibited positive *SCA* effects while 11 hybrids had significant negative *SCA* effects.

During *Rabi* at Rajendranagar, the range of *SCA* effects for harvest index was from -14.89 (P3 X P5) to 5.27 (P3 X P9, P4 X P5). Out of 31 significant crosses, 17 were positively and 14 were negatively significant. At Palem, 14 Crosses exhibited positively significant *SCA* effects, while 15 of the crosses exhibited negatively significant *SCA* effects. The *SCA* effects ranged between -8.17 (P6X P9) to 9.05 (P4X P6).

4.3.2.16 Seed Protein content (%)

The range of *SCA* effects for protein% was from -1.27 (P5 X P7) to 1.61 (P4 X P8). Out of 31 significant crosses, 13 were positively and were 18 negatively

significant during *Kharif* at Rajendranagar. At Palem, *SCA* effects ranged between -1.21 (P5 X P7) to 1.81 (P4 X P8). Out of thirty-four significant *SCA* effects 14 hybrids exhibited positive *SCA* effects while 20 hybrids had significant negative *SCA* effects.

At Rajendranagar during *Rabi*, the *SCA* effects ranged between -1.16 (P5 X P7) to 1.89 (P4 X P8). 13 crosses out of 31 exhibited positively significant and 18 crosses exhibited negatively significant *SCA* effects whereas at Palem 14 Crosses exhibited positively significant *SCA* effects, while 20 of the crosses exhibited negatively significant *SCA* effects for this character. The *SCA* effects ranged between -1.23 (P5 X P7) to 1.71 (P4 X P8).

4.3.2.17 Seed protein yield (Kg/ha)

The *SCA* effects ranged between -293.05 (P5 X P7) to 314.49 (P1 X P10). 28 crosses out of 42 exhibited positively significant and 14 crosses exhibited negatively significant *SCA* effects at Rajendranagar during *Kharif*. At Palem the range of *SCA* effects was from -234.02 (P5 X P7) to 269.08 (P3 X P9). Out of 29 significant crosses, 22 were positively and 7 were negatively significant.

During *Rabi* at Rajendranagar, the *SCA* effects ranged between -292.07 (P5 X P7) to 285.98 (P7 X P9). 26 crosses out of 39 exhibited positively significant and 13 crosses exhibited negatively significant *SCA* effects. At Palem, *SCA* effects ranged between -215.99 (P5 X P7) to 335.44 (P7 X P9). Out of forty-one significant *SCA* effects 32 hybrids exhibited positive *SCA* effects while 9 hybrids had significant negative *SCA* effects.

4.3.2.18 Oil Content (%)

The range between lowest and highest *SCA* effects was from -1.35 (P4 X P8) to 0.79 (P4 X P6). Significantly positive and negative effects were recorded in 8 and 5 hybrids, respectively during *Kharif* at Rajendranagar and at Palem *SCA* effects ranged

between -1.50 (P2 X P3) to 0.85 (P4 X P6). Out of fifteen significant *SCA* effects 9 hybrids exhibited positive *SCA* effects while 6 hybrids had significant negative *SCA* effects.

At Rajendranagar during *Rabi*, the *SCA* effects ranged -1.54 (P2 X P3) to 0.86(P1 X P8). Among the 45 hybrids tested, 20 crosses exhibited significant positive *SCA* effects while, 11 crosses showed significant negative *SCA* effects for oil percent. At Palem, a total of 6 hybrids exhibited significantly negative and 12 hybrids exhibited significant positive *SCA* effects out of 45 hybrids. The range of *SCA* effects was from -1.35 (P2 X P3) to 0.87 (P4 X P6).

4.3.2.18 Oil yield (Kg/ha)

During *Kharif* at Rajendranagar, 26 Crosses exhibited positively significant *SCA* effects, while 13 of the crosses exhibited negatively significant *SCA* effects for this character. The *SCA* effects ranged between -191.87 (P2 X P3) to 239.90(P1 X P10). At Palem the range between lowest and highest *SCA* effects was from -152.03 (P7 XP 10) to 219.35 (P4 X P6). Significant positive and negative effects were recorded in 28 and 10 hybrids, respectively.

At Rajendranagar during *Rabi*, 27 Crosses exhibited positive significant *SCA* effects, while 14 of the crosses exhibited negative significant *SCA* effects for this character. The *SCA* effects ranged between -204.96 (P2 X P3) to 239.30 (P4 X P7). At Palem the range between lowest and highest *SCA* effects was from -139.43 (P7 X P10) to 185.16 (P4 X P6). Significant positive and negative effects were recorded in 29 and 9 hybrids, respectively.

4.3.2.19 Tryptophan content (g/16gN)

During *Kharif* at Rajendranagar the range between lowest and highest *SCA* effects was from -0.06 (P1 X P5, P6 X P9) to 0.07 (P1 X P10). Significant positive

and negative effects were recorded in 6 and 4 hybrids, respectively. At Palem 5 Crosses exhibited positively significant *SCA* effects, while 4 of the crosses exhibited negatively significant *SCA* effects for this character. The *SCA* effects ranged between -0.06 (P6 X P9, P1 X P5) to 0.07(P1 X P10).

The *SCA* effects ranged between -0.06 (P1 X P5, P6 X P9) to 0.08 (P1 X P10). Out of nine significant *SCA* effects 5 hybrids exhibited positive *SCA* effects while 4 hybrids had significant negative *SCA* effects during *Rabi* at Rajendranagar. At Palem, the *SCA* effects ranged between -0.06 (P6 X P9, P1 X P5) to 0.07 (P1 X P10) .3 crosses out of 8 exhibited positively significant and 5 crosses exhibited negatively significant *SCA* effects

4.3.2.21 Grain yield (Kg/Plot)

The *SCA* effects ranged between -1.34 (P1 X P5) to 1.48 (P1 X P10) .21 crosses exhibited positively significant and 9 crosses exhibited negatively significant *SCA* effects during *Kharif* at Rajendranagar. At Palem, *SCA* effects ranged between -1.15 (P7 X P10) to 1.22 (P4 X P6). Out of thirty-two significant *SCA* effects, 25 hybrids exhibited positive *SCA* effects while 7 hybrids had significant negative *SCA* effects.

During *Rabi* at Rajendranagar the range of *SCA* effects was from to -1.38 (P1 X P5) to 1.66 (P1 X P10). Out of 37 significant crosses, 25 were positively and 12 were negatively significant. At Palem, 21 Crosses exhibited positive significant *SCA* effects, while 7 of the crosses exhibited negative significant *SCA* effects for this character. The *SCA* effects ranged between -1.00 (P6 X P9) to 1.22 (P7 X P9)

4.4 CORRELATION STUDIES

Simple correlation coefficients (phenotypic and genotypic) were calculated to determine the association between morphological, physiological, biochemical parameters and grain yield components in maize. In general, correlation studies reveal

the nature and magnitude of the association between any two characters. Correlation coefficient refers to the measure of the relationship of two characters. Correlation coefficients will serve as a tool to determine the superior lines.

4.4.1 Phenotypic and genotypic correlation

Phenotypic and genotypic correlation coefficients were estimated between grain yield components, physiological parameters and oil and protein contents, in 45 hybrids at Rajendranagar and Palem during both *Kharif* and *Rabi* seasons are presented in Table 12a, 12b, 12c and 12d. In general genotypic correlations were of slightly higher magnitude than the corresponding phenotypic values, and hence only the genotypic correlations are discussed here under.

4.4.1.1 Days to 50% tasseling

At Rajendranagar during *Kharif*, days to 50 per cent tasseling had negative and significant correlation with ASI, plant height and SLW. At Palem it had negative and significant correlation with ASI.

During *Rabi* at Rajendranagar and Palem it was found to be positively and significantly correlated with days to 50 per cent silking and days to maturity at Palem during *Kharif* and *Rabi* and at Rajendranagar during *Kharif* and *Rabi* it was positive and significant with protein content also. At Rajendranagar during *Rabi* it had negative and significant correlation with Plant height and ear height and at Palem it had negative and significant correlation with SLW.

4.4.1.2 Days to 50 per cent silking

During *Kharif*, at Rajendranagar and Palem it was found to be positively and significantly correlated with days to maturity and at Rajendranagar it was also positive

Table 12 a : Phenotypic and Genotypic correlations for 21 characters

Table 2 a : Phenotypic and Genotypic correlations for 21 characters at Rajendranagar during Kharif, 2003																						
	Tasseling	Silking	ASI	Maturity	Plant ht.	Ear height	LAI	LDW	CGR	RGR	NAR	SLW	Biomass	Chlorophyll	HI	protein %	seedproyld	Oil %	Oil yield	Tryptoph	Grain yield	
Tasseling P	1.0000	0.9852**	-0.0786	0.8791**	-0.2885*	-0.2393	-0.1001	0.0096	-0.1784	-0.0600	-0.1666	-0.2827*	-0.0373	-0.0825	0.0793	0.2568	0.1129	0.0296	0.0459	-0.1761	0.0775	
G	1.0000	1.0020**	-0.5384**	0.9561**	-0.3035*	-0.2451	-0.0998	0.0139	-0.1799	-0.0694	-0.1684	-0.3009*	-0.0341	-0.1061	0.0844	0.2994*	0.1148	0.0311	0.0436	-0.2000	0.0769	
Silking P	1.0000	0.0610	0.8750**	-0.2637*	-0.2278	-0.0995	0.0154	-0.1816	-0.1816	-0.0619	-0.1705	-0.2741*	-0.0545	-0.0787	0.0749	0.2527	0.1116	0.0366	0.0505	-0.1541	0.0740	
G	1.0000	-0.4946**	0.9585**	-0.2771*	-0.2352	-0.0987	0.0214	-0.1864	-0.1864	-0.0675	-0.1739	-0.2975*	-0.0515	-0.1105	0.0858	0.3066*	0.1155	0.0540	0.0466	-0.1798	0.0719	
ASI P	1.0000	-0.0308	0.1773	0.0786	0.0060	0.0465	-0.0174	0.0067	-0.0174	0.0067	-0.0213	0.0648	-0.1163	0.0211	-0.0207	-0.0164	-0.0081	0.0597	0.0281	0.1450	-0.0229	
G	1.0000	-0.3905**	1.5591**	0.6726**	0.1075	0.3644**	-0.2630*	0.0579	-0.2271	0.3221*	-0.9245*	-0.1534	-0.0124	-0.1534	0.0997	0.1762	-0.0257	1.1436**	0.1464	1.2211**	-0.3201*	
Maturity P	1.0000	-0.2685*	-0.1680	-0.0456	0.0042	-0.0676	-0.0374	-0.0676	-0.0374	-0.0967	-0.2462	-0.0527	-0.0488	0.0997	0.1782	0.1156	0.1269	0.1134	0.0735	-0.2422	0.0539	
G	1.0000	-0.2936*	-0.1849	-0.0503	0.0146	-0.0666	-0.0450	-0.0666	-0.0450	-0.1037	-0.2681*	-0.0190	-0.0578	0.1199	0.2642*	0.1199	0.2642*	0.1134	0.0735	-0.2422	0.0935	
Plant ht. P	1.0000	0.5348**	0.1835	0.1234	0.1900	-0.1311	0.2660*	0.3413*	0.0558	0.1811	-0.0007	-0.0690	-0.0690	-0.0007	-0.0690	0.0557	0.0001	0.1029	0.4223**	0.0784		
G	1.0000	0.5444**	0.1864	0.1321	0.1985	-0.1404	0.2843*	0.3590**	0.0525	0.2082	-0.0035	-0.0685	-0.0685	-0.0035	-0.0685	0.0593	0.0178	0.1064	0.4563**	0.0770		
Ear ht. P	1.0000	0.2770*	0.0964	0.3425*	0.1985	-0.1404	0.2843*	0.3590**	0.0525	0.2082	-0.0035	-0.0685	-0.0685	-0.0035	-0.0685	0.0593	0.0178	0.1064	0.4563**	0.0770		
G	1.0000	0.2791*	0.1045	0.3514**	0.1985	-0.1404	0.2843*	0.3590**	0.0525	0.2082	-0.0035	-0.0685	-0.0685	-0.0035	-0.0685	0.0593	0.0178	0.1064	0.4563**	0.0770		
LAI P	1.0000	0.4016**	0.4783**	0.1589	0.5059**	0.4590**	0.3934**	0.2199	0.3434*	0.2955*	0.1264	-0.2124	0.1658	0.0873	0.0873	0.2537	0.2794*	0.2430	0.5799**	0.0469	0.5726**	
G	1.0000	0.4188**	0.4860**	0.1650	0.5267**	0.4815**	0.4287**	0.2131	0.3053*	0.1506	0.5658**	0.1405	0.5520**	0.2902*	0.5824**	0.1310	0.5615**	0.0304	0.5124**	0.2036		
LDW P	1.0000	0.2325	0.0879	0.2725*	0.0879	0.2725*	0.0879	0.2725*	0.0879	0.2725*	0.0879	0.2725*	0.0879	0.2725*	0.0879	0.2725*	0.0879	0.2725*	0.0879	0.2725*	0.0879	
G	1.0000	0.2406	0.0995	0.2880*	0.5745**	0.4947**	0.2696*	0.4424**	0.1832	-0.0898	0.5191**	0.1310	0.5615**	0.0469	0.5726**	0.2430	0.5799**	0.0469	0.5726**	0.2430	0.5799**	
CGR P	1.0000	0.2276	0.5795**	0.4557**	0.5422**	0.5067**	0.5067**	0.5067**	0.5067**	0.5067**	0.5067**	0.5067**	0.5067**	0.5067**	0.5067**	0.5067**	0.5067**	0.5067**	0.5067**	0.5067**	0.5067**	
G	1.0000	0.1620	0.1058	0.1403	0.2594	0.0963	0.0963	0.0963	0.0963	0.0963	0.0963	0.0963	0.0963	0.0963	0.0963	0.0963	0.0963	0.0963	0.0963	0.0963	0.0963	
RGR P	1.0000	0.1556	0.1045	0.1540	0.3032*	0.0102	-0.0644	0.4628**	0.0995	0.5024**	0.0995	0.5024**	0.0995	0.5024**	0.0995	0.5024**	0.0995	0.5024**	0.0995	0.5024**	0.0995	
G	1.0000	0.5526**	0.3952**	0.5912**	0.7083**	0.0038	-0.0751	0.4936**	0.1833	0.5402**	0.1833	0.5402**	0.1833	0.5402**	0.1833	0.5402**	0.1833	0.5402**	0.1833	0.5402**	0.1833	
NAR P	1.0000	0.6162**	0.4542**	0.7083**	0.0038	-0.0751	0.4936**	0.1833	0.5402**	0.1833	0.5402**	0.1833	0.5402**	0.1833	0.5402**	0.1833	0.5402**	0.1833	0.5402**	0.1833	0.5402**	
G	1.0000	0.4340**	0.4756**	0.4756**	0.4756**	0.4756**	0.4756**	0.4756**	0.4756**	0.4756**	0.4756**	0.4756**	0.4756**	0.4756**	0.4756**	0.4756**	0.4756**	0.4756**	0.4756**	0.4756**	0.4756**	
SLW P	1.0000	0.4698**	0.5496**	0.5496**	0.5496**	0.5496**	0.5496**	0.5496**	0.5496**	0.5496**	0.5496**	0.5496**	0.5496**	0.5496**	0.5496**	0.5496**	0.5496**	0.5496**	0.5496**	0.5496**	0.5496**	
G	1.0000	0.4448**	0.5455**	0.5455**	0.5455**	0.5455**	0.5455**	0.5455**	0.5455**	0.5455**	0.5455**	0.5455**	0.5455**	0.5455**	0.5455**	0.5455**	0.5455**	0.5455**	0.5455**	0.5455**	0.5455**	
Biomass P	1.0000	0.8737**	0.8737**	0.8737**	0.8737**	0.8737**	0.8737**	0.8737**	0.8737**	0.8737**	0.8737**	0.8737**	0.8737**	0.8737**	0.8737**	0.8737**	0.8737**	0.8737**	0.8737**	0.8737**	0.8737**	
G	1.0000	0.5420**	0.5420**	0.5420**	0.5420**	0.5420**	0.5420**	0.5420**	0.5420**	0.5420**	0.5420**	0.5420**	0.5420**	0.5420**	0.5420**	0.5420**	0.5420**	0.5420**	0.5420**	0.5420**	0.5420**	
Chlorophyll P	1.0000	0.1024	-0.0309	0.5420**	0.5420**	0.5420**	0.5420**	0.5420**	0.5420**	0.5420**	0.5420**	0.5420**	0.5420**	0.5420**	0.5420**	0.5420**	0.5420**	0.5420**	0.5420**	0.5420**	0.5420**	
G	1.0000	0.1335	-0.0086	0.6247**	0.6247**	0.6247**	0.6247**	0.6247**	0.6247**	0.6247**	0.6247**	0.6247**	0.6247**	0.6247**	0.6247**	0.6247**	0.6247**	0.6247**	0.6247**	0.6247**	0.6247**	
arvestIndex P	1.0000	-0.1159	0.3928**	0.3928**	0.3928**	0.3928**	0.3928**	0.3928**	0.3928**	0.3928**	0.3928**	0.3928**	0.3928**	0.3928**	0.3928**	0.3928**	0.3928**	0.3928**	0.3928**	0.3928**	0.3928**	
G	1.0000	-0.1457	0.3982**	0.3982**	0.3982**	0.3982**	0.3982**	0.3982**	0.3982**	0.3982**	0.3982**	0.3982**	0.3982**	0.3982**	0.3982**	0.3982**	0.3982**	0.3982**	0.3982**	0.3982**	0.3982**	
Protein % P	1.0000	0.1974	0.1974	0.1974	0.1974	0.1974	0.1974	0.1974	0.1974	0.1974	0.1974	0.1974	0.1974	0.1974	0.1974	0.1974	0.1974	0.1974	0.1974	0.1974	0.1974	
G	1.0000	0.2166	0.2166	0.2166	0.2166	0.2166	0.2166	0.2166	0.2166	0.2166	0.2166	0.2166	0.2166	0.2166	0.2166	0.2166	0.2166	0.2166	0.2166	0.2166	0.2166	
edproteinyield P	1.0000	0.0379	0.9290**	0.9290**	0.9290**	0.9290**	0.9290**	0.9290**	0.9290**	0.9290**	0.9290**	0.9290**	0.9290**	0.9290**	0.9290**	0.9290**	0.9290**	0.9290**	0.9290**	0.9290**	0.9290**	
G	1.0000	0.0540	0.9437**	0.9437**	0.9437**	0.9437**	0.9437**	0.9437**	0.9437**	0.9437**	0.9437**	0.9437**	0.9437**	0.9437**	0.9437**	0.9437**	0.9437**	0.9437**	0.9437**	0.9437**	0.9437**	
Oil % P	1.0000	0.2187	0.2187	0.2187	0.2187	0.2187	0.2187	0.2187	0.2187	0.2187	0.2187	0.2187	0.2187	0.2187	0.2187	0.2187	0.2187	0.2187	0.2187	0.2187	0.2187	
G	1.0000	0.3511**	0.3511**	0.3511**	0.3511**	0.3511**	0.3511**	0.3511**	0.3511**	0.3511**	0.3511**	0.3511**	0.3511**	0.3511**	0.3511**	0.3511**	0.3511**	0.3511**	0.3511**	0.3511**	0.3511**	
Oil yield. P	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
G	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
Oil yield. P	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
G	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
Tryptophan P	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
G	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
Grain yield. P	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
G	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.000														

** Significant at 1% level

* Significant at 5% level

Table 12 c : Phenotypic and Genotypic correlations for 21 characters at Palem during Kharif, 2003

	Tasseling	Silking	ASI	Maturity	Plant ht.	Ear ht.	LAI	LDW	CGR	RGR	NAR	SLW	Biomass	Chlorophyll	HI	protein %	seed provid	Oil %	Oil yield	Tryphtophan	Grain yield
Tasseling P	1.0000	0.9607**	-0.1534	0.8198**	-0.0999	-0.0440	0.1134	0.0051	-0.0349	0.0247	0.0972	-0.1107	-0.1340	-0.0744	-0.0407	0.1673	-0.0273	0.0089	-0.0972	-0.2089	-0.0954
Silking G	1.0000	0.9985**	-0.3068*	1.0622**	-0.1164	-0.0504	0.1314	0.0159	-0.0440	0.0333	0.1278	-0.1520	-0.1309	-0.0250	-0.0678	0.2066	-0.0177	0.0124	-0.1189	-0.2331	-0.1474
ASI P	1.0000	1.0000	-0.2489	1.0840**	-0.1333	-0.0752	0.1253	0.0272	-0.0318	0.0646	0.0848	-0.1674	-0.1975	-0.0241	-0.0443	0.1692	-0.0289	-0.0354	-0.1321	-0.2397	-0.1163
Maturity G	1.0000	1.0000	-0.0035	-0.0656	-0.0656	-0.0229	-0.0195	0.0561	-0.0308	0.0596	-0.0850	-0.0665	-0.1277	-0.1080	-0.0252	-0.1182	-0.0605	-0.0404	-0.1321	-0.2562	-0.1522
Plant ht. P	1.0000	0.0431	-0.2397	-0.3678**	-0.1318	0.1823	0.1823	0.1823	0.1982	0.4966**	-0.7029**	-0.1824	-1.0183**	0.0420	0.3883**	-0.6548**	-0.1736	-0.8320**	-0.1757	-0.3103*	-0.0704
Ear ht. P	1.0000	1.0000	-0.1304	-0.0537	0.0912	-0.0519	0.0669	-0.0274	-0.0352	0.0059	0.0957	-0.1929	-0.1538	-0.0807	-0.0842	0.0997	-0.0635	0.0128	-0.0998	-0.2299	-0.1280
LAI P	1.0000	0.8575**	0.3178*	0.7871**	0.3262*	-0.0271	0.2791*	-0.0271	-0.0724	-0.0701	0.4066**	0.1658	0.4396**	0.2001	0.0750	-0.2645*	0.3503**	0.1976	0.4506**	-0.0793	0.4314**
LDW P	1.0000	1.0000	0.2711*	0.3178*	0.3262*	0.0219	0.2890*	-0.0219	-0.0724	-0.0701	0.4066**	0.1658	0.4396**	0.2001	0.0750	-0.2645*	0.3503**	0.1976	0.4506**	-0.0793	0.4314**
CGR P	1.0000	1.0000	0.2711*	0.3178*	0.3262*	0.0219	0.2890*	-0.0219	-0.0724	-0.0701	0.4066**	0.1658	0.4396**	0.2001	0.0750	-0.2645*	0.3503**	0.1976	0.4506**	-0.0793	0.4314**
RGR P	1.0000	1.0000	0.2711*	0.3178*	0.3262*	0.0219	0.2890*	-0.0219	-0.0724	-0.0701	0.4066**	0.1658	0.4396**	0.2001	0.0750	-0.2645*	0.3503**	0.1976	0.4506**	-0.0793	0.4314**
NAR P	1.0000	1.0000	0.2711*	0.3178*	0.3262*	0.0219	0.2890*	-0.0219	-0.0724	-0.0701	0.4066**	0.1658	0.4396**	0.2001	0.0750	-0.2645*	0.3503**	0.1976	0.4506**	-0.0793	0.4314**
SLW P	1.0000	1.0000	0.2711*	0.3178*	0.3262*	0.0219	0.2890*	-0.0219	-0.0724	-0.0701	0.4066**	0.1658	0.4396**	0.2001	0.0750	-0.2645*	0.3503**	0.1976	0.4506**	-0.0793	0.4314**
Biomass P	1.0000	1.0000	0.2711*	0.3178*	0.3262*	0.0219	0.2890*	-0.0219	-0.0724	-0.0701	0.4066**	0.1658	0.4396**	0.2001	0.0750	-0.2645*	0.3503**	0.1976	0.4506**	-0.0793	0.4314**
Chlorophyll P	1.0000	1.0000	0.2711*	0.3178*	0.3262*	0.0219	0.2890*	-0.0219	-0.0724	-0.0701	0.4066**	0.1658	0.4396**	0.2001	0.0750	-0.2645*	0.3503**	0.1976	0.4506**	-0.0793	0.4314**
TestIndex P	1.0000	1.0000	0.2711*	0.3178*	0.3262*	0.0219	0.2890*	-0.0219	-0.0724	-0.0701	0.4066**	0.1658	0.4396**	0.2001	0.0750	-0.2645*	0.3503**	0.1976	0.4506**	-0.0793	0.4314**
Protein % P	1.0000	1.0000	0.2711*	0.3178*	0.3262*	0.0219	0.2890*	-0.0219	-0.0724	-0.0701	0.4066**	0.1658	0.4396**	0.2001	0.0750	-0.2645*	0.3503**	0.1976	0.4506**	-0.0793	0.4314**
dproteinylid P	1.0000	1.0000	0.2711*	0.3178*	0.3262*	0.0219	0.2890*	-0.0219	-0.0724	-0.0701	0.4066**	0.1658	0.4396**	0.2001	0.0750	-0.2645*	0.3503**	0.1976	0.4506**	-0.0793	0.4314**
Oil % P	1.0000	1.0000	0.2711*	0.3178*	0.3262*	0.0219	0.2890*	-0.0219	-0.0724	-0.0701	0.4066**	0.1658	0.4396**	0.2001	0.0750	-0.2645*	0.3503**	0.1976	0.4506**	-0.0793	0.4314**
Oil yield P	1.0000	1.0000	0.2711*	0.3178*	0.3262*	0.0219	0.2890*	-0.0219	-0.0724	-0.0701	0.4066**	0.1658	0.4396**	0.2001	0.0750	-0.2645*	0.3503**	0.1976	0.4506**	-0.0793	0.4314**
Tryphtophan P	1.0000	1.0000	0.2711*	0.3178*	0.3262*	0.0219	0.2890*	-0.0219	-0.0724	-0.0701	0.4066**	0.1658	0.4396**	0.2001	0.0750	-0.2645*	0.3503**	0.1976	0.4506**	-0.0793	0.4314**
Grain yield P	1.0000	1.0000	0.2711*	0.3178*	0.3262*	0.0219	0.2890*	-0.0219	-0.0724	-0.0701	0.4066**	0.1658	0.4396**	0.2001	0.0750	-0.2645*	0.3503**	0.1976	0.4506**	-0.0793	0.4314**

** Significant at 1% level

* Significant at 5% level

Table 12 d : Phenotypic and Genotypic correlations for 21 characters

at Palem during Rabi, 2002-03													
	Tasselling	Silking	ASI	Maturity	Plant ht.	Ear height	LAI	LDW	CGR	RGR	NAR	SLW	Biomass
Tasselling P	1.0000	0.9824**	-0.1816	0.7612**	-0.1265	0.0106	-0.0954	-0.0850	-0.1076	0.0736	-0.0323	-0.2964*	-0.1496
G	1.0000	0.9961**	0.0069	1.1486**	-0.1434	0.0099	-0.1042	-0.1078	-0.1170	0.0774	-0.0063	-0.3375*	-0.2137
Silking P	1.0000	0.0055	0.0055	0.7744**	-0.0942	0.0495	-0.0974	-0.0980	-0.1047	0.0689	-0.0352	-0.3119*	-0.1553
G	1.0000	0.0953	0.0953	1.1479**	-0.1109	0.0427	-0.1030	-0.1183	-0.1143	0.0626	-0.0263	-0.3329*	-0.1911
ASI P	1.0000	0.0017	0.1814	0.2035	0.1814	0.2035	-0.0015	-0.0605	0.0242	-0.0318	-0.0123	-0.0556	-0.1612
G	1.0000	0.0506	0.3597**	0.3716**	0.0076	0.0076	0.0076	-0.1253	0.0257	-0.1624	-0.2267	0.0344	0.2440
Maturity P	1.0000	-0.0850	0.0112	-0.1203	-0.0956	-0.1314	-0.1203	-0.0956	-0.1314	0.0581	-0.0766	-0.2606	-0.1529
G	1.0000	-0.1192	0.0263	-0.1578	-0.1005	-0.1956	-0.1578	-0.1005	-0.1956	0.0431	-0.0694	-0.3698**	-0.2842*
Plant ht. P	1.0000	0.7595**	0.3404*	0.3404*	0.1923	0.2965*	0.3404*	0.1923	0.2965*	-0.0654	0.3096*	0.1514	0.3689**
G	1.0000	0.8146**	0.3497**	0.3497**	0.2284	0.3041*	0.3497**	0.2284	0.3041*	-0.0763	0.3412*	0.1654	0.4244**
Ear ht. P	1.0000	0.2406	0.1735	0.3109*	0.1735	0.3109*	0.2406	0.1735	0.3109*	-0.1836	0.1944	0.2393	0.4243**
G	1.0000	0.2565	0.2096	0.3340*	0.2096	0.3340*	0.2565	0.2096	0.3340*	-0.1976	0.2108	0.2521	0.5327**
LAI P	1.0000	0.4059**	0.4783*	0.4783*	0.1000	0.4059**	0.4059**	0.4059**	0.4783*	0.2010	0.3573**	0.1946	0.1941
G	1.0000	0.4247**	0.4884*	0.4884*	0.1000	0.4247**	0.4247**	0.4247**	0.4884*	0.2198	0.3777**	0.1990	0.2167
LDW P	1.0000	0.1760	0.1760	0.1760	0.1000	0.1760	0.1760	0.1760	0.1760	-0.0318	0.1915	0.3901**	0.2321
G	1.0000	0.1843	0.1843	0.1843	1.0000	0.1843	0.1843	0.1843	0.1843	0.3428*	0.4807**	0.4171**	0.2974*
CGR P	1.0000	0.3120*	0.3120*	0.3120*	1.0000	0.3120*	0.3120*	0.3120*	0.3120*	1.0000	0.1872	0.0652	-0.0526
G	1.0000	0.3428*	0.3428*	0.3428*	1.0000	0.3428*	0.3428*	0.3428*	0.3428*	1.0000	0.2124	0.0737	-0.0420
RGR P	1.0000	0.4501**	0.4501**	0.4501**	1.0000	0.4501**	0.4501**	0.4501**	0.4501**	1.0000	0.1872	0.0652	-0.0526
G	1.0000	0.4807**	0.4807**	0.4807**	1.0000	0.4807**	0.4807**	0.4807**	0.4807**	1.0000	0.2124	0.0737	-0.0420
NAR P	1.0000	0.3822**	0.3822**	0.3822**	1.0000	0.3822**	0.3822**	0.3822**	0.3822**	1.0000	0.1872	0.0652	-0.0526
G	1.0000	0.4683**	0.4683**	0.4683**	1.0000	0.4683**	0.4683**	0.4683**	0.4683**	1.0000	0.2124	0.0737	-0.0420
SLW P	1.0000	0.4532**	0.4532**	0.4532**	1.0000	0.4532**	0.4532**	0.4532**	0.4532**	1.0000	0.1872	0.0652	-0.0526
G	1.0000	0.5236**	0.5236**	0.5236**	1.0000	0.5236**	0.5236**	0.5236**	0.5236**	1.0000	0.2124	0.0737	-0.0420
Biomass P	1.0000	0.4475**	0.4475**	0.4475**	1.0000	0.4475**	0.4475**	0.4475**	0.4475**	1.0000	0.1872	0.0652	-0.0526
G	1.0000	0.5236**	0.5236**	0.5236**	1.0000	0.5236**	0.5236**	0.5236**	0.5236**	1.0000	0.2124	0.0737	-0.0420
Chlorophyll P	1.0000	0.4771**	0.4771**	0.4771**	1.0000	0.4771**	0.4771**	0.4771**	0.4771**	1.0000	0.1872	0.0652	-0.0526
G	1.0000	0.5236**	0.5236**	0.5236**	1.0000	0.5236**	0.5236**	0.5236**	0.5236**	1.0000	0.2124	0.0737	-0.0420
arvestindex P	1.0000	0.4961**	0.4961**	0.4961**	1.0000	0.4961**	0.4961**	0.4961**	0.4961**	1.0000	0.1872	0.0652	-0.0526
G	1.0000	0.5236**	0.5236**	0.5236**	1.0000	0.5236**	0.5236**	0.5236**	0.5236**	1.0000	0.2124	0.0737	-0.0420
Protein % P	1.0000	0.4961**	0.4961**	0.4961**	1.0000	0.4961**	0.4961**	0.4961**	0.4961**	1.0000	0.1872	0.0652	-0.0526
G	1.0000	0.5236**	0.5236**	0.5236**	1.0000	0.5236**	0.5236**	0.5236**	0.5236**	1.0000	0.2124	0.0737	-0.0420
edprotein yield P	1.0000	0.4961**	0.4961**	0.4961**	1.0000	0.4961**	0.4961**	0.4961**	0.4961**	1.0000	0.1872	0.0652	-0.0526
G	1.0000	0.5236**	0.5236**	0.5236**	1.0000	0.5236**	0.5236**	0.5236**	0.5236**	1.0000	0.2124	0.0737	-0.0420
Oil % P	1.0000	0.4961**	0.4961**	0.4961**	1.0000	0.4961**	0.4961**	0.4961**	0.4961**	1.0000	0.1872	0.0652	-0.0526
G	1.0000	0.5236**	0.5236**	0.5236**	1.0000	0.5236**	0.5236**	0.5236**	0.5236**	1.0000	0.2124	0.0737	-0.0420
Oil yield P	1.0000	0.4961**	0.4961**	0.4961**	1.0000	0.4961**	0.4961**	0.4961**	0.4961**	1.0000	0.1872	0.0652	-0.0526
G	1.0000	0.5236**	0.5236**	0.5236**	1.0000	0.5236**	0.5236**	0.5236**	0.5236**	1.0000	0.2124	0.0737	-0.0420
Tryptophan P	1.0000	0.4961**	0.4961**	0.4961**	1.0000	0.4961**	0.4961**	0.4961**	0.4961**	1.0000	0.1872	0.0652	-0.0526
G	1.0000	0.5236**	0.5236**	0.5236**	1.0000	0.5236**	0.5236**	0.5236**	0.5236**	1.0000	0.2124	0.0737	-0.0420
Grain yield P	1.0000	0.4961**	0.4961**	0.4961**	1.0000	0.4961**	0.4961**	0.4961**	0.4961**	1.0000	0.1872	0.0652	-0.0526
G	1.0000	0.5236**	0.5236**	0.5236**	1.0000	0.5236**	0.5236**	0.5236**	0.5236**	1.0000	0.2124	0.0737	-0.0420

** Significant at 1% level

* Significant at 5% level

and significant with protein content, whereas it had negative and significant correlation with ASI, Plant height and SLW at Rajendranagar. 198

During *Rabi*, at Rajendranagar days to 50 per cent silking was found to be positively and significantly correlated with days to maturity and protein content, whereas it had negative and significant correlation with plant height and ear height. Days to 50 per cent silking was found to be positively and significantly correlated with days to maturity, whereas it had negative and significant correlation with SLW at Palem.

4.4.1.3 Anthesis silking interval

During *Kharif* at Rajendranagar it was positive and significant with Plant height, ear height, LDW, SLW, Oil per cent and Tryptophan content whereas it had negative and significant correlation with Days to maturity, CGR, total biomass and grain yield. At Palem it had significant and positive correlation with RGR and HI and negative correlation with ear height, NAR, total biomass, Protein content, Oil per cent and Tryptophan content.

Anthesis silking interval exhibited positive and significant correlation with plant height and negative correlation with CGR, Protein content and tryptophan content at Rajendranagar during *Rabi* and at Palem significant positive correlation was exhibited by Plant height, ear height and total chlorophyll content and negative correlation with Tryptophan content.

4.4.1.4 Days to maturity

Days to maturity exhibited significant negative correlation with plant height at Rajendranagar during *Kharif* and at Palem significantly positive correlation was exhibited by RGR and chlorophyll content.

A significant negative correlation was exhibited by Plant height; ear height and LDW during *Rabi* at Rajendranagar and at Palem significant negative correlation was exhibited by SLW, total biomass, Seed protein yield/ha, Oil yield/ha and grain yield/plot.

4.4.1.5 Plant height (cm)

During *Kharif* at Rajendranagar it exhibited significant and positive correlation with ear height, NAR, SLW and tryptophan and at Palem it exhibited significant and positive correlation with ear height, leaf area index, CGR, NAR, bio mass, seed protein yield/ha, oil yield/ha, grain yield/plot and significant negative correlation with protein content.

Plant height exhibited significant and positive correlation with ear height, CGR, SLW, total biomass, Oil yield/ha and grain yield/plot at Rajendranagar during *Rabi*. It exhibited significant and positive correlation with ear height, LAI, CGR, NAR, Total biomass, seed protein yield/ha, oil yield/ha and grain yield/plot at Palem.

4.4.1.6 Ear height (cm)

During *Kharif* at Rajendranagar it had a positive significant correlation with LAI, CGR, NAR, SLW, chlorophyll content, tryptophan and at Palem it had a positive significant correlation with LAI, CGR, NAR, biomass, seed protein yield/ha oil yield/ha and grain yield/plot. Significantly negative correlation was exhibited by protein.

During *Rabi* at Rajendranagar ear height had a positive significant correlation with LAI, CGR, SLW, chlorophyll content, and significantly positive correlation was exhibited by CGR, total biomass, HI, seed protein yield/ha and Tryptophan and negative correlation with Protein content at Palem.

During *Kharif* at Rajendranagar and Palem significant positive correlation were exhibited by CGR, NAR, SLW, bio mass, total chlorophyll, harvest index, seed protein yield/ha, Oil per cent, oil yield/ha and grain yield/plot in addition to LDW at Rajendranagar

LAI had a positive significant correlation with LDW, CGR, NAR, total chlorophyll content, seed protein yield/ha, oil yield/ha and grain yield/plot during *Rabi* at Rajendranagar and Palem in addition to SLW and total biomass at Rajendranagar and harvest index at Palem.

4.4.1.8 Leaf Dry Weight (gm^{-2})

During *Kharif* at Rajendranagar significantly positive correlation were exhibited by NAR, SLW, bio mass, harvest index, seed protein yield/ha, oil yield/ha Tryptophan content and grain yield/plot and only SLW exhibited significant positive correlation at Palem.

During *Rabi* at Rajendranagar LDW had a positive significant correlation with NAR, total biomass, total chlorophyll content, seed protein yield/ha, oil yield/ha, and grain yield/plot. And significantly positive correlations were exhibited by SLW, total biomass, total chlorophyll content, oil per cent, seed protein yield/ha, oil yield/ha and tryptophan at Palem.

4.4.1.9 Crop Growth Rate ($\text{gm}^{-2}\text{d}^{-1}$)

CGR had a positive significant correlation with NAR, SLW, biomass, total chlorophyll, seed protein yield/ha, oil yield/ha and grain yield/plot at Rajendranagar

and Palem during both the seasons and in addition significant positive correlation was exhibited by RGR at Palem.

4.4.1.10 Relative Growth Rate ($\text{g g}^{-1}\text{d}^{-1}$)

At Rajendranagar during *Kharif* positive significant correlation was exhibited by total chlorophyll content, seed protein yield and oil yield. Significant positive correlations were exhibited by chlorophyll at Palem.

During *Rabi* at Rajendranagar, RGR had a positive significant correlation with harvest index and at Palem significant positive correlation was exhibited by chlorophyll content.

4.4.1.11 Net Assimilation Rate ($\text{g m}^{-2} \text{d}^{-1}$)

At Rajendranagar and Palem during both the seasons significant positive correlation were exhibited by SLW, total biomass, chlorophyll, seed protein yield/ha, oil yield/ha, grain yield/plot in addition to oil per cent at Palem during *Rabi*.

4.4.1.12 Specific Leaf Weight (mg cm^{-2})

During *Kharif* and *Rabi* at both the locations significantly positive correlations were exhibited by total biomass, total chlorophyll, seed protein yield/ha, oil yield/ha, grain yield/plot.

4.4.1.13 Total bio mass (kg/plot)

During *Kharif* at Rajendranagar and Palem significant positive correlation were exhibited by, chlorophyll, Harvest index, seed protein yield/ha, oil yield/ha and grain yield/plot. At Palem significant positive correlations were exhibited by

chlorophyll, Harvest index, seed protein yield/ha, oil percent, oil yield/ha and grain yield/plot.

Total bio mass had a positive significant correlation with chlorophyll, seed protein yield/ha, oil yield/ha, grain yield/plot at Rajendranagar during *Rabi* and at Palem positive significant correlation were exhibited by total chlorophyll content, seed protein yield/ha, oil per cent, oil yield/ha, grain yield/plot.

4.4.1.14 Total chlorophyll content (mg/g)

Chlorophyll had a positive significant correlation with seed protein yield/ha, oil yield/ha and grain yield/plot at two locations and in two seasons

4.4.1.15 Harvest index (%)

Harvest index had a positive significant correlation with seed protein yield/ha, oil yield/ha and grain yield/plot at two locations and in two seasons

4.4.1.16 Seed protein content (%)

The association of protein content with all the parameters was non-significant at both the locations and in both the seasons.

4.4.1.17 Seed protein yield (Kg/ha)

Seed protein yield had a positive significant correlation with oil yield/ha and grain yield/plot in two seasons at both locations

4.4.1.18 Oil percent

Oil per cent had a positive significant correlation with oil yield/ha in two seasons at both locations in addition at Palem during *Rabi* it had positive significant correlation with grain yield/plot.

4.4.1.19 Oil yield (Kg/ha)

Oil yield had a positive significant correlation with grain yield/plot at Rajendranagar and Palem during two seasons

4.4.1.20 Tryptophan content

The association of tryptophan content with grain yield was non-significant at both the locations and in both the seasons.

4.5 PATH COEFFICIENT ANALYSIS

The direct and indirect effects of path matrix for grain yield at phenotypic and genotypic levels are presented in Table 13a, 13b, 13c and 13d. The genotypic and phenotypic effects in general, exhibited a similar trend; hence, the genotypic effects alone are presented here under. The residual effects of the path analysis for genotypic effect was -0.044, -0.1964, -0.06 and 0.064 at *Kharif* and *Rabi* Rajendranagar and *Kharif* and *Rabi* Palem respectively.

4.5.1 Days to 50 per cent tasseling

This character had a negative direct effect on yield (-0.0658) at Rajendranagar during *Kharif*. The correlation of this character with yield was 0.0769. Its negative indirect effect was through ASI, days to maturity, ear height, LAI, CGR, NAR, biomass, protein per cent, and oil yield / ha. Its positive indirect effects were through

Table 13 a : Phenotypic and Genotypic path coefficients for 21 characters at Rajendranagar during Kharif, 2003

	Tassling	Silking	ASI	Maturity	Plant height	Ear height	LAI	LDW	CGR	RGR	NAR	SLW	Biomass	Chlorophyll	HI	protein % seedproyld	Oil %	Oil yield	Tryptophan	Grain yield
Tassling P	0.16071	0.6469	-0.0002	-0.1438	-0.0064	0.0109	-0.0074	0.0002	0.0002	0.0011	-0.0055	-0.0075	-0.0062	-0.0012	0.0031	-0.0535	0.0011	-0.0021	0.0019	0.775
Tassling G	-0.0658	0.3339	-0.0191	-0.2332	0.0045	-0.0001	-0.0093	0.0008	-0.0034	0.0020	-0.0145	0.0263	-0.0056	0.0035	0.0015	-0.1111	0.1840	-0.0349	0.0126	0.0769
Silking P	0.1583	0.04761	0.0001	-0.1431	-0.0058	0.0104	-0.0074	0.0003	0.0002	0.0011	-0.0057	-0.0073	-0.0090	-0.0011	0.0036	-0.0527	0.0844	-0.0023	0.0016	0.0740
Silking G	-0.0659	0.33321	-0.0175	-0.2338	0.0041	-0.0001	-0.0092	0.0013	-0.0035	0.0019	-0.0150	0.0260	-0.0085	0.0037	0.0015	-0.1138	0.1851	-0.0372	0.0113	0.0719
ASI P	-0.0126	0.0029	0.00221	0.0050	-0.0039	-0.0036	0.0004	0.0010	0.0000	-0.0001	-0.0007	0.0017	-0.0192	0.0003	-0.0008	0.0034	-0.0061	-0.0013	-0.0015	-0.0229
ASI G	0.0354	-0.3648	0.0952	-0.0230	0.0003	0.0100	-0.0092	0.0022	-0.0049	-0.0016	-0.0195	-0.0282	-0.1518	0.0051	-0.0002	-0.0654	-0.0411	0.1705	-0.0768	-0.3201
Maturity P	0.1413	0.0016	0.00361	-0.0660	0.0076	-0.0034	0.0001	0.0007	0.0007	0.0007	-0.0032	-0.0065	-0.0087	-0.0007	0.0039	-0.0371	0.00874	0.0017	0.0021	0.0021
Maturity G	-0.0629	0.3394	-0.0138	0.0439	-0.0001	-0.0047	0.0009	0.0009	-0.0012	0.0013	-0.0089	0.0235	-0.0031	0.0019	0.0021	-0.0980	0.2034	0.0169	0.0152	0.0935
Plant ht. P	-0.0464	-0.0025	0.0004	0.0439	0.0148	0.0002	0.0173	0.0081	0.0037	0.0040	0.0245	-0.0314	0.0092	0.0025	0.0000	0.0144	0.0950	0.0027	-0.0047	0.0784
Plant ht. G	0.0200	-0.0023	0.0553	0.0716	-0.0149	-0.0042	0.0136	0.0026	-0.0002	0.0023	0.0089	0.0091	0.0092	0.0069	-0.0001	0.0254	0.0950	0.0027	-0.0047	0.0784
Ear ht. P	-0.0385	-0.0008	0.0002	0.0275	0.0041	-0.0454	0.0259	0.0064	0.0065	-0.0005	0.0262	-0.0349	0.0361	-0.0114	0.0022	0.0876	0.2665	0.1300	-0.0207	0.0206
Ear ht. G	0.0161	-0.00784	0.0000	0.0075	0.0041	-0.0126	0.0742	0.0083	-0.0005	-0.0028	0.0168	0.0122	0.0650	0.0078	0.0113	-0.0128	0.4558	0.0079	-0.0284	0.0918
LAI P	-0.0161	-0.0047	0.0000	0.0075	0.0041	-0.0126	0.0742	0.0083	-0.0005	-0.0028	0.0168	0.0122	0.0650	0.0078	0.0113	-0.0128	0.4558	0.0079	-0.0284	0.0918
LAI G	0.0066	-0.0029	0.0038	0.0075	0.0041	-0.0126	0.0742	0.0083	-0.0005	-0.0028	0.0168	0.0122	0.0650	0.0078	0.0113	-0.0128	0.4558	0.0079	-0.0284	0.0918
LDW P	0.0015	0.0007	0.0001	0.0129	-0.0036	-0.0020	0.0028	0.0025	0.0090	-0.0047	0.0453	-0.0421	0.0704	-0.0217	0.0051	-0.0303	0.0737	0.0473	-0.5055	0.6443
LDW G	-0.0287	0.0086	0.0000	0.0111	0.0042	-0.0156	0.0355	0.0048	-0.0010	-0.0036	0.0184	0.0112	0.0814	0.0062	0.0072	0.0187	0.3926	0.0048	-0.0258	0.5824
CGR P	0.0118	-0.0021	-0.0093	0.0163	-0.0029	0.0002	0.0451	0.0147	0.0186	-0.0064	0.0499	-0.0399	0.0890	-0.0169	0.0034	0.0426	0.8486	0.0362	-0.4635	0.5726
CGR G	0.0046	-0.0025	0.0021	0.0110	0.0021	0.0000	0.0153	0.0061	0.0042	-0.0282	0.0134	-0.0091	0.0253	-0.0101	0.0017	-0.0037	0.4194	-0.0019	-0.2090	0.2271
RGR P	-0.0268	0.0081	0.0000	0.0158	0.0059	-0.0076	0.0403	0.0176	0.0108	-0.0044	0.0184	-0.0539	0.0746	-0.0236	0.0004	0.0134	0.3501	0.0037	-0.0231	0.4790
RGR G	0.0111	-0.0079	-0.0080	0.0253	-0.0042	0.0001	0.0489	0.0176	0.0108	-0.0044	0.0184	-0.0539	0.0746	-0.0236	0.0004	0.0134	0.3501	0.0037	-0.0231	0.4790
NAR P	-0.0454	0.0030	0.0001	0.0403	0.0046	-0.0170	0.0340	0.0108	-0.0004	-0.0028	0.0134	-0.0091	0.0253	-0.0101	0.0017	-0.0037	0.4194	-0.0019	-0.2090	0.2271
NAR G	0.0198	-0.0091	0.0114	0.0654	-0.0053	0.0002	0.0447	0.0350	0.0085	-0.0029	0.0530	-0.0875	0.0771	-0.0183	0.0014	-0.0107	0.8539	-0.0001	-0.4125	0.5287
SLW P	-0.0060	0.0026	-0.0003	0.0086	0.0012	-0.0091	0.0292	0.0094	-0.0005	-0.0025	0.0132	0.0115	0.1653	0.0062	0.0115	0.0023	0.6031	0.0003	-0.0366	0.8044
SLW G	0.0022	-0.0072	-0.0328	0.0046	-0.0008	0.0001	0.0398	0.0302	0.0101	-0.0043	0.0391	-0.0411	0.1642	-0.0182	0.0054	0.0108	1.4004	0.0201	-0.7089	0.9021
Chlorophyll P	-0.0133	-0.0037	0.0000	0.0080	0.0040	-0.0134	0.0415	0.0044	-0.0005	-0.0045	0.0197	0.0126	0.0735	0.0139	0.0040	0.0064	0.4100	0.0057	-0.0267	0.5414
Chlorophyll G	0.0070	-0.0368	-0.0054	0.0141	-0.0031	0.0002	0.0605	0.0164	0.0094	-0.0085	0.0609	-0.0481	0.0896	-0.0333	0.0023	0.0032	1.0013	0.0489	-0.5239	0.6509
arvestIndex P	0.0127	0.0036	0.0000	-0.0163	0.0000	-0.0057	0.0213	0.0063	-0.0002	-0.0017	0.0003	0.0020	0.0481	0.0014	0.0395	0.0241	0.2971	-0.0042	-0.0174	0.4104
arvestIndex G	-0.0056	0.0026	-0.0004	-0.0293	0.0001	0.0001	0.0272	0.0202	0.0036	-0.0028	0.0003	-0.0071	0.0505	-0.0044	0.0175	0.0541	0.6383	-0.0245	-0.3128	0.4497
Protein % P	0.0413	0.0020	0.0000	-0.0292	-0.0015	0.0096	0.0046	0.0031	0.0001	0.0000	-0.0021	0.0008	-0.0018	-0.0004	-0.0046	-0.0061	0.1493	-0.0049	0.0025	-0.0316
Protein % G	-0.0197	0.0022	0.0062	-0.0644	0.0010	-0.0001	0.0076	0.0089	-0.0021	-0.0003	-0.0065	-0.0025	-0.0048	0.0003	-0.0026	-0.0061	0.3472	-0.0386	0.0424	-0.0052
edproteinyield P	0.0181	0.0053	0.0000	-0.0189	0.0012	-0.0075	0.0447	0.0111	-0.0005	-0.0044	0.0154	0.0135	0.1318	0.0076	0.0155	-0.0411	0.7564	0.0014	-0.0427	0.9063
edproteinyield G	-0.0075	0.0035	-0.0009	-0.0309	-0.0009	0.0001	0.0564	0.0345	0.0099	-0.0074	0.0425	-0.0466	0.1434	-0.0208	0.0070	-0.0804	1.6029	0.0080	-0.7540	0.9908
Oil % P	0.0048	0.0017	0.0001	-0.0077	0.0000	-0.0027	0.0160	0.0010	-0.0001	-0.0004	0.0033	0.0001	0.0014	0.0022	-0.0045	0.0280	0.0286	0.0367	-0.0101	0.0976
Oil % G	-0.0020	0.00180	0.0405	-0.0277	-0.0003	0.0000	0.0295	0.0086	0.0045	0.0004	0.0158	0.0001	0.0221	-0.0109	-0.0029	0.0961	0.0865	0.1491	-0.2805	0.1388
Oil yield P	0.0074	0.0024	0.0001	-0.0121	0.0023	-0.0113	0.0458	0.0105	-0.0006	-0.0042	0.0167	0.0128	0.1315	0.0081	0.0149	0.0112	0.7027	0.0080	0.0460	0.8998
Oil yield G	-0.0029	0.00155	0.0052	-0.0179	-0.0016	0.0001	0.0587	0.0337	0.0108	-0.0074	0.0465	-0.0452	0.1457	-0.0218	0.0069	0.0197	1.5126	0.0524	-0.7989	1.0093
Tryptophan P	-0.0283	-0.0073	0.0003	0.0329	0.0094	-0.0120	0.0084	0.0056	0.0000	0.0013	0.0023	0.0024	0.0001	0.0005	0.0021	-0.0363	0.0342	0.0030	-0.0013	0.0066
Tryptophan G	0.0132	-0.0599	0.0433	0.0591	-0.0067	0.0001	0.0116	0.0177	0.0009	0.0029	0.0063	-0.0075	0.0044	-0.0019	0.0011	-0.0662	0.0734	0.0194	-0.0348	0.0132

** Significant at 1% level

* Significant at 5% level

Table 13 b : Phenotypic and Genotypic path coefficients for 21 characters at Rajendranagar during Rabi, 2002-03

	Tassling	Silking	ASI	Maturity	Plant ht.	Ear ht.	LAI	LDW	CGR	RGR	NAR	SLW	Biomass	Chlorophyll	HI	protein	seedproyld	Oil %	Oil yield	Tryptophan	Grain y
Tassling P	[0.2927]	-0.2072	-0.0022	-0.0477	-0.0001	-0.0059	-0.0067	-0.0001	-0.0048	0.0014	0.0006	-0.0002	-0.0071	-0.0014	0.0019	-0.0171	0.0319	0.0046	-0.0070	-0.0019	0.0237
G	[6.7931]	-7.2185	-0.0456	0.2850	0.1102	-0.0102	0.0061	-0.0011	-0.0444	-0.0010	0.0060	0.0302	0.0216	0.0105	-0.0048	-0.0228	0.1263	-0.0004	-0.0007	-0.0224	0.0171
Silking P	[6.2850]	-0.2128	0.0070	-0.0477	-0.0001	-0.0057	-0.0069	-0.0002	-0.0055	0.0013	0.0001	-0.0002	-0.0074	-0.0017	0.0017	-0.0155	0.0227	0.0034	-0.0134	-0.0022	0.0021
G	[6.7741]	-7.2387	0.0243	0.2890	0.1037	-0.0100	0.0061	-0.0012	-0.0509	-0.0011	0.0042	0.0290	0.0236	0.0111	-0.0043	-0.0207	0.1049	-0.0004	-0.0013	-0.0252	0.0160
ASI P	-0.0315	-0.0371	[0.0400]	0.0000	0.1037	0.0000	-0.0011	0.0000	-0.0033	-0.0001	0.0024	0.0000	-0.0014	-0.0013	-0.0008	0.0061	-0.0383	-0.0047	-0.0285	-0.0015	-0.0932
G	-0.3315	-0.1884	0.9335	-0.0492	-0.0886	0.0029	0.0003	-0.0009	-0.0858	-0.0022	-0.0240	-0.0161	0.0265	0.0080	0.0062	0.0282	-0.2868	0.0002	-0.0078	-0.0373	-0.0146
Maturity P	0.2431	-0.1769	0.0021	[-0.0574]	-0.0001	-0.0055	-0.0047	-0.0002	-0.0044	0.0001	-0.0002	-0.0002	-0.0066	-0.0014	0.0015	-0.0138	0.0201	0.0015	0.0045	-0.0020	-0.0003
G	7.2675	-7.8510	0.1723	[0.2664]	0.1013	-0.0095	0.0050	-0.0015	-0.0431	-0.0008	0.0007	0.0307	0.0270	0.0123	-0.0047	-0.0186	0.1083	-0.0002	-0.0001	-0.0229	0.0390
Plant ht. P	-0.1143	0.0775	0.0037	0.0181	[0.0002]	0.0108	0.0073	0.0001	0.0093	0.0004	0.0235	0.0002	0.0146	0.0023	-0.0009	0.0089	0.0677	-0.0060	0.1479	0.0012	0.2504
G	-2.8418	2.8485	0.3140	-0.1024	-0.0001	0.0178	-0.0069	0.0005	0.0860	0.0004	0.0051	0.0003	0.0064	0.0034	0.0003	0.0120	0.2763	0.0003	0.0198	0.0131	0.2908
Ear ht. P	-0.0883	0.0621	0.0009	0.0160	0.0001	[0.0196]	0.0196	0.0001	0.0096	-0.0004	0.0051	0.0003	0.0064	0.0034	0.0003	0.0126	0.0327	-0.0056	0.0787	0.0027	0.1719
G	-2.3688	2.4734	0.0911	-0.0866	-0.1604	[0.0293]	-0.0176	0.0007	0.0830	0.0025	0.0312	-0.0456	-0.0236	-0.0250	-0.0009	0.0163	0.1298	0.0004	0.0098	0.0262	0.1653
LAI P	-0.0299	0.0222	-0.0007	0.0042	0.0000	0.0058	[0.0656]	0.0015	0.0700	0.0002	0.0895	-0.0108	0.0231	0.0056	0.0009	-0.0007	0.1673	-0.0191	0.2639	0.0010	0.5341
G	-0.7106	0.7603	-0.0043	-0.0227	-0.0312	0.0088	[-0.0584]	0.0015	-0.0003	0.0025	0.0078	0.0003	0.0209	0.0031	-0.0022	-0.0007	0.6302	0.0011	0.0320	0.0104	0.5604
LDW P	-0.0597	0.0461	-0.0027	0.0134	0.0000	0.0026	-0.0173	[0.0052]	0.0404	0.0026	0.0474	-0.0384	-0.0667	-0.0210	0.0013	-0.0067	0.4175	0.0001	0.0208	0.0198	0.3366
G	-1.4746	1.6705	-0.1683	-0.0747	-0.0253	0.0039	-0.0173	0.0001	0.0278	-0.0004	0.0091	0.0004	0.0281	0.0045	0.0009	0.0099	0.1522	-0.0112	0.2499	-0.0003	0.4930
CGR P	-0.0503	0.0419	-0.0048	0.0090	0.0001	0.0067	0.0193	0.0009	0.0089	0.0014	0.0995	-0.0809	-0.0797	-0.0325	0.0024	-0.0021	0.6119	0.0002	0.0310	-0.0036	0.5168
G	-1.3136	1.6030	-0.3487	-0.0500	-0.0987	0.0106	-0.0178	0.0009	0.0229	0.0002	0.5355	-0.0587	-0.0880	-0.0308	-0.0020	0.0126	0.5854	0.0006	0.0306	-0.0022	0.5168
RGR P	0.0121	-0.0085	-0.0002	-0.0001	0.0000	-0.0026	0.0022	-0.0001	-0.0003	0.0335	0.0034	0.0001	-0.0011	0.0017	0.0030	0.0026	0.0643	0.0031	0.0847	-0.0010	0.1967
G	-0.3667	-0.4568	0.1130	0.0115	0.0066	-0.0041	-0.0018	-0.0008	-0.0025	[-0.0178]	0.0239	-0.0125	0.0031	-0.0126	-0.0074	0.0026	0.2238	-0.0002	0.0106	-0.0045	0.2408
NAR P	0.0063	-0.0005	-0.0033	0.0003	0.0000	0.0033	0.0319	0.0002	0.0085	0.0038	[0.0301]	0.0006	0.0245	0.0057	-0.0008	0.0014	0.1577	-0.0100	0.2652	0.0005	0.5253
G	0.2368	-0.1768	-0.1308	0.0011	-0.0362	0.0053	-0.0305	0.0014	0.0717	-0.0025	[0.1714]	-0.0938	-0.0765	-0.0372	0.0019	0.0023	0.6211	0.0006	0.0337	0.0027	0.5660
SLW P	-0.0453	0.0330	-0.0004	0.0076	0.0000	0.0052	0.0392	0.0002	0.0089	0.0025	0.0146	0.0003	0.0246	0.0046	-0.0009	-0.0012	0.1508	-0.0049	0.2428	-0.0003	0.4820
G	-1.2696	1.3002	0.0932	-0.0507	-0.0688	0.0083	-0.0368	0.0012	0.0834	-0.0014	0.0995	-0.1616	-0.0797	-0.0325	0.0024	-0.0021	0.6119	0.0002	0.0310	-0.0036	0.5244
Biomass P	-0.0391	0.0293	-0.0011	0.0071	0.0000	0.0023	0.0283	0.0003	0.0146	-0.0007	0.0138	0.0005	0.0534	0.0052	0.0010	-0.0002	0.2685	-0.0137	0.4171	0.0006	0.7874
G	-0.9200	1.0713	-0.1555	-0.0451	-0.0842	0.0043	-0.0269	0.0022	0.1270	0.0003	0.0823	-0.0809	-0.1593	[-0.0651]	-0.0056	0.0077	0.7525	0.0009	0.0393	0.0127	0.6686
Chlorophyll P	-0.0374	0.0325	-0.0047	0.0072	0.0000	0.0060	0.0326	0.0002	0.0111	0.0050	0.0154	0.0005	0.0248	[0.0112]	0.0019	0.0059	0.1673	-0.0135	0.2808	0.0013	0.3558
G	-1.0957	1.2353	-0.1152	-0.0505	-0.0645	0.0113	-0.0339	0.0017	0.1087	-0.0034	0.0979	-0.0808	-0.0848	[-0.0651]	-0.0056	0.0077	0.7525	0.0009	0.0393	0.0127	0.6686
arvestIndex P	0.0491	-0.0317	-0.0029	-0.0075	0.0000	0.0006	0.0053	0.0000	0.0023	0.0088	-0.0020	-0.0001	0.0048	0.0019	[0.0115]	0.0087	0.1310	0.0088	0.1675	-0.0001	0.3558
G	1.2552	-1.2074	-0.2260	0.0485	0.0210	0.0010	-0.0051	-0.0003	0.0177	-0.0051	-0.0127	0.0148	-0.0134	-0.0111	-0.0258	0.0112	0.5142	-0.0005	0.0210	-0.0017	0.3927
Protein % P	0.0803	-0.0528	-0.0039	-0.0127	0.0000	-0.0040	0.0007	0.0001	-0.0044	-0.0014	-0.0007	0.0000	0.0002	-0.0011	-0.0016	[-0.0623]	0.0669	0.0044	-0.0271	0.0018	-0.0177
G	2.1279	-2.0593	-0.3620	0.0682	0.0435	-0.0066	-0.0005	0.0005	-0.0398	0.0006	-0.0054	-0.0047	-0.0011	0.0069	0.0040	[-0.0728]	0.2637	-0.0003	0.0033	0.0172	-0.0233
seedproteinyield P	0.0279	-0.0145	-0.0046	-0.0035	0.0000	0.0019	0.0328	0.0002	0.0127	0.0064	0.0142	0.0005	0.0430	0.0056	0.0045	-0.0125	[0.3340]	-0.0089	0.4626	0.0005	0.9032
G	0.7061	-0.6251	-0.2204	0.0237	-0.0599	0.0031	-0.0303	0.0018	0.1107	-0.0033	0.0876	-0.0814	-0.1370	-0.0403	-0.0109	-0.0158	[1.2147]	0.0005	0.0585	0.0058	0.9882
Oil % P	-0.0153	0.0083	0.0022	0.0010	0.0000	0.0013	0.0143	0.0000	0.0035	-0.0012	0.0034	0.0001	0.0084	0.0017	-0.0011	0.0031	0.0337	[-0.0877]	0.1652	0.0005	0.1414
G	-0.5082	0.5214	0.0366	-0.0117	-0.0178	0.0023	-0.0136	0.0001	0.0293	0.0006	0.0225	-0.0081	-0.0246	-0.0118	0.0027	0.0039	0.1190	[0.0049]	0.1652	0.0034	0.1722
Oil yield P	-0.0039	0.0054	-0.0022	-0.0005	0.0000	0.0029	0.0326	0.0002	0.0131	0.0053	0.0150	0.0005	0.0420	0.0059	0.0036	0.0032	0.2910	-0.0273	[0.5311]	0.0002	0.9183
G	-0.0740	0.1450	-0.1136	-0.0005	-0.0817	0.0045	-0.0293	0.0017	0.1100	-0.0029	0.0906	-0.0784	-0.1321	-0.0401	-0.0085	0.0038	1.1132	0.0016	[0.0638]	0.0024	0.9753
Tryptophan P	-0.0499	0.0422	-0.0053	0.0105	0.0000	0.0047	0.0061	0.0001	-0.0007	-0.0029	0.0012	0.0000	0.0031	0.0013	-0.0001	-0.0098	0.0155	-0.0043	0.0104	[0.0112]	0.0333
G	-1.5116	1.8135	-0.3465	-0.0607	-0.0343	0.0076	-0.0061	0.0010	-0.0051	0.0008	0.0047	0.0057	-0.0071	-0.0082	0.0004	-0.0125	0.0706	0.0002	0.0015	[0.1005]	0.0145

** Significant at 1% level
* Significant at 5% level

Table 13 d : Phenotypic and Genotypic path coefficients for 21 characters at Palem during Rabi, 2002-03

	Tasseling	Silking	ASI	Maturity	Plant ht.	Ear ht.	LAI	LDW	CGR	RGR	NAR	SLW	Biomass	Chlorophyll	HI	protein %	seedproyld	Oil %	Oil yld.	Tryptophan	r Grain yld
Tasseling P	0.4831	0.0091	0.0334	0.0105	0.0105	0.0015	-0.0033	0.0030	0.0028	0.0059	-0.0016	0.0036	-0.0030	0.0049	0.0000	-0.0134	-0.1639	-0.0001	-0.0281	-0.0007	-0.2334
G	[-0.5765]	0.0094	-0.0003	0.0850	0.0055	0.0055	-0.0204	-0.0040	-0.0080	0.0144	-0.0029	-0.0116	0.0147	0.0865	0.0150	-0.0199	-0.2859	0.0107	-0.0209	-0.0173	-0.2554
Silking P	9.6827	0.0094	0.0340	0.0078	0.0071	0.0071	-0.0034	0.0035	0.0027	0.0056	-0.0017	0.0038	-0.0031	0.0044	0.0001	-0.0124	-0.1547	-0.0001	-0.0264	-0.0009	-0.2092
G	[0.4917]	-0.0003	-0.0003	0.0658	0.0239	-0.0202	-0.0202	-0.0044	-0.0078	0.0116	-0.0121	-0.0114	0.1026	0.0685	0.0102	-0.0194	-0.2645	0.0104	-0.0191	-0.0230	-0.2408
ASI P	9.6447	0.0027	0.0001	0.0658	0.0239	-0.0202	-0.0202	-0.0044	-0.0078	0.0116	-0.0121	-0.0114	0.1026	0.0685	0.0102	-0.0194	-0.2645	0.0104	-0.0191	-0.0230	-0.2408
G	[-0.0499]	0.0001	0.0001	0.0658	0.0239	-0.0202	-0.0202	-0.0044	-0.0078	0.0116	-0.0121	-0.0114	0.1026	0.0685	0.0102	-0.0194	-0.2645	0.0104	-0.0191	-0.0230	-0.2408
Maturity P	0.0665	-0.9472	1.3743	0.0000	-0.2132	0.2082	0.0015	-0.0047	0.0018	-0.0302	-0.0006	0.0007	-0.0003	-0.0030	0.0004	0.0064	0.0632	-0.0001	0.0116	-0.0008	0.1481
G	[-0.4389]	-0.0001	[0.0438]	0.0070	0.0070	0.0146	-0.0309	-0.0037	0.0134	0.0080	-0.0318	-0.0127	0.1526	0.1178	0.0138	-0.0286	-0.3369	0.0032	-0.0280	-0.0009	-0.2224
Plant ht. P	11.1213	-1.4056	0.0695	0.0707	0.0707	0.0146	-0.0309	-0.0037	0.0134	0.0080	-0.0318	-0.0127	0.1526	0.1178	0.0138	-0.0286	-0.3369	0.0032	-0.0280	-0.0009	-0.2224
G	[0.0438]	0.0695	[-0.0031]	0.0707	0.0707	0.0146	-0.0309	-0.0037	0.0134	0.0080	-0.0318	-0.0127	0.1526	0.1178	0.0138	-0.0286	-0.3369	0.0032	-0.0280	-0.0009	-0.2224
Ear ht. P	0.0729	-0.0463	-0.0090	0.0037	[-0.0829]	0.1097	0.0118	-0.0068	-0.0077	-0.0053	0.0151	-0.0018	0.0075	-0.0053	0.0008	0.0289	0.2876	-0.0005	0.0727	-0.0005	0.4371
G	[-1.3882]	1.1021	0.0000	0.0000	[-0.5928]	0.4564	0.0684	0.0085	0.0208	-0.0142	0.1565	0.0057	-0.2279	-0.0053	0.0008	0.0289	0.2876	-0.0005	0.0727	-0.0005	0.4371
LAI P	-0.0061	0.0243	-0.0101	0.0005	-0.0630	[0.1444]	0.0083	-0.0061	-0.0081	-0.0148	0.0095	-0.0029	0.0086	-0.0153	-0.0342	0.0410	0.4448	0.0252	0.0472	-0.0168	0.4804
G	0.0958	-0.4245	0.5107	0.0000	-0.4829	[0.5603]	0.0502	0.0078	0.0228	-0.0367	0.0967	0.0087	-0.2860	-0.1055	-0.0723	0.0705	0.4174	-0.0005	0.0734	-0.0001	0.4616
LDW P	0.0950	-0.4799	0.0001	-0.0053	-0.0282	0.0347	[0.0346]	-0.0143	-0.0125	0.0162	0.0174	-0.0024	0.0039	-0.0182	0.0018	0.0129	0.3020	-0.0005	0.0736	-0.0007	0.4240
G	[-1.0086]	1.0236	0.0105	0.0000	-0.2073	0.1437	[0.1956]	0.0158	0.0333	0.0409	0.1732	0.0068	-0.1164	-0.0095	0.0003	0.0173	0.4548	0.0290	0.0484	0.0196	0.4626
RGR P	-0.0424	0.0339	0.0016	0.0025	-0.0058	-0.0246	0.0449	0.0166	-0.0062	-0.0260	0.0252	-0.0043	0.0098	-0.0152	0.0016	0.0135	0.4538	-0.0004	0.1056	0.0002	0.6198
G	[-1.1352]	1.1355	0.0353	0.0000	-0.1803	0.1871	0.0955	0.0068	0.0682	0.0637	0.2205	0.0126	-0.3019	-0.2786	-0.0682	0.0187	0.6975	0.0344	0.0705	0.0078	0.6911
NAR P	0.0186	-0.0173	0.0006	-0.0034	-0.0257	0.0281	0.0124	-0.0068	-0.0117	0.0151	[0.0488]	-0.0032	0.0078	-0.0135	0.0003	0.0135	0.6011	-0.0004	0.0843	0.0000	0.5159
G	[-0.0612]	0.2612	-0.3115	0.0000	-0.2023	0.1181	0.0739	0.0079	0.0328	0.0395	[0.4587]	0.0101	-0.2583	-0.2655	-0.0378	0.0135	0.6011	-0.0004	0.0843	-0.0037	0.5625
SLW P	-0.1709	-0.1534	0.0028	-0.0114	-0.0125	0.0346	0.0067	-0.0138	-0.0091	0.0053	0.0127	[-0.0122]	0.0092	-0.0135	0.0003	0.0135	0.3601	-0.0004	0.0735	0.0007	0.4640
G	[-3.2676]	3.3081	0.0473	0.0001	-0.0981	0.1413	0.0389	0.0155	0.0250	0.0137	0.1341	[0.0344]	-0.2811	-0.2537	-0.0185	0.0194	0.5744	0.0220	0.0512	0.0192	0.5226
Biomass P	0.0863	-0.0763	0.0008	-0.0067	-0.0306	0.0613	0.0067	-0.0082	-0.0126	-0.0042	0.0189	-0.0055	[0.0203]	-0.0078	0.0000	0.0212	0.4736	-0.0008	0.1152	-0.0002	0.6513
G	[-2.0690]	1.8993	0.3353	0.0001	-0.2516	0.2985	0.0424	0.0110	0.0384	-0.0078	0.2207	0.0180	[-0.5370]	-0.1553	-0.0044	0.0300	0.8185	0.0547	0.0841	-0.0049	0.8192
Chlorophyll P	0.0795	-0.0609	-0.0043	0.0000	-0.0124	0.0206	0.0178	-0.0095	-0.0112	0.0238	0.0186	-0.0046	0.0045	[-0.0354]	0.0009	-0.0053	0.3106	-0.0004	0.0694	-0.0001	0.3980
G	[-1.4769]	1.1999	0.4827	0.0001	-0.1205	0.1043	0.1169	0.0115	0.0335	0.0701	0.2148	0.0154	-0.1471	[-0.5671]	-0.0484	-0.0116	0.5378	0.0318	0.0521	0.0050	0.5033
arvestIndex P	-0.0038	0.0081	-0.0026	-0.0015	-0.0098	0.0364	0.0091	-0.0016	-0.0060	0.0063	0.0050	-0.0005	-0.0001	-0.1024	[-0.2682]	0.0137	0.4036	0.0064	0.0357	0.0002	0.3492
G	[-0.5416]	0.3761	0.2765	0.0000	-0.0757	0.1511	0.0569	0.0020	0.0174	0.0168	0.0646	0.0024	-0.0088	-0.1043	[-0.2682]	0.0137	0.4036	0.0064	0.0357	0.0002	0.3492
Protein % P	-0.0399	0.0315	0.0017	0.0027	0.0124	-0.0346	-0.0023	-0.0040	0.0018	0.0049	-0.0023	0.0008	-0.0022	-0.0010	-0.0004	0.0139	0.2270	-0.0072	-0.0045	0.0051	0.4312
G	0.7251	-0.7272	-0.0204	0.0000	0.0916	-0.1489	-0.0127	-0.0047	-0.0048	0.0126	-0.0233	-0.0025	0.0607	-0.0247	0.0139	[-0.2653]	0.2270	-0.0072	-0.0045	0.0051	0.4312
edproteinyield P	0.1260	-0.1014	-0.0042	-0.0103	-0.0318	0.0503	0.0139	-0.0127	-0.0158	0.0062	0.0242	-0.0058	0.0128	-0.0147	0.0023	-0.0375	[0.7500]	-0.0006	0.1462	-0.0004	0.8969
G	[-2.4560]	2.3319	0.2768	0.0001	-0.2339	0.2075	0.0789	0.0137	0.0422	0.0160	-0.0233	-0.0025	0.0607	-0.0247	0.0139	[-0.2653]	0.2270	-0.0072	-0.0045	-0.0004	0.8969
Oil % P	-0.0272	0.0287	-0.0028	0.0004	-0.0152	0.0311	0.0069	-0.0096	-0.0063	0.0069	0.0077	-0.0022	0.0061	-0.0058	0.0002	0.0105	0.1730	-0.0025	0.0762	0.0005	0.9739
G	0.8950	-0.8910	-0.0379	0.0000	-0.1285	0.1404	0.0489	-0.0096	-0.0063	0.0069	0.0077	-0.0022	0.0061	-0.0058	0.0002	0.0105	0.1730	-0.0025	0.0762	0.0005	0.9739
Oil yield P	0.0990	-0.0792	-0.0035	-0.0093	-0.0368	0.0648	0.0156	-0.0144	-0.0168	0.0072	0.0251	-0.0055	0.0143	-0.0150	0.0021	0.0082	0.6699	-0.0012	0.1637	-0.0003	0.8881
G	-1.9210	1.8038	0.2479	0.0001	-0.2653	0.2690	0.0898	0.0165	0.0456	0.0161	0.2538	0.0167	-0.4281	-0.2803	-0.0908	0.0113	1.0281	0.0647	0.1055	-0.0069	0.9747
Tryptophan P	0.0702	-0.0743	0.0071	-0.0072	0.0077	-0.0036	0.0044	-0.0051	-0.0008	0.0068	0.0001	-0.0016	-0.0007	0.0004	0.0002	-0.0326	-0.0567	-0.0002	-0.0079	[0.0058]	-0.0078
G	[-1.2338]	1.6834	-0.6617	0.0000	0.0731	-0.0329	0.0282	0.0066	0.0039	0.0178	-0.0125	0.0049	0.0193	-0.0210	-0.0100	-0.0451	-0.0874	0.0135	-0.0053	[0.1358]	-0.1246

** Significant at 1% level

* Significant at 5% level

days to 50 per cent silking, plant height, LDW, RGR, SLW, chlorophyll, harvest index, seed protein yield/ha, oil per cent and tryptophan.

At Palem during *Kharif* this character had a positive direct effect on yield (1.6991). The correlation of this character with yield was -0.1474 . Its negative indirect effect was through days to 50 per cent silking, ASI, days to maturity, ear height, LAI, CGR, harvest index, chlorophyll protein content oil per cent, oil yield / ha, seed protein yield/ha and tryptophan. Its positive indirect effects were through plant height, LDW, RGR, NAR, SLW and bio mass.

This character had a positive direct effect on yield (6.7931) at Rajendranagar during *Rabi*. The correlation of this character with yield was 0.01. Its negative indirect effect was through days to 50 per cent silking, ASI, ear height, LDW, CGR, RGR, harvest index, protein content, oil per cent, oil yield / ha and tryptophan. Its positive indirect effects were through days to maturity, plant height, LAI, NAR, SLW, bio mass, chlorophyll, seed protein yield/ha.

At Palem during *Rabi* this character had a positive direct effect on yield (9.6827). The correlation of this character with yield was -0.2554 . Its negative indirect effect was through days to 50 per cent silking, ear height, LAI, LDW, CGR, NAR, SLW, protein content, oil yield / ha and tryptophan. Its positive indirect effects were through ASI, days to maturity, plant height, RGR, bio mass, seed protein yield/ha, chlorophyll, harvest index and oil per cent

4.5.2 Days to 50 per cent silking

This character had a positive direct effect on yield (0.2232) at Rajendranagar during *Kharif*. The correlation of this character with yield was 0.0719. Its negative indirect effect was through days to 50 per cent tasseling, ASI, days to maturity, ear height, LAI, CGR, NAR, biomass, protein content, and oil yield / ha. Its positive

indirect effects were through, plant height, LDW, RGR, SLW, chlorophyll, harvest index, seed protein yield/ha, oil percent and tryptophan.

At Palem during *Kharif* this character had a negative direct effect on yield (-1.5805). The correlation of this character with yield was -0.1522. Its negative indirect effect was through days to maturity, ASI, ear height, LAI, CGR, harvest index, chlorophyll, protein content, oil yield / ha, Seed protein yield/ha and tryptophan. Its positive indirect effects were through days to 50 per cent tasseling, plant height, LDW, RGR, NAR, SLW, bio mass and oil percent.

This character had a negative direct effect on yield (-7.2387) at Rajendranagar during *Rabi*. The correlation of this character with yield was 0.0160 its negative indirect effect was through ear height, LDW, CGR, RGR, harvest index, protein content, oil per cent, oil yield / ha and tryptophan.. Its positive indirect effects were through days to 50 per cent tasseling, days to maturity, ASI, plant height, LAI, NAR, SLW, bio mass, chlorophyll and seed protein yield/ha.

At Palem during *Rabi* this character had a negative direct effect on yield (-9.9364). The correlation of this character with yield was -0.2408. Its negative indirect effect was through days to maturity, LAI, LDW, CGR, NAR, SLW, protein content, seed protein yield/ha, oil yield / ha and tryptophan. Its positive indirect effects were through days to 50 per cent tasseling, ASI, plant height, ear height, RGR, chlorophyll, harvest index, bio mass and oil per cent.

4.5.3 Anthesis silking interval

This character had a positive direct effect on yield (0.0854) at Rajendranagar during *Kharif*. The correlation of this character with yield was -0.3201. Its negative indirect effect was through days to 50 per cent silking, plant height, CGR, RGR, NAR, SLW, bio mass, harvest index, protein content, oil yield / ha seed protein yield/ha, and

tryptophan. Its positive indirect effects were through days to 50 per cent tasseling, days to maturity, ear height, LAI, LDW, chlorophyll and oil per cent.

At Palem during *Kharif* this character had a positive direct effect on yield (0.1003). The correlation of this character with yield was -0.0416 . Its negative indirect effect was through days to 50 per cent tasseling, days to maturity, ear height, NAR, oil yield / ha, Seed protein yield/ha and tryptophan. Its positive indirect effects were through days to 50 per cent silking, plant height, LAI, LDW, CGR, RGR, SLW, bio mass, chlorophyll, harvest index, oil per cent and protein content.

This character had a positive direct effect on yield (0.9335) at Rajendranagar during *Rabi*. The correlation of this character with yield was -0.0146 . Its negative indirect effect was through days to 50 per cent tasseling, days to 50 per cent silking, plant height, LDW, CGR, RGR, NAR, seed protein yield/ha, oil yield / ha and tryptophan. Its positive indirect effects were through days to maturity, ear height, LAI, SLW, protein content, bio mass, chlorophyll, harvest index and oil per cent.

At Palem during *Rabi* this character had a positive direct effect on yield (1.3743). The correlation of this character with yield was 0.1521. Its negative indirect effect was through days to 50 per cent silking, plant height, LDW, RGR, NAR, bio mass, chlorophyll, harvest index, oil per cent and tryptophan.. Its positive indirect effects were through days to 50 per cent tasseling, days to maturity, ear height, LAI, CGR, SLW, protein content seed protein yield/ha and oil yield / ha.

4.5.4 Days to maturity

This character had a negative direct effect on yield (-0.2439) at Rajendranagar during *Kharif*. The correlation of this character with yield was 0.0935. Its negative indirect effect was through days to 50 per cent tasseling, ear height, ASI, LAI, CGR, NAR, bio mass, protein content, and oil yield / ha. Its positive indirect effects were

through days to 50 per cent silking, plant height, LDW, RGR, SLW, chlorophyll, harvest index, seed protein yield/ha, oil per cent and tryptophan.

At Palem during *Kharif* this character had a negative direct effect on yield (-0.1312). The correlation of this character with yield was -0.1559. Its negative indirect effect was through days to 50 per cent silking, ear height, LAI, CGR, LDW, harvest index, chlorophyll, protein content, oil yield / ha, seed protein yield/ha and tryptophan. Its positive indirect effects were through days to 50 percent tasseling, ASI, plant height, RGR, NAR, SLW, biomass and oil percent.

This character had a positive direct effect on yield (0.2664) at Rajendranagar during *Rabi*. The correlation of this character with yield was 0.0390. Its negative indirect effect was through days to 50 per cent silking, ear height, LDW, CGR, RGR, harvest index, protein content, oil per cent, oil yield / ha and tryptophan. Its positive indirect effects were through days to 50 per cent tasseling, ASI, plant height, LAI, NAR, SLW, bio mass, chlorophyll and seed protein yield/ha.

At Palem during *Rabi* this character had a negative effect on yield (-0.0003) correlation of this character with yield was -0.331. Its negative indirect effect was through days to 50 per cent silking, ASI, LAI, LDW, CGR, NAR, SLW, protein content, seed protein yield/ha, oil yield / ha and tryptophan. Its positive indirect effects were through days to 50 per cent tasseling, plant height, ear height, RGR, bio mass, chlorophyll, harvest index and oil per cent.

4.5.5 Plant height (cm)

This character had a negative direct effect on yield (-0.0148) at Rajendranagar during *Kharif*. The correlation of this character with yield was 0.0770. Its negative indirect effect was through days to 50 per cent silking, SLW, chlorophyll, harvest index, oil yield / ha and tryptophan. Its positive indirect effects were through days to

50 per cent tasseling, ASI, days to maturity, ear height, LAI, LDW, CGR, RGR, NAR, bio mass, protein content, seed protein yield/ha and oil per cent.

At Palem during *Kharif* this character had a negative direct effect on yield (-0.0476). The correlation of this character with yield was 0.4573. Its negative indirect effect was through days to 50 per cent tasseling, ASI, LAI, LDW, RGR, SLW, biomass, oil percent and tryptophan. Its positive indirect effects were through days to 50 per cent silking, days to maturity, ear height, CGR, NAR, harvest index chlorophyll, protein content, seed protein yield/ha and oil yield / ha.

This character had a positive direct effect on yield (0.2664) at Rajendranagar during *Rabi*. The correlation of this character with yield was 0.0390. Its negative indirect effect was through days to 50 per cent silking, ear height, LDW, CGR, RGR, harvest index, protein content, oil per cent, oil yield / ha and tryptophan. Its positive indirect effects were through days to 50 per cent tasseling, ASI, plant height, LAI, NAR, SLW, bio mass, chlorophyll and seed protein yield/ha.

At Palem during *Rabi* this character had a negative effect on yield (-0.0003). Correlation of this character with yield was -0.331. Its negative indirect effect was through days to 50 per cent silking, ASI, LAI, LDW, CGR, NAR, SLW, protein content, seed protein yield/ha, oil yield / ha and tryptophan. Its positive indirect effects were through days to 50 per cent tasseling, plant height, ear height, RGR, bio mass, chlorophyll, harvest index and oil per cent.

4.5.6 Ear height (cm)

This character had a positive direct effect on yield (0.0004) at Rajendranagar during *Kharif*. The correlation of this character with yield was 0.2026. Its negative indirect effect was through days to 50 per cent silking, plant height, RGR, SLW, chlorophyll, oil yield / ha and tryptophan. Its positive indirect effects were through

days to 50 per cent tasseling, ASI, days to maturity, LAI, LDW, CGR, NAR, bio mass, harvest index, protein content, seed protein yield/ha and oil per cent

At Palem during *Kharif* this character had a positive direct effect on yield (0.0794). The correlation of this character with yield was 0.4736. Its negative indirect effect was through ASI, plant height, LAI, RGR, SLW, biomass, oil percent and tryptophan. Its positive indirect effects were through days to 50 per cent tasseling, days to 50 per cent silking, days to maturity, LDW, CGR, NAR, harvest index, chlorophyll, protein content, seed protein yield/ha and oil yield / ha.

This character had a positive direct effect on yield (0.0293) at Rajendranagar during *Rabi*. The correlation of this character with yield was 0.1653. Its negative indirect effect was through days to 50 per cent tasseling, days to maturity, plant height, LAI, SLW, bio mass, chlorophyll and harvest index. Its positive indirect effects were through days to 50 per cent silking, ASI, LDW, CGR, RGR, NAR, protein content, seed protein yield/ha, oil yield / ha, oil per cent and tryptophan.

At Palem during *Rabi* this character had a positive direct effect on yield (0.5603). The correlation of this character with yield was 0.5408. Its negative indirect effect was through days to 50 per cent silking, plant height, RGR, biomass, chlorophyll, harvest index, and tryptophan. Its positive indirect effects were through days to 50 per cent tasseling, ASI, days to maturity, LAI, LDW, CGR, NAR, SLW, protein content, seed protein yield/ha, oil per cent and oil yield / ha.

4.5.7 Leaf area index (LAI)

This character had a positive direct effect on yield (0.0928) at Rajendranagar during *Kharif*. The correlation of this character with yield was 0.6443. Its negative indirect effect was through days to 50 per cent silking, plant height, RGR, SLW, chlorophyll, protein content, oil yield / ha and tryptophan. Its positive indirect effects

were through days to 50 per cent tasseling, ASI, days to maturity, ear height, LDW, CGR, NAR, bio mass, harvest index, seed protein yield/ha and oil per cent

At Palem during *Kharif* this character had a negative direct effect on yield (-0.0923). The correlation of this character with yield was 0.4822. Its negative indirect effect was through days to 50 per cent silking, days to maturity, ASI, plant height, LDW, SLW, bio mass, protein content, oil per cent and. Its positive indirect effects were through days to 50 per cent tasseling, ear height, CGR, RGR, NAR, harvest index, chlorophyll, Seed protein yield/ha, oil yield /ha and tryptophan.

This character had a negative direct effect on yield (-0.0584) at Rajendranagar during *Rabi*. The correlation of this character with yield was 0.5604. Its negative indirect effect was through days to 50 per cent tasseling, ASI, days to maturity, plant height, RGR, SLW, biomass, chlorophyll, harvest index and protein content. Its positive indirect effects were through days to 50 per cent silking, ear height, LDW, CGR, NAR, seed protein yield/ha, oil per cent, oil yield / ha and tryptophan.

At Palem during *Rabi* this character had a positive direct effect on yield (0.1956). The correlation of this character with yield was 0.4626. Its negative indirect effect was through days to 50 per cent tasseling, plant height and bio mass. Its positive indirect effects were through days to 50 per cent silking, ASI, days to maturity, ear height, LDW, CGR, RGR, NAR, SLW, chlorophyll, harvest index, protein content, seed protein yield/ha, oil per cent, oil yield / ha and tryptophan content.

4.5.8 Leaf dry weight (LDW) (gm-2)

This character had a positive direct effect on yield (0.0610) at Rajendranagar during *Kharif*. The correlation of this character with yield was 0.5824. Its negative indirect effect was through days to 50 per cent tasseling, days to maturity, plant height, LDW, RGR, SLW, chlorophyll, protein content, oil yield / ha and tryptophan. Its

positive indirect effects were through days to 50 per cent silking, ASI, ear height, LAI, CGR, NAR, bio mass, harvest index, seed protein yield/ha and oil per cent 215

At Palem during *Kharif* this character had a positive direct effect on yield (0.0053). The correlation of this character with yield was 0.1163. Its negative indirect effect was through days to 50 per cent silking, ASI, CGR, NAR, harvest index, protein content, oil per cent and Its positive indirect effects were through days to 50 per cent tasseling, days to maturity, plant height, ear height, LAI, RGR, SLW, bio mass, chlorophyll, seed protein yield/ha, oil yield / ha and tryptophan.

This character had a positive direct effect on yield (0.0052) at Rajendranagar during *Rabi*. The correlation of this character with yield was 0.3366. Its negative indirect effect was through days to 50 per cent tasseling, ASI, days to maturity, plant height, LAI, SLW, biomass, chlorophyll, and protein content. Its positive indirect effects were through days to 50 per cent silking, ear height, CGR, RGR, NAR, harvest index, seed protein yield/ha, oil per cent, oil yield / ha and tryptophan.

At Palem during *Rabi* this character had a negative direct effect on yield (-0.0371). The correlation of this character with yield was 0.3248. Its negative indirect effect was through plant height, RGR, biomass, chlorophyll, harvest index, and protein content. Its positive indirect effects were through days to 50 per cent tasseling, days to 50 per cent silking, days to maturity, ASI, ear height, LAI, CGR, NAR, SLW, oil per cent, oil yield / ha, seed protein yield/ha and tryptophan.

4.5.9 Crop growth rate (CGR) ($\text{g m}^{-2} \text{d}^{-1}$)

This character had a positive direct effect on yield (0.0186) at Rajendranagar during *Kharif*. The correlation of this character with yield was 0.5726. Its negative indirect effect was through days to 50 per cent silking, ASI; plant height, RGR, SLW, chlorophyll, oil yield / ha and tryptophan. Its positive indirect effects were through days to 50 per cent tasseling, days to maturity, ear height, LAI, LDW, NAR, bio mass, harvest index, protein content, seed protein yield/ha and oil per cent

At Palem during *Kharif* this character had a positive direct effect on yield (0.0291). The correlation of this character with yield was 0.6373. Its negative indirect effect was through plant height, LAI, SLW, biomass and oil percent. Its positive indirect effects were through days to 50 per cent tasseling, days to 50 per cent silking, ASI, ear height, days to maturity, LDW, RGR, NAR, chlorophyll, harvest index protein content, seed protein yield/ha, oil yield / ha and tryptophan content.

This character had a positive direct effect on yield (0.2298) at Rajendranagar during *Rabi*. The correlation of this character with yield was 0.5168. Its negative indirect effect was through days to 50 per cent tasseling, ASI, days to maturity, plant height, LAI, SLW, biomass, chlorophyll, harvest index and tryptophan. Its positive indirect effects were through days to 50 per cent silking, ear height, LDW, RGR, NAR, protein content, seed protein yield/ha, oil yield/ha and oil per cent.

At Palem during *Rabi* this character had a positive direct effect on yield (0.0682). The correlation of this character with yield was 0.6911. Its negative indirect effect was through days to 50 per cent tasseling, days to maturity, plant height, chlorophyll, harvest index, biomass and tryptophan. Its positive indirect effects were through days to 50 per cent silking, ASI, ear height, LAI, LDW, RGR, NAR, SLW, bio mass, protein content, seed protein yield/ha, oil yield / ha and oil per cent.

4.5.10 Relative growth rate (RGR) ($\text{g g}^{-1} \text{d}^{-1}$)

This character had a negative direct effect on yield (-0.0178) at Rajendranagar during *Rabi*. The correlation of this character with yield was 0.2408. Its negative indirect effect was through days to 50 per cent silking, ear height, LAI, LDW, CGR, SLW, harvest index, oil per cent, seed protein yield/ha and tryptophan. Its positive indirect effects were through days to 50 per cent tasseling, days to maturity, ASI, plant height, NAR, bio mass, chlorophyll, oil yield / ha and protein content.

At Palem during *Rabi* this character had a positive direct effect on yield (0.1859). The correlation of this character with yield was 0.0830. Its positive indirect effect was through days to 50 per cent tasseling, days to maturity, plant height, LAI, CGR, NAR, SLW, bio mass, harvest index, oil per cent, oil yield / ha seed protein yield/ha and tryptophan. Its negative indirect effects were through days to 50 per cent silking, ASI, ear height, LDW, chlorophyll and protein content.

This character had a positive direct effect on yield (0.028) at Rajendranagar during *Kharif*. The correlation of this character with yield was 0.2271. Its negative indirect effect was through days to 50 per cent silking, ear height, SLW, chlorophyll, protein content and oil yield / ha. Its positive indirect effects were through days to 50 per cent tasseling, ASI, days to maturity, plant height, LAI, LDW, CGR, NAR, bio mass, harvest index, oil per cent, seed protein yield/ha and tryptophan.

At Palem during *Kharif* this character had a positive direct effect on yield (0.0096). The correlation of this character with yield was 0.1931. Its positive indirect effect was through days to 50 per cent tasseling, ASI, plant height, LDW, CGR, NAR, chlorophyll content, protein content, seed protein yield/ha, oil per cent, oil yield / ha and harvest index. Its negative indirect effects were through days to 50 per cent silking, days to maturity, ear height, LAI, SLW, biomass, and tryptophan content.

4.5.11 Net assimilation rate (NAR) ($\text{g m}^{-2} \text{d}^{-1}$)

This character had a positive direct effect on yield (0.0860) at Rajendranagar during *Kharif*. The correlation of this character with yield was 0.5325. Its negative indirect effect was through ASI, plant height, RGR, SLW, chlorophyll, and tryptophan. Its positive indirect effects were through days to 50 per cent tasseling, days to 50 per cent silking, days to maturity, ear height, LAI, LDW, CGR, bio mass, harvest index, protein content, seed protein yield/ha, oil per cent and oil yield / ha.

At Palem during *Kharif* this character had a positive direct effect on yield (0.0767). The correlation of this character with yield was 0.5739. Its positive indirect effect was through days to 50 per cent tasseling, ear height, CGR, RGR, chlorophyll, harvest index, protein content, seed protein yield/ha and oil yield / ha. Its negative indirect effects were through days to 50 per cent silking, ASI, days to maturity, plant height, LDW, LAI, SLW, bio mass, oil per cent and tryptophan.

This character had a positive direct effect on yield (0.1714) at Rajendranagar during *Rabi*. The correlation of this character with yield was 0.5660. Its negative indirect effect was through days to 50 per cent silking, ASI, plant height, LAI, RGR, SLW, biomass, chlorophyll, harvest index, seed protein yield/ha oil per cent, and tryptophan. Its positive indirect effects were through days to 50 per cent tasseling, days to maturity, ear height, CGR, LDW, protein content and oil yield / ha.

At Palem during *Rabi* this character had a positive direct effect on yield (0.4587). The correlation of this character with yield was 0.5625. Its negative indirect effect was through ASI, plant height, bio mass, chlorophyll, harvest index, and tryptophan. Its positive indirect effects were through days to 50 per cent tasseling, days to 50 per cent silking, days to maturity, ear height, LAI, LDW, CGR, RGR, SLW, protein content, seed protein yield/ha, oil per cent and oil yield / ha.

4.5.12 Specific leaf weight (mg cm^{-2})

This character had a negative direct effect on yield (-0.0875) at Rajendranagar during *Kharif*. The correlation of this character with yield was 0.5287. Its negative indirect effect was through days to 50 per cent silking, plant height, RGR, protein per cent, oil yield / ha, oil per cent and tryptophan. Its positive indirect effects were through days to 50 per cent tasseling, ASI, days to maturity, ear height, LAI, LDW, CGR, NAR, biomass, chlorophyll, harvest index and seed protein yield/ha.

At Palem during *Kharif* this character had a negative direct effect on yield (-0.0421). The correlation of this character with yield was 0.4883. Its positive indirect effect was through days to 50 per cent silking, days to maturity, ear height, LDW, CGR, RGR, NAR, chlorophyll, harvest index, seed protein yield/ha, oil yield / ha and tryptophan. Its negative indirect effects were through days to 50 per cent tasseling, ASI, plant height, LAI, biomass, protein content and oil per cent.

This character had a negative direct effect on yield (-0.1616) at Rajendranagar during *Rabi*. The correlation of this character with yield was 0.5244. Its negative indirect effect was through days to 50 per cent tasseling, days to maturity, plant height, RGR, bio mass, chlorophyll, protein content and tryptophan content. Its positive indirect effects were through days to 50 per cent silking, ASI, ear height, CGR, LAI, LDW, NAR, harvest index, seed protein yield/ha, oil per cent and oil yield / ha.

At Palem during *Rabi* this character had a positive direct effect on yield (0.0344). The correlation of this character with yield was 0.5226. Its negative indirect effect was through days to 50 per cent tasseling, plant height, total biomass, total chlorophyll content and harvest index. Its positive indirect effects were through days to 50 per cent silking, ASI, days to maturity, ear height, LAI, LDW, CGR, RGR, NAR, protein per cent, seed protein yield/ha, oil yield / ha, oil per cent and tryptophan

4.5.13 Total bio mass (Kg/Plot)

This character had a positive direct effect on yield (0.1642) at Rajendranagar during *Kharif*. The correlation of this character with yield was 0.9021. Its negative indirect effect was through days to 50 per cent silking, ASI, plant height, RGR, SLW, chlorophyll, oil yield / ha and tryptophan. Its positive indirect effects were through days to 50 per cent tasseling, days to maturity, ear height, LAI, LDW, CGR, NAR, harvest index, protein per cent, seed protein yield/ha and oil per cent.

At Palem during *Kharif* this character had a negative direct effect on yield (-0.0212). The correlation of this character with yield was 0.8416. Its positive indirect effect was through days to 50 per cent tasseling, days to 50 per cent silking, days to maturity, plant height, ear height, LDW, CGR, RGR, NAR, chlorophyll, harvest index, protein per cent, Seed protein yield/ha, oil yield / ha and tryptophan. Its negative indirect effects were through ASI, LAI, SLW, biomass and oil percent.

This character had a negative direct effect on yield (-0.1593) at Rajendranagar during *Rabi*. The correlation of this character with yield was 0.8811. Its negative indirect effect was through days to 50 per cent tasseling, ASI, days to maturity, plant height, SLW, and its positive indirect effects were through days to 50 per cent silking, ear height, LAI, LDW, CGR, RGR, NAR, chlorophyll, harvest index, protein content, seed protein yield/ha, oil per cent, oil yield / ha and tryptophan content.

At Palem during *Rabi* this character had a negative direct effect on yield (-0.5370). The correlation of this character with yield was 0.8192. Its negative indirect effect was through days to 50 per cent tasseling, plant height, RGR, chlorophyll, harvest index and Tryptophan. Its positive indirect effects were through days to 50 per cent silking, ASI, days to maturity, ear height, LAI, LDW, CGR, NAR, SLW protein per cent, seed protein yield/ha, oil per cent and oil yield / ha.

4.5.14 Total chlorophyll content (mg/g)

This character had a negative direct effect on yield (-0.0333) at Rajendranagar during *Kharif*. The correlation of this character with yield was 0.6509. Its negative indirect effect was through days to 50 per cent silking, ASI, plant height, RGR, SLW, oil yield / ha and tryptophan. Its positive indirect effects were through days to 50 per cent tasseling, days to maturity, ear height, LAI, LDW, CGR, NAR, bio mass, harvest index, protein content, seed protein yield/ha and oil per cent.

At Palem during *Kharif* this character had a positive direct effect on yield (0.0123). The correlation of this character with yield was 0.4484. Its positive indirect effect was through days to 50 per cent silking, ASI, days to maturity, ear height, CGR, RGR, NAR, harvest index, Seed protein yield/ha, oil yield / ha and tryptophan. Its negative indirect effects were through days to 50 per cent tasseling, plant height, LAI, LDW, SLW, bio mass, protein content and oil per cent.

This character had a negative direct effect on yield (-0.0651) at Rajendranagar during *Rabi*. The correlation of this character with yield was 0.6686. Its negative indirect effect was through days to 50 per cent tasseling, ASI, days to maturity, plant height, LAI, LDW, RGR, SLW, biomass and harvest index. Its positive indirect effects were through days to 50 per cent silking, ear height, CGR, NAR, protein content, seed protein yield/ha, oil per cent, oil yield / ha and tryptophan.

At Palem during *Rabi* this character had a negative direct effect on yield (-0.5671). The correlation of this character with yield was 0.5033. Its negative indirect effect was through days to 50 per cent tasseling, plant height, protein content, bio mass and harvest index. Its positive indirect effects were through days to 50 per cent silking, ASI, days to maturity, ear height, LAI, LDW, CGR, RGR, NAR, SLW, seed protein yield/ha oil per cent, oil yield / ha and Tryptophan.

4.5.15 Harvest index

This character had a positive direct effect on yield (0.0175) at Rajendranagar during *Kharif*. The correlation of this character with yield was 0.4497. Its negative indirect effect was through days to 50 per cent tasseling, ASI, days to maturity, SLW, chlorophyll, oil percent, oil yield / ha and tryptophan. Its positive indirect effects were through days to 50 per cent silking, plant height, ear height, LAI, LDW, CGR, RGR, NAR, bio mass, protein content and seed protein yield/ha.

At Palem during *Kharif* this character had a positive direct effect on yield (0.0014). The correlation of this character with yield was 0.5114. Its positive indirect effect was through days to 50 per cent silking, days to maturity, ear height, ASI, LDW, CGR, RGR, NAR, chlorophyll, protein per cent, Seed protein yield/ha, oil yield / ha bio mass and oil per cent. Its negative indirect effects were through days to 50 per cent tasseling, plant height, LAI, SLW and tryptophan.

This character had a negative direct effect on yield (-0.0258) at Rajendranagar during *Rabi*. The correlation of this character with yield was 0.3927. Its negative indirect effect was through days to 50 per cent silking, LAI, LDW, RGR, NAR, chlorophyll, biomass, oil per cent, seed protein yield/ha and tryptophan. Its positive indirect effects were through days to 50 per cent tasseling, ASI, days to maturity, plant height, ear height, CGR, SLW, harvest index, protein content and oil yield / ha.

At Palem during *Rabi* this character had a negative direct effect on yield (-0.2682). The correlation of this character with yield was 0.4312. Its positive indirect effect was through days to 50 per cent silking, days to maturity, ear height, LAI, LDW, CGR, RGR, NAR, SLW, protein per cent, seed protein yield/ha, oil per cent oil yield / ha and. Tryptophan. Its negative indirect effects were through days to 50 per cent tasseling, ASI, plant height, biomass, chlorophyll and harvest index.

4.5.16 Seed protein content (%)

This character had a negative direct effect on yield (-0.3711) at Rajendranagar during *Kharif*. The correlation of this character with yield was -0.0082. Its negative indirect effect was through days to 50 per cent tasseling, days to maturity, ear height, CGR, RGR, NAR, SLW, biomass, oil per cent, harvest index, oil per cent and tryptophan. Its positive indirect effects were through days to 50 per cent silking, ASI, plant height, LAI, LDW, chlorophyll, seed protein yield/ha, and oil yield / ha.

At Palem during *Kharif* this character had a negative direct effect on yield (-0.1844). The correlation of this character with yield was -0.560. Its positive indirect effect was through days to 50 per cent tasseling, plant height, LDW, bio mass, chlorophyll, protein content, seed protein yield/ha oil per cent and tryptophan. Its negative indirect effects were through days to 50 per cent silking, days to maturity, ASI, ear height, LAI, CGR, RGR, NAR, SLW, harvest index and oil yield / ha.

This character had a negative direct effect on yield (-0.0728) at Rajendranagar during *Rabi*. The correlation of this character with yield was -0.0233. Its negative indirect effect was through days to 50 per cent silking, ASI, ear height, LAI, CGR, RGR, SLW, biomass oil yield / ha and oil per cent.. Its positive indirect effects were through days to 50 per cent tasseling, days to maturity, plant height, LDW, NAR, bio mass, chlorophyll, harvest index, seed protein yield/ha and tryptophan

At Palem during *Rabi* this character had a negative direct effect on yield (-0.2653). The correlation of this character with yield was -0.0823. Its negative indirect effect was through days to 50 per cent silking, ASI, ear height, LAI, CGR, NAR, SLW, oil yield / ha and Tryptophan Its positive indirect effects were through days to 50 per cent tasseling, days to maturity, plant height, LDW, RGR, bio mass, harvest index chlorophyll, seed protein yield/ha and oil per cent.

4.5.17 Seed protein yield/ha

This character had a positive direct effect on yield (1.6029) at Rajendranagar during *Kharif*. The correlation of this character with yield was 0.9908. Its negative indirect effect was through days to 50 per cent tasseling, ASI, days to maturity, plant height, LAI, RGR, SLW, chlorophyll, protein percent, oil yield / ha and tryptophan. Its positive indirect effects were through days to 50 per cent silking, ear height, LDW, CGR, NAR, bio mass, harvest index and oil per cent.

At Palem during *Kharif* this character had a positive direct effect on yield (0.7038). The correlation of this character with yield was 0.9677. Its positive indirect effect was through days to 50 per cent silking, plant height, LDW, CGR, RGR, chlorophyll, oil yield / ha and tryptophan. Its negative indirect effects were through days to 50 per cent tasseling, days to maturity, ASI, ear height, LAI, NAR, SLW, bio mass, harvest index, protein content and oil per cent.

This character had a positive direct effect on yield (1.2147) at Rajendranagar during *Rabi*. The correlation of this character with yield was 0.9882. Its negative indirect effect was through days to 50 per cent silking, ASI, plant height, LAI, RGR, SLW, chlorophyll, harvest index and protein content. Its positive indirect effects were through days to 50 per cent tasseling, days to maturity, ear height, LDW, CGR, NAR, bio mass, oil per cent, oil yield / ha and tryptophan content.

At Palem during *Rabi* this character had a positive direct effect on yield (1.1272). The correlation of this character with yield was 0.9739. Its negative indirect effect was through days to 50 per cent tasseling, plant height, CGR, bio mass, chlorophyll, harvest index, protein content and Tryptophan. Its positive indirect effects were through days to 50 per cent silking, ASI, days to maturity, ear height, LAI, LDW, NAR, RGR, SLW, seed protein yield/ha and oil yield / ha.

4.5.18 Oil content (%)

This character had a positive direct effect on yield (0.1491) at Rajendranagar during *Kharif*. The correlation of this character with yield was 0.1388. Its negative indirect effect was through days to 50 per cent tasseling, days to maturity, plant height, chlorophyll, harvest index, oil yield / ha and tryptophan. Its positive indirect effects were through days to 50 percent silking, ASI, ear height, LAI, LDW, CGR, RGR, NAR, SLW, biomass, protein percent and seed protein yield/ha.

At Palem during *Kharif* this character had a negative direct effect on yield (-0.1042). The correlation of this character with yield was 0.3083. Its positive indirect effect was through days to 50 per cent silking, days to maturity, ear height, LDW, CGR, NAR, chlorophyll, protein per cent, seed protein yield/ha oil yield / ha, harvest index and tryptophan. Its negative indirect effects were through days to 50 percent tasseling, ASI, plant height, LAI, RGR, SLW and bio mass.

This character had a positive direct effect on yield (0.0049) at Rajendranagar during *Rabi*. The correlation of this character with yield was 0.1722. Its negative indirect effect was through days to 50 per cent tasseling, plant height, days to maturity, SLW, biomass and chlorophyll. Its positive indirect effects were through days to 50 per cent silking, ASI, ear height, LAI, LDW, CGR RGR, NAR, bio mass, harvest index, protein content, seed protein yield/ha, oil yield / ha and tryptophan.

At Palem during *Rabi* this character had a positive direct effect on yield (0.1161). The correlation of this character with yield was 0.3020. Its negative indirect effect was through days to 50 per cent silking, plant height, biomass, chlorophyll and harvest index. Its positive indirect effects were through days to 50 per cent tasseling, ASI, days to maturity, ear height, RGR, NAR, LAI, LDW, CGR, SLW, protein per cent, seed protein yield/ha, oil yield / ha and Tryptophan.

4.5.19 Oil yield (kg/ ha)

This character had a negative direct effect on yield (-0.7989) at Rajendranagar during *Kharif*. The correlation of this character with yield was 1.0093. Its negative indirect effect was through days to 50 per cent tasseling, days to maturity, plant height, RGR, SLW, chlorophyll, and tryptophan. Its positive indirect effects were through days to 50 per cent silking, ASI, ear height, LAI, LDW, CGR, NAR, bio mass, harvest index, protein content, seed protein yield/ha, and oil per cent.

At Palem during *Kharif* this character had a positive direct effect on yield (0.3676). The correlation of this character with yield was 0.9759. Its positive indirect effect was through days to 50 per cent silking, days to maturity, ear height, LDW, CGR, RGR, NAR, chlorophyll, harvest index, protein content and Seed protein yield/ha. Its negative indirect effects were through days to 50 per cent tasseling, ASI, plant height, LAI, SLW, bio mass, oil per cent and tryptophan.

This character had a positive direct effect on yield (0.0638) at Rajendranagar during *Rabi*. The correlation of this character with yield was 0.9753. Its negative indirect effect was through days to 50 per cent tasseling, ASI, days to maturity, plant height, LAI, RGR, SLW, bio mass, chlorophyll and harvest index. Its positive indirect effects were through days to 50 per cent silking, ear height, LDW, CGR, NAR, protein content, seed protein yield/ha, oil per cent and tryptophan.

At Palem during *Rabi* this character had a positive direct effect on yield (0.1055). The correlation of this character with yield was 0.9747. Its negative indirect effect was through plant height, bio mass, chlorophyll, harvest index, and tryptophan content. Its positive indirect effects were through days to 50 per cent tasseling, days to 50 per cent silking, ASI, days to maturity, ear height, LAI, LDW, CGR, NAR, RGR, SLW, protein per cent, seed protein yield/ha and oil per cent.

4.5.20 Tryptophan content (g/16gN)

This character had a negative direct effect on yield (-0.0629) at Rajendranagar during *Kharif*. The correlation of this character with yield was 0.0132. Its positive indirect effect was through days to 50 per cent tasseling, ASI, days to maturity, ear height, LAI, LDW, CGR, RGR, NAR, bio mass, harvest index, seed protein yield/ha and oil per cent. Its negative indirect effects were through days to 50 per cent silking, plant height, SLW, chlorophyll, protein content and oil yield / ha.

At Palem during *Kharif* this character had a positive direct effect on yield (0.0431). The correlation of this character with yield was -0.0045 . Its positive indirect effect was through days to 50 per cent silking, days to maturity, plant height, ear height, CGR, LDW, and bio mass. Its negative indirect effects were through days to 50 per cent tasseling, ASI, LAI, RGR, NAR, SLW, chlorophyll, harvest index, protein per cent, seed protein yield/ha, oil per cent and oil yield / ha.

This character had a positive direct effect on yield (0.1005) at Rajendranagar during *Rabi*. The correlation of this character with yield was 0.0145. Its negative indirect effect was through days to 50 per cent tasseling, days to maturity, plant height, LAI, LDW, CGR, bio mass, chlorophyll and protein content. Its positive indirect effects were through days to 50 per cent silking, ASI, ear height, RGR, NAR, SLW, harvest index, seed protein yield/ha, oil per cent and oil yield/ha.

At Palem during *Rabi* this character had a positive direct effect on yield (0.1358). The correlation of this character with yield was -0.1246 . Its positive indirect effect was through days to maturity, plant height, LAI, LDW, CGR, RGR, SLW, bio mass, protein content and oil per cent. Its negative indirect effects were through days to 50 per cent tasseling, days to 50 per cent silking, ASI, ear height, NAR, chlorophyll, harvest index, oil yield / ha and seed protein yield/ha.

4.6 STABILITY PARAMETERS FOR MORPHOLOGICAL, PHYSIOLOGICAL AND BIO CHEMICAL PARAMETERS AND GRAIN YIELD

4.6.1 Grading of environments

The genotypes X environment interaction was estimated in parental lines and their possible crosses and are presented in Table 14. The pooled analysis of variance for 21 characters over Two locations for both the seasons *Viz.*, Rajendranagar- *Kharif*

Table 14: Pooled analysis of Variance for 21 characters involving 55 QPM parents and hybrids over four environments

Source of variation	df	Days to 50% tasseling	Days to 50% silking	ASI	Days to maturity	Plant height	Ear height	LAI	LDW	CGR	RGR
Varieties	54	44.780**	44.64**	0.321NS	41.9**	1039.40**	415.85**	3.328**	249.59**	91.840**	0.0002NS
Env.(Linear)	1	2635**	2686**	0.458NS	2486.8**	19312.55**	2720.59**	8.076**	4093.32**	40.451**	0.0001NS
Var*Env.(Linear)	54	2.626**	3.145**	0.159NS	4.159**	713.42**	242.58**	0.430NS	1104.88**	0.394NS	0.0000NS
Pooled deviation	110	3.448**	3.079**	0.315NS	3.189**	237.18**	22.09**	0.104NS	483.329**	2.506NS	0.0000NS
Pooled error	440	0.929	0.952	0.229	1.699	12.65	3.69	0.002	23.339	0.288	0.0000
S.E.(b)		0.268	0.251	6.157	0.265	0.821	0.669	0.840	2.559	1.847	1.7340

Table Contd.....

Source of variation	NAR	SLW	Total biomass	Total Chlorophyll	Harvest Index	Seed protein%	Seed protein yield	Oil %	Oil yield	Tryptophan	Grain yield
Varieties	3.34**	5.529**	1.748**	0.046NS	44.767**	2.175**	101206**	0.821 NS	48182**	0.041NS	2.184 **
Env.(Linear)	4.56**	7.942**	1.136NS	0.205NS	416.31**	0.444NS	310087**	5.361 NS	219925**	0.001NS	5.884 **
Var*Env.(Linear)	0.49NS	0.458NS	0.108NS	0.003NS	17.580**	0.006NS	12763**	0.025 NS	5025**	0.000NS	0.336 NS
Pooled deviation	0.26NS	0.459NS	0.175NS	0.002NS	5.044**	0.008NS	1948.6**	0.024 NS	1415.71**	0.000NS	0.026 NS
Pooled error	0.04	0.056	0.031	0.001	0.696	0.019	670.9	0.037	122.55	0.005	0.029
S.E.(b)	1.76	1.788	2.919	0.858	0.817	1.032	0.588	0.494	0.595	0.567	0.497

and *Rabi* and *Palem Kharif* and *Rabi* revealed significant differences among genotypes. Environment (linear) was also significant for all characters except ASI, RGR, total chlorophyll content, protein content and tryptophan content. The magnitude of environment (linear) was higher for all characters except ASI, RGR, total chlorophyll content, protein content and tryptophan content. The G X E interaction was significant for all characters except ASI, LAI, CGR, RGR, NAR, SLW, total biomass, total chlorophyll content, protein content, oil percent, tryptophan content and grain yield. Pooled deviation was significant for Days to 50 % tasseling, days to 50 % silking, days to maturity, plant height, ear height, LDW, HI, seed protein yield and oil yield.

The mean values and environmental index for morphological, physiological and biochemical and grain yield under each environment in the present study at two locations for two seasons are presented in Table15.

A comparative study of environmental mean with grand mean helped to grade the environments. Among the four environments *Palem Rabi* was graded as more favourable environment for grain yield as indicated by highest positive environmental index value. The characters *Viz.*, CGR, SLW was found to express fully at *Rajendranagar Kharif*. During *Rabi* the characters, days to maturity, LAI, total biomass, protein content are found to express full to their potential. *Palem Rabi* was found to be favourable for Days to 50% tasseling, days to 50% silking, plant height, ear height, NAR, HI, seed protein yield, oil per cent and oil yield.

4.6.2 Estimates of stability parameters of ten parents

The stability parameters, namely mean, regression coefficient and deviation from regression are presented in Table16

Table 15: Mean and Environmental index for grain yield and its components under each environment

Characters	Environments				
		Rajendranagar		Palem	
		Kharif	Rabi	Kharif	Rabi
Days to 50% tasseling	Mean	57.57	64.35	57.73	64.78
	ij	-3.53	3.24	-3.38	3.68
Days to 50% silking	Mean	59.87	66.73	60.11	67.21
	ij	-3.6076	3.2470	-3.3712	3.7318
ASI	Mean	2.30	2.38	2.38	2.43
	ij	-0.0712	0.0076	0.0076	0.0561
Days to maturity	Mean	91.98	99.09	92.73	99.02
	ij	-3.7273	3.3879	-2.9758	3.3152
Plant height	Mean	154.67	154.67	171.50	174.99
	ij	-9.2896	-9.2836	7.5407	11.0328
Ear height	Mean	68.38	66.20	72.58	75.21
	ij	-2.2104	-4.3922	1.9841	4.6187
LAI	Mean	2.41	2.46	2.04	2.07
	ij	0.1628	0.2177	-0.2072	-0.1732
LDW	Mean	238.20	236.45	247.23	237.61
	ij	-1.6783	-3.4189	7.3611	-2.2626
CGR	Mean	27.47	27.05	26.63	26.34
	ij	0.5978	0.1795	-0.2433	-0.5350
RGR	Mean	0.05	0.05	0.05	0.05
	ij	0.0013	-0.0002	-0.002	-0.0008
NAR	Mean	9.46	9.42	9.53	9.79
	ij	-0.0927	-0.1259	-0.0210	0.2406
SLW	Mean	11.79	11.29	11.38	11.46
	ij	0.3109	-0.1904	-0.1024	-0.018
Total biomass	Mean	3.28	3.47	3.45	3.41
	ij	-0.1180	0.0651	0.0492	0.0037
Total Chlorophyll content	Mean	1.37	1.35	1.42	1.34
	ij	0.0008	-0.0209	0.0493	-0.0292
Harvest Index	Mean	45.02	44.89	47.57	47.82
	ij	-1.3077	-1.4347	1.2452	1.4972
Seed Protein content	Mean	10.33	10.45	10.39	10.44
	ij	-0.0685	0.0466	-0.0108	0.0326
Seed protein yield	Mean	569.54	603.00	654.02	660.71
	ij	-52.2789	-18.8194	32.2074	38.8916
Oil Per cent	Mean	6.58	6.78	6.77	7.02
	ij	-0.2035	-0.0107	-0.0210	0.2352
Oil yield	Mean	361.26	400.07	427.08	445.25
	ij	-47.1510	-8.3440	18.6614	36.8345
Tryptophan content	Mean	0.67	0.67	0.68	0.68
	ij	-0.0027	-0.0014	0.0034	0.0007
Grain yield	Mean	2.81	2.92	3.18	3.17
	ij	-0.2136	-0.1042	0.1640	0.1538
Total	ij	-124.47	-35.56	58.94	101.35

Table 16 : Estimates of Stability parameters of 10 Parents of QPM

Parents	Days to 50% tasselling			Days to 50% silking			ASI		
	MEAN	bi	S ² di	MEAN	bi	S ² di	MEAN	bi	S ² di
P1	64.50	1.01	-0.87	67.00	0.99	-0.02	2.50	-7.64	0.03
P2	62.92	1.03	1.60**	65.50	1.00	0.36	2.58	4.79	0.05
P3	59.42	1.04	-0.33	62.08	0.98	-0.84	2.67	-3.88	0.04
P4	57.92	0.90	-0.27	60.08	0.84	-0.25	2.17	-5.70	-0.20
P5	62.92	1.02	4.04**	65.00	0.98	4.69**	2.08	-2.85	-0.22
P6	63.42	0.86	8.28**	65.67	0.93	6.10**	2.25	6.73	-0.04
P7	63.58	1.27	0.75**	65.92	1.16	0.07	2.33	-1.94	0.09*
P8	63.33	1.08	2.25**	66.67	1.12	1.64**	3.33	7.52	0.53**
P9	65.67	1.25	1.20**	67.67	1.23	1.33**	2.00	0.00	-0.23
P10	65.83	1.20	-0.28	68.58	1.26	-0.76	2.75	8.55	-0.16
Mean of bi		0.99			0.99			1.00	
SE of bi		0.27			0.25			6.16	

Parents	Days to maturity			Plant height			Ear height		
	MEAN	bi	S ² di	MEAN	bi	S ² di	MEAN	bi	S ² di
P1	98.50	1.04	-0.62	136.84	-1.90**	16.34**	59.48	-0.82**	3.37**
P2	97.58	0.85	-0.50	134.38	1.60	227.76**	53.94	2.10	-0.63
P3	94.50	0.90	-1.39	159.90	-1.34**	625.81**	69.45	-2.33**	12.31**
P4	92.00	1.05	-1.40	155.51	1.58	151.56**	63.30	2.31*	0.40
P5	97.25	0.93	6.01**	142.27	0.79	156.54**	63.58	2.06	3.32**
P6	98.08	0.99	4.62**	135.74	0.87	-12.68	63.28	-0.35*	-1.87
P7	98.00	1.66*	1.15**	131.98	-0.53	32.94**	61.47	0.23	-3.42
P8	98.92	1.07	0.74*	169.13	1.63	81.21**	67.45	0.70	0.86
P9	100.25	1.24	0.77*	170.66	-0.02	-3.10	75.33	-1.15**	6.78**
P10	100.92	1.37	-1.37	162.75	1.79	157.68**	83.62	0.35	-1.10
Mean of bi		0.99			1.00			1.00	
SE of bi		0.27			0.82			0.67	

** Significant at 1 % level

Table contd.....

Parents	Leaf area index at 60 DAS			Leaf dry weight at 90 DAS			Crop growth rate at 80-75 DAS		
	MEAN	bi	S ² di	MEAN	bi	S ² di	MEAN	bi	S ² di
P1	1.45	0.21	0.00	192.91	0.12	-18.08	21.68	1.02	-0.14
P2	1.93	-1.08*	0.00**	196.03	-0.11	-19.63	21.55	0.18	-0.20
P3	1.11	-0.93*	0.00**	199.53	-0.44	45.15**	21.97	0.79	-0.25
P4	1.97	4.44**	0.01**	249.40	0.82	-16.79	21.02	0.64	-0.28
P5	1.45	1.08	0.00	191.50	7.34*	1758.50**	22.13	0.25	-0.26
P6	1.10	1.48	0.00	226.85	0.28	-17.87	21.80	0.81	-0.25
P7	1.26	0.12	0.00**	220.72	13.52**	980.86**	20.52	0.72	-0.28
P8	2.43	2.15	0.00*	260.08	-0.13	35.11**	21.23	0.51	-0.28
P9	1.15	0.55	0.00	241.72	7.84**	129.19**	21.05	0.00	-0.11
P10	3.02	4.08**	0.01**	253.25	0.02	-4.81	21.27	0.75	-0.28
Mean of bi		1.00			1.00			1.00	
SE of bi		0.84			2.56			1.85	

Parents	Relative growth rate at 60-75 DAS			Net assimilation rate at 60-75 DAS			Specific leaf weight at 90 DAS		
	MEAN	bi	S ² di	MEAN	bi	S ² di	MEAN	bi	S ² di
P1	0.04	0.98	0.00	8.53	0.32	-0.01	10.14	-0.15	-0.06
P2	0.05	1.33	0.00	8.56	-0.69	-0.04	8.39	-0.89	0.02
P3	0.06	2.31	0.00	7.99	2.87	0.26**	8.97	1.31	0.06**
P4	0.05	1.33	0.00	8.75	0.33	0.03**	10.04	0.27	-0.04
P5	0.06	3.77	0.00**	8.13	-2.37	0.41**	11.33	-2.93*	0.89**
P6	0.05	1.86	0.00	9.58	0.32	0.00	9.85	1.76	-0.01
P7	0.04	1.33	0.00	7.84	0.30	0.02*	9.74	0.41	0.58**
P8	0.05	5.35*	0.00**	8.27	3.16	0.08**	10.38	-2.16	0.28**
P9	0.05	-4.25**	0.00**	8.45	2.25	-0.01	10.10	0.59	0.82**
P10	0.04	1.33	0.00	8.75	3.23	-0.04	12.22	1.35	0.13**
Mean of bi		0.99			0.99			1	
SE of bi		1.73			1.76			1.79	

Table contd.....

Parents	Biomass			Chlorophyll content			Harvest index		
	MEAN	bi	S ² di	MEAN	bi	S ² di	MEAN	bi	S ² di
P1	1.77	-1.06	0.03**	1.35	1.13	0.00	50.11	2.12	2.25**
P2	1.80	0.37	-0.02	1.15	1.39	0.00	47.69	1.64	0.86**
P3	2.26	-1.16	0.03**	1.10	0.83	0.00	51.45	0.51	0.55**
P4	2.24	1.14	0.08**	1.39	0.86	0.00	38.56	-1.78**	-0.02
P5	2.45	0.79	0.17**	1.36	0.95	0.00	51.86	-0.94*	26.42**
P6	2.32	-0.13	0.15**	1.28	0.08	0.00	49.10	-0.04	17.77**
P7	2.40	0.38	-0.02	1.26	-0.06	0.00	48.79	1.35	3.58**
P8	2.57	-1.97	-0.03	1.23	0.99	0.00	50.17	0.25	-0.23
P9	2.19	1.23	0.05**	1.28	0.47	0.00	42.53	1.70	39.89**
P10	2.31	0.35	0.05**	1.40	1.32	0.00	49.53	0.62	3.72**
Mean of bi		1.00			1.00			1.00	
SE of bi		2.92			0.86			0.82	

Parents	Protein content			Seed protein yield			Oil per cent		
	MEAN	bi	S ² di	MEAN	bi	S ² di	MEAN	bi	S ² di
P1	10.71	-0.11	0.13**	374.58	0.21	-586.81	6.72	0.07	0.00
P2	11.06	1.12	0.02**	354.31	0.85	-604.46	6.71	0.93	-0.04
P3	10.58	-0.39	-0.02	485.82	-0.03	-430.75	6.51	1.05	-0.03
P4	11.19	1.05	-0.02	316.05	0.10	-643.39	7.12	0.32	-0.03
P5	10.20	-0.72	-0.01	571.20	-0.11	-365.51	6.27	0.91	-0.03
P6	10.53	-0.68	-0.01	476.18	0.36	-345.88	6.26	0.66	0.05**
P7	10.64	0.66	-0.02	461.03	1.04	-458.09	6.41	0.92	-0.03
P8	9.21	1.51	-0.02	470.16	0.25	-495.17	6.63	-0.14*	-0.03
P9	11.13	-0.31	0.00	313.63	0.62	-644.28	6.96	0.62	-0.03
P10	10.02	0.23	-0.02	449.95	-0.33*	-85.21	6.50	0.68	-0.03
Mean of bi		1.00			1.00			1.00	
SE of bi		1.03			0.59			0.49	

Table contd.....

Parents	Oil yield			Thiophan			Grain Yield		
	MEAN	bi	S ² di	MEAN	bi	S ² di	MEAN	bi	S ² di
P1	244.09	0.24	-114.40	0.75	0.87	0.00	1.75	0.41	-0.03
P2	207.80	0.71	176.32**	0.79	0.39	0.00	1.58	1.11	-0.01
P3	299.39	0.27	45.45	0.65	0.32	0.00	2.21	0.64	0.00
P4	213.17	0.53	348.60**	0.83	1.26	0.00	1.43	0.01*	-0.03
P5	349.21	0.31	61.69*	0.54	0.92	0.00	2.77	0.13	-0.02
P6	281.35	0.41	326.19**	0.56	1.11	0.00	2.31	0.51	-0.02
P7	276.58	0.93	-1.33	0.60	0.73	0.00	2.20	0.89	-0.02
P8	340.37	0.07	129.42**	0.52	0.34	0.00	2.53	0.03	-0.03
P9	195.94	0.51	-108.89	0.87	0.61	0.00	1.54	0.88	0.00
P10	284.57	-0.33*	458.56**	0.63	3.23**	0.00	2.34	-0.91**	-0.03
Mean of bi		1.00			1.03			0.99	
SE of bi		0.59			0.57			0.49	

4.6.2.1 Days to 50% tasseling

Among ten parents, P3 and P4 recorded lower means, regression coefficient equal to unity and non-significant deviation from regression estimates. These are found to be stable for this character.

4.6.2.2 Days to 50% silking

The parental line P3 and P4 possessed lower means, regression coefficient nearing to unity. Deviation from regression estimates was non significant.

4.6.2.3 Anthesis silking interval

All the parental lines recorded non-significant regression coefficient. The parental lines P2 and P6 recorded average mean values, regression coefficient values equal to unity with non-significant S^2_{di} values and found to be stable.

4.6.2.4 Days to maturity

The parents P3 and P4 recorded lower mean values, non-significant regression coefficient equal to unity and non-significant S^2_{di} values and found to be stable for this character.

4.6.2.5 Plant height (cm)

The parents P2, P4, P8 and P10 recorded unit regression coefficient but S^2_{di} values are significant. So these are not found to be stable.

4.6.2.6 Ear height (cm)

The parental lines P2 and P4 recorded b_i values more than unity and S^2d_i values non significant. In this P4 parent was having average mean value, more than unit regression coefficient and non-significant S^2d_i value and found to be stable for this character.

4.6.2.7 Leaf area index (LAI)

The parents P4 and P10 recorded b_i values more than unity and deviation from regression estimates are significant. P5 and P6 are found to be stable with average mean values, unit regression coefficient and S^2d_i values equal to zero.

4.6.2.8 Leaf dry weight (gm^{-2})

The parental lines P5, P7 and P9 recorded average mean values and more than unit b_i values and S^2d_i values were also significant. So these are not found to be stable for this character.

4.6.2.9 Crop growth rate ($\text{gm}^{-2}\text{d}^{-1}$)

The parental line P1 recorded average mean value with b_i value equal to unity and non-significant S^2d_i value. P3, P6, P7 and P10 recorded b_i values nearing to unity and non-significant S^2d_i values. P1 was found to be stable for this character.

4.6.2.10 Relative Growth Rate ($\text{gg}^{-1}\text{d}^{-1}$)

All the parents recorded b_i values equal to unity except P1 and P9. P2, P3, P4, P6, P7 and P10 recorded average mean value with unit regression coefficient and S^2d_i values equal to zero and these parents are found to be stable for this character.

4.6.2.11 Net Assimilation Rate ($\text{gm}^{-2}\text{d}^{-1}$)

The parents P6, P9 and P10 possessed average mean values and regression coefficient values are less than one and equal to one respectively with non-significant $S^2\text{di}$ values.

4.6.2.12 Specific leaf weight (mgcm^{-2})

The parental lines P3, P6 and P10 recorded bi values equal to unity. P6 was found to be stable with average mean value, bi value equal to unity and non-significant $S^2\text{di}$ values.

4.6.2.13 Total Biomass (kg/plot)

Two parents P4 and P9 recorded bi values equal to unity and significant $S^2\text{di}$ values. So these are not stable for this character.

4.6.2.14 Total Chlorophyll content (mg/g)

In respect of chlorophyll content P1, P2 and P10 recorded average mean values, bi values equal to unity and $S^2\text{di}$ equal to zero and found to be stable for this character.

4.6.2.15 Harvest index (%)

The parental lines P1, P2, P7 and P9 recorded average mean values and possessed bi values equal to unity but $S^2\text{di}$ values significant and not equal to zero. So these are not found to be stable.

4.6.2.16 Protein content (%)

The parental line P4 possessed higher mean, bi value equal to unity and S^2_{di} value approaching zero and non significant. However P8 also possessed unit regression coefficient and S^2_{di} equaling to zero but lower mean value. P4 was found to be stable for this character.

4.6.2.17 Seed protein yield (kg/ ha)

The parental line P7 recorded average mean value, unit regression coefficient with non-significant S^2_{di} and found to be stable. However P3 and P5 recorded higher mean values but bi and S^2_{di} values were negative and non significant.

4.6.2.18 Oil content (%)

The parental line P3 recorded average mean value with unit regression coefficient and non significant S^2_{di} and found to be stable. However P2 also recorded average mean value with regression coefficient value nearing to unity and non-significant deviation from regression coefficient estimates.

4.6.2.19 Oil yield (kg / ha)

The parental line P7 recorded average mean value with unit regression coefficient and non significant S^2_{di} and found to be stable. However P2, P5 and P7 also recorded average mean values with regression coefficient values nearing to unity and non-significant S^2_{di} values.

4.6.2.20 Tryptophan content (g/16gN)

One parent P10 recorded average mean value with significant and more than unit regression coefficient and S^2_{di} value equal to zero. P4 parent observed higher

mean value with b_i value equal to unity and deviation from regression was equal to zero. The parental lines P1, P5 and P6 recorded average and lesser mean values with b_i values approaching one and equal to one with S^2d_i value equal to zero. P4 is found to be stable and P10 is specifically adapted to favourable environments.

4.6.2.21 Grain yield (kg/ plot)

The parental line P5 recorded higher mean value with less than unit regression coefficient and non significant S^2d_i . The parental lines P2, P7 and P9 recorded less average mean values (1.58, 2.22 and 1.04) but regression coefficient values equal to unity and nearing to unity (1.11, 0.89 and 0.88 respectively) and non-significant S^2d_i values. P5 was found to be stable.

4.6.3 Estimates of stability parameters of crosses

The data on mean of four locations and stability parameters of 45 crosses are given in Table 17.

4.6.3.1 Days to 50% tasseling

In respect of days to 50 % tasseling 19 crosses have equal to unity and 1 cross recorded more than unity and 15 crosses are nearing to unit regression coefficient values. The cross P2 XP8 recorded lower mean value regression coefficient value equal to unity and non- significant S^2d_i value and found to be stable. 8 crosses recorded non-significant S^2d_i value and found to be stable. The mean over locations ranged between 66.5 (P2 X P10) to 54.58 (P2 X P3).

4.6.3.2 Days to 50% silking

Out of 45 hybrids, 18 crosses recorded equal to unit regression coefficient and 2 crosses have significant regression coefficient and 9 crosses have non-significant

Table contd.....									
Crosses	Relative growth rate at 60-75 DAS			Net assimilation rate at 60-75 DAS			Specific leaf weight at 90		
	Mean	bi	S2di	Mean	bi	S2di	Mean	bi	S2di
P1 X P2	0.04	-1.54	0.00**	8.13	-1.29	0.06**	11.87	1.74	0.69**
P1 X P3	0.04	1.33	0.00	9.76	-2.35	0.09**	11.42	-2.63*	0.31**
P1 X P4	0.04	1.33	0.00	9.51	4.16	0.02**	11.99	2.22	0.90**
P1 X P5	0.04	1.41	0.00	9.38	-0.66	0.01	11.95	0.63	-0.03
P1 X P6	0.04	2.21	0.00	10.07	2.46	0.04**	11.68	0.88	1.06**
P1 X P7	0.04	1.33	0.00	10.52	2.08	1.00**	12.10	5.25*	0.33**
P1 X P8	0.04	0.53	0.00	10.34	2.09	0.04**	12.05	-2.04	0.34**
P1 X P9	0.06	0.12	0.00	10.45	-0.32	0.17**	13.23	0.12	0.17**
P1 X P10	0.06	1.86	0.00	11.25	-6.11**	0.08**	12.08	2.70	0.42**
P2 X P3	0.04	1.41	0.00	9.38	0.19	0.00	12.95	2.61	0.70**
P2 X P4	0.05	1.31	0.00**	10.37	-0.82	0.03**	12.76	3.26	0.11**
P2 X P5	0.05	5.56**	0.00**	9.44	0.13	1.23**	13.12	-0.68	0.23**
P2 X P6	0.04	0.80	0.00	9.96	1.76	-0.01	10.70	-1.39	1.01**
P2 X P7	0.05	-5.58**	0.00**	10.15	1.77	0.27**	12.71	2.97	0.67**
P2 X P8	0.05	3.72	0.00*	9.10	-1.91	0.19**	12.87	2.68	0.20**
P2 X P9	0.05	0.98	0.00	9.23	1.42	0.66**	12.11	1.11	0.39**
P2 X P10	0.05	-0.73	0.00**	10.40	1.14	0.09**	11.92	0.77	0.35**
P3 X P4	0.05	0.42	0.00	10.03	7.28**	1.09**	10.83	1.16	0.05**
P3 X P5	0.05	1.94	0.00	10.95	-3.27*	0.66**	12.46	1.17	2.13**
P3 X P6	0.05	1.96	0.00**	10.85	2.89	0.15**	11.34	0.99	0.90**
P3 X P7	0.04	1.33	0.00	9.73	4.93*	0.00	9.75	1.79	0.14**
P3 X P8	0.04	1.33	0.00	10.94	-0.64	0.72**	11.85	1.68	0.08**
P3 X P9	0.04	0.53	0.00	9.35	-3.45*	-0.01	11.90	1.49	0.41**
P3 X P10	0.05	-5.70**	0.00**	10.58	0.01	0.15**	12.44	1.76	0.29**
P4 X P5	0.05	1.33	0.00	10.24	3.79	0.45**	13.01	0.47	0.00
P4 X P6	0.06	2.80	0.00**	11.13	1.89	0.23**	12.53	3.66	0.06**
P4 X P7	0.04	0.53	0.00	9.09	2.27	0.35**	12.61	0.52	2.15**
P4 X P8	0.05	1.33	0.00	9.58	2.02	0.05**	12.12	-0.11	0.05**
P4 X P9	0.04	0.98	0.00	8.63	0.13	0.02*	12.48	4.10	0.15**
P4 X P10	0.04	1.51	0.00	9.94	0.13	0.41**	10.01	0.58	-0.04
P5 X P6	0.05	-0.44	0.00**	11.60	-1.15	0.29**	12.56	3.03	0.64**
P5 X P7	0.05	1.56	0.00	9.04	4.09	0.71**	10.11	1.52	0.04**
P5 X P8	0.05	0.75	0.00	10.52	1.05	0.01	12.74	1.86	0.51**
P5 X P9	0.04	0.98	0.00	9.05	3.16	0.12**	10.48	0.65	1.16**
P5 X P10	0.05	0.88	0.00	8.79	1.35	0.79**	11.47	0.05	0.07**
P6 X P7	0.05	1.51	0.00	8.44	2.31	0.04**	11.49	-1.18	0.01
P6 X P8	0.04	1.33	0.00	9.69	0.38	0.01	11.99	2.84	-0.05
P6 X P9	0.06	1.86	0.00	8.97	-0.03	-0.04	10.97	2.17	0.10**
P6 X P10	0.05	0.53	0.00	8.95	1.89	0.11**	10.28	2.16	0.30**
P7 X P8	0.06	1.33	0.00	8.89	2.69	0.41**	11.02	1.05	0.54**
P7 X P9	0.06	0.53	0.00	10.55	1.30	0.14**	12.18	1.36	0.05**
P7 X P10	0.05	1.86	0.00	10.04	-1.87	0.13**	12.40	0.84	1.22**
P8 X P9	0.04	1.38	0.00**	9.14	-0.98	0.05**	9.27	-3.42*	0.00
P8 X P10	0.04	-0.88	0.00	8.86	2.91	0.05**	10.35	-0.94	0.44**
P9 X P10	0.05	-0.03	0.00	9.44	6.48**	0.10**	12.09	4.09	0.28**
Mean of bi		1.00			1.00			1.00	
SE of bi		2.92			0.86			0.82	

Table contd.....									
Crosses	Total Biomass			Total Chlorophyll content			Harvest index		
	Mean	bi	S2di	Mean	bi	S2di	Mean	bi	S2di
P1 X P2	2.94	4.79	1.42**	1.26	2.07	0.00	47.88	-0.09	0.13
P1 X P3	3.23	5.72	-0.01	1.39	0.69	0.00	42.17	1.10	12.50**
P1 X P4	3.69	3.53	0.00	1.25	0.47	0.00	46.31	-0.67*	1.30**
P1 X P5	2.96	5.51	0.59**	1.38	0.68	0.00	45.46	3.32**	6.05**
P1 X P6	3.66	3.97	0.02**	1.45	0.30	0.00	47.53	1.34	1.10**
P1 X P7	3.64	3.16	0.14**	1.40	-0.22	0.01**	48.23	1.08	3.18**
P1 X P8	3.83	-1.20	0.02**	1.29	0.78	0.00	46.38	1.28	-0.49
P1 X P9	3.71	0.04	0.13**	1.50	0.26	0.00	49.95	1.63	0.71**
P1 X P10	4.25	-0.03	0.04**	1.61	1.22	0.00	49.21	0.24	0.47**
P2 X P3	3.11	5.54	0.28**	1.25	1.78	0.00	43.77	3.19**	2.29**
P2 X P4	3.71	0.07	0.47**	1.53	1.54	0.00	50.22	0.76	-0.18
P2 X P5	3.80	0.53	0.02**	1.49	1.50	0.00	49.84	1.33	-0.57
P2 X P6	3.88	0.80	-0.01	1.43	1.12	0.00	45.97	-0.42	-0.66
P2 X P7	4.13	-0.41	0.12**	1.42	0.67	0.00	48.25	0.20	3.54**
P2 X P8	4.13	0.99	0.06**	1.38	0.59	0.00	50.43	1.08	-0.36
P2 X P9	3.89	1.31	0.00	1.30	1.06	0.00	45.76	-0.97*	-0.55
P2 X P10	4.13	-1.54	0.14**	1.39	0.69	0.00	49.72	0.80	-0.58
P3 X P4	3.76	-1.86	0.16**	1.41	0.93	0.00	46.21	2.59	3.37**
P3 X P5	3.35	6.57	0.58**	1.53	1.37	0.01**	39.19	7.83**	-0.29
P3 X P6	3.78	0.11	0.00	1.33	0.61	0.00**	45.81	1.88	-0.38
P3 X P7	3.90	-2.04	0.03**	1.41	-0.31	0.04**	47.30	0.93	-0.13
P3 X P8	3.68	2.65	0.00	1.39	-2.35**	0.00**	47.93	0.82	1.73**
P3 X P9	3.96	-1.42	0.11**	1.47	1.19	0.00	47.58	0.94	1.67**
P3 X P10	3.38	3.51	0.27**	1.40	2.40	0.02**	42.30	3.44**	1.89**
P4 X P5	4.25	-1.19	0.03**	1.51	-0.14	0.00**	49.31	0.08	2.24**
P4 X P6	4.12	-1.73	0.23**	1.59	0.91	0.00**	51.18	1.69	-0.50
P4 X P7	3.78	1.49	0.15**	1.29	1.40	0.00	46.57	-0.06	20.79**
P4 X P8	3.36	0.20	0.00	1.26	1.05	0.00	41.88	0.42	4.91**
P4 X P9	3.80	2.10	0.04**	1.38	0.94	0.00	44.14	0.63	16.93**
P4 X P10	3.50	1.74	-0.02	1.39	1.15	0.00	45.34	2.50	0.41**
P5 X P6	3.77	-0.39	0.13**	1.55	1.15	0.00	49.05	0.71	1.49**
P5 X P7	3.01	3.59	0.15**	1.41	1.01	0.00	41.45	0.33	1.98**
P5 X P8	4.20	-0.58	0.02**	1.49	1.04	0.00	48.08	0.44	-0.68
P5 X P9	3.80	-0.85	0.12**	1.33	4.81**	0.01**	44.66	-1.56**	-0.37
P5 X P10	3.96	1.55	-0.03	1.31	1.27	0.00**	46.08	0.00	1.79**
P6 X P7	3.61	1.04	0.03**	1.25	1.28	0.00	43.81	1.49	0.14
P6 X P8	3.72	-0.08	0.11**	1.34	0.80	0.00	46.69	0.88	1.41**
P6 X P9	3.07	0.19	0.06**	1.33	1.30	0.00	40.14	-1.27**	-0.28
P6 X P10	3.07	1.18	0.59**	1.40	2.08	0.01**	43.14	1.89	17.54**
P7 X P8	3.08	-1.47	0.21**	1.36	1.15	0.00	41.36	0.83	17.49**
P7 X P9	3.87	-0.83	0.74**	1.49	1.63	0.00**	49.07	2.10	11.41**
P7 X P10	2.91	-1.27	0.09**	1.37	1.73	0.01**	41.47	-0.75*	1.41**
P8 X P9	3.71	5.06	0.18**	1.19	1.34	0.00	43.36	0.65	8.85**
P8 X P10	3.87	5.34	0.01	1.23	1.07	0.00	42.25	3.74**	1.11**
P9 X P10	3.81	-0.24	0.03**	1.37	1.12	0.00	45.59	1.26	0.59**
ean of bi		0.99			0.99			1.00	
SE of bi		1.73			1.76			1.79	

Table contd.....									
Crosses	Oil yield/ha			Tryptophan content			Grain yield/plot		
	Mean	bi	S2di	Mean	bi	S2di	Mean	bi	S2di
P1 X P2	399.17	3.75**	622.78*	0.77	1.10	0.00	2.73	4.70**	0.04**
P1 X P3	352.07	1.66	488.92**	0.79	-1.66**	0.00	2.48	1.60	-0.02
P1 X P4	450.31	2.23*	414.88*	0.81	1.28	0.00	3.24	0.33	-0.02
P1 X P5	367.61	4.11**	839.33*	0.59	0.92	0.00	2.58	5.77**	0.06**
P1 X P6	443.22	2.23*	856.11**	0.60	0.60	0.00	3.39	2.31**	0.03**
P1 X P7	443.59	1.65	186.33*	0.65	0.48	0.00	3.39	3.04**	-0.01
P1 X P8	523.24	1.03	-32.13	0.57	0.63	0.00	3.35	0.48	-0.02
P1 X P9	448.87	0.66	-90.34	0.85	0.65	0.00	3.66	0.43	-0.02
P1 X P10	612.84	0.53	550.71**	0.77	0.86	0.00	4.12	-0.13*	-0.01
P2 X P3	259.66	2.49*	517.18*	0.80	2.02	0.00	2.53	4.94**	0.02*
P2 X P4	492.36	0.98	35.07	0.79	1.19	0.00	3.85	2.13*	0.07**
P2 X P5	516.13	1.10	-49.86	0.66	0.96	0.00	3.78	0.37	-0.02
P2 X P6	435.69	0.68	-13.97	0.69	1.12	0.00	3.40	-0.53**	-0.02
P2 X P7	518.67	-0.49*	363.31*	0.67	0.86	0.00	3.90	-1.18**	0.12**
P2 X P8	567.24	0.97	139.89**	0.60	2.10	0.00	4.24	0.48	-0.03
P2 X P9	461.12	0.39	540.09**	0.83	1.06	0.00	3.38	0.22	-0.01
P2 X P10	599.86	0.09	757.46**	0.68	1.28	0.00	4.09	-0.76**	-0.02
P3 X P4	462.00	2.12	094.65*	0.81	1.38	0.00	3.30	2.60**	-0.03
P3 X P5	570.35	1.52	159.54**	0.61	0.76	0.00	3.86	1.59	-0.02
P3 X P6	400.63	1.44	-83.43	0.63	1.15	0.00	3.30	2.15*	-0.02
P3 X P7	466.33	0.52	249.78**	0.66	1.15	0.00	3.45	-0.00*	-0.02
P3 X P8	473.86	1.74	337.03**	0.59	2.27*	0.00	3.41	1.72	-0.02
P3 X P9	477.24	0.16	407.90*	0.83	1.00	0.00	3.57	0.04	0.06**
P3 X P10	355.10	3.16**	605.36*	0.69	0.82	0.00	2.52	4.46**	0.01
P4 X P5	580.32	0.32	122.77**	0.72	0.74	0.00	4.12	-0.20*	-0.03
P4 X P6	619.77	0.37	-98.02	0.73	1.00	0.00	4.33	0.08	-0.03
P4 X P7	479.71	-0.48*	1000.35*	0.69	2.05	0.00	3.19	-0.87**	-0.02
P4 X P8	338.82	1.66	137.45**	0.62	1.16	0.00	2.51	1.75	-0.03
P4 X P9	406.48	0.24	-86.74	0.83	0.68	0.00	2.78	0.12	-0.03
P4 X P10	413.18	2.28*	695.24*	0.70	0.77	0.00	2.96	3.02**	-0.01
P5 X P6	467.12	0.37	37.96	0.56	1.12	0.00	3.65	-0.16*	-0.03
P5 X P7	280.48	1.25	88.10**	0.56	1.89	0.00	2.16	1.81	-0.03
P5 X P8	542.37	0.94	505.43**	0.52	0.73	0.00	3.92	0.46	0.03**
P5 X P9	400.39	-1.25**	111.95*	0.69	1.76	0.00	3.08	-2.83**	0.02**
P5 X P10	444.67	0.40	616.84**	0.58	1.31	0.00	3.43	0.36	0.00
P6 X P7	366.61	1.35	28.46	0.59	1.51	0.00	2.86	1.59	-0.02
P6 X P8	412.54	0.78	43.19	0.54	0.76	0.00	3.21	0.82	0.01
P6 X P9	248.33	-0.49*	800.10**	0.65	1.25	0.00	2.08	-1.50**	-0.01
P6 X P10	302.32	2.78**	733.12*	0.55	0.74	0.00	2.40	4.41**	0.0

S^2di values. The cross P7 XP9 and P8 X P9 recorded unit regression coefficient and non-significant S^2di value and found to be stable

4.6.3.3 Anthesis silking interval

The mean values ranged from 1.75 (P3 XP7) to 2.92 (P6 XP7). Out of 45 hybrids 20 crosses recorded non- significant regression coefficient equal to unity and 13 crosses recorded non-significant S^2di values. The cross P2 XP6 recorded unit regression coefficient and non-significant S^2di value and found to be stable.

4.6.3.4 Days to maturity

The mean over locations ranged from 89.25 (P2 XP3) to 101 (P2 XP10). The estimates of b_i and S^2di indicated 12 hybrids as stable. The crosses P1 X P6, P1 X P2, P2 X P8, P6 X P7, P7 X P9 and P4 X P7 had average days to maturity with desired stability parameters.

4.6.3.5 Plant height (cm)

The average plant height ranged from 135.95 (P2 X P6) to 188.8 (P3 X P6). 20 crosses recorded unit regression coefficient out of these four crosses recorded significant regression coefficient more than unity. The crosses P1 X P2 and P3 X P5 recorded higher plant height and were found to be stable with unit regression coefficient and non-significant S^2di value.

4.6.3.6 Ear height (cm)

The mean over four locations ranged from 54.06 (P6 XP9) to 88.72 (P3 XP9). 16 crosses recorded significant regression coefficient more than unity. The crosses P3 XP8 and P2 XP7 recorded more than average ear height and found to be stable with more than unit regression coefficient and non-significant S^2di value.

4.6.3.7 Leaf Area Index (LAI)

Average LAI at 60 DAS ranged from 1.11(P8 XP10) to 3.99 (P5 X P6). 4 hybrids exhibited more than unit regression coefficient. The crosses P1 XP3, P3 XP5, P7 XP8 recorded average mean value with unit regression coefficient and S^2di value equal to zero and found to be stable.

4.6.3.8 Leaf dry weight (gm^{-2})

LDW ranged from 200.25 (P3 XP6) to 313.08 (P1 XP4). Three crosses exhibited unit regression coefficient and four crosses exhibited significant regression coefficient more than unity.

4.6.3.9 Crop growth rate ($gm^{-2}d^{-1}$)

CGR values ranged between 21.90 (P7 XP10) to 38.02 (P4 XP6). Out of 45 crosses, 22 crosses recorded unit regression coefficient and 16 crosses with S^2di value non-significant and out of this P1 X P10, P2 X P3 and P4 X P6 were found to be stable for this character.

4.6.3.10 Relative growth rate ($g\ g^{-1}d^{-1}$)

Out of 45 hybrids, 25 crosses exhibited unit regression coefficient with one cross more than unity. 19 crosses were found to be stable with unit regression and non significant $S^2 di$ value.

4.6.3.11 Net assimilation rate ($gm^{-2}d^{-1}$)

The values ranged between 11.6 (P5 X P6) to 8.13 (P1 X P2). Out of 45 crosses 25 hybrids were found to have unit regression coefficient with two crosses more than unity. The crosses (P3 X P7, P5 X P8 and P6 X P8) were found to be stable.

4.6.3.12 Specific leaf weight (mgcm^{-2})

This character ranged from 9.27 (P8 X P9) to 13.23 (P1 X P9). Out of 45 crosses, 26 crosses exhibited unit regression coefficient with one cross (P1 X P7) significant. P6 X P8 was found to be stable.

4.6.3.13 Total bio mass (kg/ plot)

The mean over the location varied from 2.91 (P7 X P10) to 4.25 (P1 X P10 and P4 X P5). This character did not show significant bi estimates, but 20 crosses recorded unit regression coefficient. The crosses (P1 X P4, P2 X P9 and P3 X P8) were found to be stable.

4.6.3.14 Total Chlorophyll content (mg/g)

This character ranged between 1.25 (P1 X P4 and P6 X P7) to 1.61 (P1 X P10). Out of 45 crosses, 27 crosses exhibited unit regression coefficient with one cross more than unity. Out of these 20 crosses were desirable for this character.

4.6.3.15 Harvest index (%)

In this the range varies between 39.19 (P3 X P5) to 51.18 (P4 X P6). Twenty crosses showed unit regression coefficient with five crosses more than unity. Six crosses showed non significant S^2 di values and regression coefficient value equal to unity. The cross P6 X P7 was found to be stable.

4.6.3.16 Seed protein content (%)

This character ranged between 9.21 (P1 X P8) to 12.28 (P4 X P8). Out of 45 crosses, 30 crosses shown unit regression coefficient and 1 cross was found to be significant. The crosses P3 X P4 and P4 X P5 shown unit regression coefficient and non-significant S^2_{di} values and found to be stable for this character.

4.6.3.17 Seed protein yield (kg/ha)

The mean over locations ranged from 431.27 (P7 XP10) to 898.56 (P4 X P6). In this 18 crosses recorded unit regression coefficient out of which 8 crosses were significant. The crosses P8 X P10, P3 X P4 were found to be stable with average mean value, more than unit regression coefficient and non-significant deviation from regression estimates.

4.6.3.18 Oil content (%)

The oil per cent in hybrids ranged from 5.27 (P2 X P3) to 7.88 (P1 X P8). The b_i and S^2_{di} estimates of stability parameter were found to be non-significant for all most all the crosses. The cross combinations P1 X P2, P3 X P4, P4 X P5, P5 X P8 were found to be stable with high mean value, unit regression coefficient and non-significant S^2_{di} values.

4.6.3.19 Oil yield (kg/ha)

There was a wide difference among the hybrids for oil yield varying from 248.33 (P6 X P9) to 619.77 (P4 XP6). 12 crosses were found to have unit regression coefficient with nine crosses more than unity. P1 X P8, P2 X P6, P3 X P6 and P6 X P7 possessed b_i value equal to unity and deviation from regression coefficient was non-significant and these were found to be stable for this character.

4.6.3.20 Tryptophan content (g/16gN)

In respect of tryptophan content, it ranged from 0.52 (P5 X P8) to 0.85 (P1 X P9). The linear component G X E interaction for this character was non-significant. Twenty-five cross combinations exhibited stability with unit regression coefficient and one cross more than unit regression coefficient and S2di estimates are non-significant. The crosses P1 X P2, P1 X P4, P2 X P3, P3 X P9 and P4 X P6 were found to be stable with higher tryptophan content.

4.6.3.21 Grain yield (kg/plot)

It ranged from 2.08 (P6 X P9) to 4.24 (P4 X P6). Out of 45 cross combinations seven crosses exhibited unit regression coefficient with 12 crosses more than unit regression coefficient and non-significant S2di values. The cross P3 X P5 was found to be stable with high mean value.

DISCUSSION

CHAPTER V

DISCUSSION

Maize occupies a prominent position among cultivated crops from the plant breeder's point of view due to the fact that many of the basic and important concepts that have revolutionised the breeding methods are the outcome of research carried out in maize. Though extensive research has been carried out in the crop for many quantitative characters but potential aspects like breeding for high protein content, oil content coupled with high grain yields, remain relatively unemphasised. Maize protein is considered as of poor quality because of its low lysine and tryptophan. Lysine and tryptophan content in the normal yellow maize is 2.73 and 0.48 g/16gN respectively as against to the suggested level of 5.5 and 1.0g/16gN(FAO or WHO). With the discovery of mutant gene opaque-2 (Mertz *et. al*, 1964) followed by floury-2 (Nelson *et. al*, 1965) which alter and enhance amino acid profile and also improve over all nutritional quality of the maize endosperm protein opened new vistas, for the development of high quality protein hybrids coupled with high grain yield and oil in maize. Thus there is every need in present day to evolve new high yielding QPM hybrids, which could exceed the yields of existing best hybrids in terms of quantity and quality. The studies on gene effects of various economic traits like grain yield, morphological and physiological growth parameters would be helpful in formulating suitable breeding methodology for the development of high yielding quality protein maize hybrids.

With this objective 10 QPM parents were selected based on top cross data and combining ability studies. These were mated in diallel fashion. The resulting 45 hybrids with parents and two checks were evaluated at two locations for two seasons viz., Rajendranagar *Kharif* and *Rabi*, Palem *Kharif* and *Rabi*. The data were collected on morphological, physiological and biochemical parameters and grain yield. The results obtained are discussed briefly under different heads.

5.1 NATURE OF GENE ACTION AND COMBINING ABILITY FOR MORPHOLOGICAL, PHYSIOLOGICAL AND BIOCHEMICAL PARAMETERS AND GRAIN YIELD.

Success in plant breeding is largely dependent upon the choice of suitable parents. Though the perse performance of parents is primary indication regarding their usefulness, but their long-term potentialities are not known at the beginning of a breeding programme. The concept of combining ability has gained importance in plant breeding as it provides the means of understanding the nature of gene action for developing suitable breeding procedures. It is especially useful for testing procedures in which it is designed to study the parental lines for future breeding programmes and the breeding procedures to be adopted. General combining ability (*gca*) refers to the average performance of a line in a series of hybrid combinations and is attributable to additive (fixable) gene action, while the specific combining ability (*sca*) refers to the deviation in the performance of a cross that would be expected on the basis of the average performance of the line involved and is attributable primarily to dominant, over dominant and epistatic effects of genes (non-

additive). The comparison of *gca* and *sca* variance components provides an estimate of the predominance of additive gene effects or the non-additive effects. Additive component of genetic variance is fixable through normal selection procedures, whereas as non-additive component is not fixable and its presence for controlling traits necessitates exploitation of hybrid vigour through heterosis breeding.

The analysis of genetic variance was also an equally important objective to gain knowledge regarding the nature and magnitude of gene action, which has an important bearing on the choice of most appropriate and efficient breeding procedures for enhanced performance of hybrids derived there from.

The analysis of variance revealed significant differences among the genotypes for all the characters studied indicating the existence of sufficient variation in the material studied. Cross (1977) and Han *et.al.*(1991) observed additive and dominance gene effects depending on either parents or inbred lines. The combining ability analysis revealed significant mean squares due to general and specific combining ability indicating that both additive and non-additive gene actions were important in the inheritance of these characters. The relative importance of additive and non-additive gene action was reported by Mukherjee *et.al* (1971), Nawar and Hosary (1984) and Muthiah *et.al.*(1989).They also observed predominant role of *sca* for plant height and ear height.

The estimates of components of variance, σ^2_{gca} and σ^2_{sca} indicated the preponderance of non-additive gene action for the characters studied here. The findings

are in consonance with earlier reports for days to 50 per cent tasseling (Venkatesh, 1994); days to 50 percent silking (Nawar and Hosary, 1984; Vasal *et. al.*, 1993; Kalia *et.al.*, 1994; Spaner *et.al.*, 1996) and days to maturity, and for plant height (Vasal, 1993; Singh and Singh, 1998); ear height (Nawar and Hosary, 1984; Beck and Vasal, 1990; Singh and Singh, 1998); Anthesis silking interval (Johnson and Tanner, 1972; Daynard and Kannenberg, 1976; Djisbar and Gardner, 1989 and Bolanus, 1995); Chlorophyll content (Fleming and Palmer, 1975; Mureson *et.al.*, 1975; Orchinnikova, 1975; Milaev, 1976; Krebs *et.al.*, 1996; Sherevarya, 1976; Fattakhova *et.al.*, 1997 and Khotyleva *et.al.*, 1988); Total biomass (Pastzor *et.al.*, 1984; Abdul Shakoor, 1988 and Djisbar and Gardner, 1989); Grain yield (Debnath and Sarkar, 1981; Nawar and Hosary, 1984; Jha and Khera, 1992; Satyanarayana *et.al.*, 1994 and Joshi *et.al.*, 1998).

In contrast to the present findings preponderance of additive both additive and non-additive gene action was also reported by several workers for various traits.

The parental lines P4 and P3 not only possessed low mean values but were also good general combiners for days to 50 per cent tasseling, silking and maturity and thus, these parents contributed maximum favourable genes for earliness at all the four locations. Hence they can be used as potential donors for inducing earliness. The crosses P1 X P9 at two locations, P4 X P9 and P2 X P5 at one location were the best specific combiners with significant negative *sca* effects for earliness. These crosses were not having good general combiners in parentage except P4 and were the resultant of non-

additive gene action, which can be improved through suitable population improvement in addition to utilising them in heterosis breeding.

In respect of plant height and ear height P3, P9 and P10 parents were found to be taller at all the locations but only P3 and P10 possessed significant *GCA* effects and recorded as good general combiners. An examination of *SCA* effects of the crosses at all the locations indicated that P4 X P6, P3 X P6 in addition P2 X P3 for ear height were best specific crosses. These crosses were not having good general combiners in parentage and were resultant of non-additive gene action. The relative importance of non-additive gene action for plant height was also reported by Vasal (1993) and Singh and Singh, 1998.

For LAI P4, P8 and P10 recorded high perse mean values but only P4 was found to be good combiners for this character in addition to P5 at all the locations. These parents can be utilised in breeding programmes aimed at improving the LAI. The best specific crosses are P7 X P9, P7 X P10, P4 X P6, P2 X P7, P5 X P6 and P1 X P10. Major crosses are not having good general combiners in parentage except P4 X P6, P5 X P6. These two crosses have one good general combiner in parentage indicating additive x dominance type of interaction and they may be advanced for deriving of desirable transgressive segregants and homozygous lines in subsequent generations as suggested by Langham (1961). Hence they can be used in heterosis breeding; other crosses were not having good general combiners in parentage and were the resultant of non-additive gene action, which can be improved through suitable population improvement.

For LDW P4, P7 and P10 possessed high mean values but only P4 is good general combiner in addition to P8 and P9. The best specific crosses were P2 X P9, P1 X P3, P1 X P5 and P5 X P10. These crosses were not having good general combiners in parentage and were the resultant of non-additive gene action, which can be improved through suitable population improvement in addition to utilising them in heterosis breeding. P2 X P9 has one good general combiner in parentage and can be used in heterosis breeding.

In respect of CGR and RGR P5 and P3 have high mean values but only P5 is the good combiner for this character. This parent can be used in breeding programme aimed at improving the CGR. The best specific crosses were P4 X P6, P2 X P10, P2 X P8, P5 X P6, P7 X P9. Except P5 X P6 all the crosses involved both low combiners indicating the presence of dominance type of gene action. Such crosses could be utilised in the production of homozygous lines (Darrah and Hallauer, 1972).

For NAR P6, P4 and P10 have higher mean values but only P6 was found to be good combiners in addition to P3. An examination of *SCA* effects of the crosses at all the locations indicated that P5 X P6, P1 X P10 and P3 X P8 were the best specific crosses. They were having atleast one good general combiner in their crosses. Hence, they can be used in heterosis breeding.

SLW varied from 8.39 to 12.22 at different locations and higher SLW was observed in P10, P5, P4, P7 P9 and P1. Among these parents P4 and P5 were good general combiners in addition to P1 at Palem in *Rabi* season. The crosses P2 X P3, P1 X

P9, P4 X P7, P7 X P10 were the results of poor combiner and thus were resultant of non-additive gene action, then for improving any scheme utilising non-additive gene action is suggested.

For total biomass P8, P5 and P7 recorded higher mean values but only P8 was the good general combiner in addition to P4 and P9. Among these parents P4 and P8 contributed maximum favourable genes and can be used as donors for increasing biomass. The cross combinations P1 X P10, P8 X P10, P1 X P7, P4 X P5 were the best specific crosses. The cross P4 X P8 was the resultant of good combiners but did not exhibit significant *sca* effect and can be considered for recombination breeding.

As far as total chlorophyll is considered P10, P4, P5 and P1 were having higher mean values and out of these P10, P1 were good general combiners in addition to P2 at all the locations. P10 and P2 contributed maximum favourable genes and can be used for further breeding programme for increasing total chlorophyll content. The cross combinations P1 X P2, P3 X P7, P5 X P8, P5 X P9, P5 X P10 were the best specific crosses. The cross P2 X P10 where both the parents were good general combiners but did not exhibit significant *sca* effect and such crosses can be considered for recombination breeding for getting better transgressive segregates with maximum chlorophyll content having favourable genes from both parents.

In respect of Harvest index P5, P1 and P8 recorded higher mean values but only P1 and P8 are good general combiners in addition to P2 at all the locations. The best

specific crosses are P4 X P6, P7 X P9, P4 X P5, P3 X P9, P3 X P8, P2 X P8, P2 X P4 and P1 X P9 over the locations. In case of cross combination P2 X P8 both parents were good general combiners and gene action is due to additive x additive, which is fixable in nature. Hence, selection can be effectively practiced in the cross P2 X P8 to isolate true breeding genotypes from the subsequent generations.

The protein content of maize has nutritional value and it was demonstrated that protein per cent can be increased by breeding (Wood worth *et.al.*,1952). In the present investigation it is to note that P2, P4 and P9 contributed maximum favourable genes and are good combiners. The best specific crosses reported in the present investigation were viz., P4 X P8, P5 X P10 and P7 X P9. Of these P4 X P8 and P7 X P9 were having atleast one good general combiner in their crosses. Hence, they can be used in heterosis breeding (Table 18) (Fig.7 and11). In respect of seed protein yield / ha P5, P3, P6 possessed high mean values but only P5 was the good general combiner in addition to P2 and P4. These can be inter crossed with P5 to obtain higher seed protein yield/ha. While considering all the locations P7 X P9, P3 X P9, P1 X P10, P4 X P6, P2 X P8, P2 X P7 and P2 X P10 were good combinations. Out of these first 3 crosses did not have good combiners and remaining 4 were having one good combiner in their crosses. Therefore, heterosis breeding and recurrent selection is suggested to improve these characters.

With global acceptance the maize oil has been considered as quality oil with least detrimental effect on human health. Attention has been diverted to high oil rate of maize (Pal and Prodhan, 1994). Analysis for oil content was revealed to identify potential

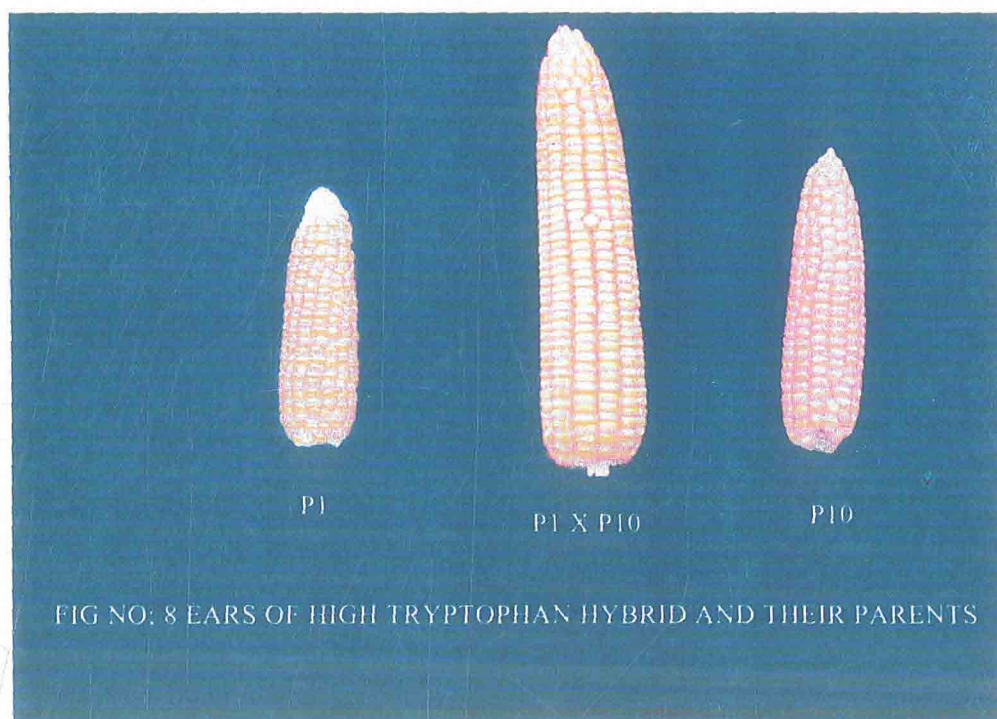
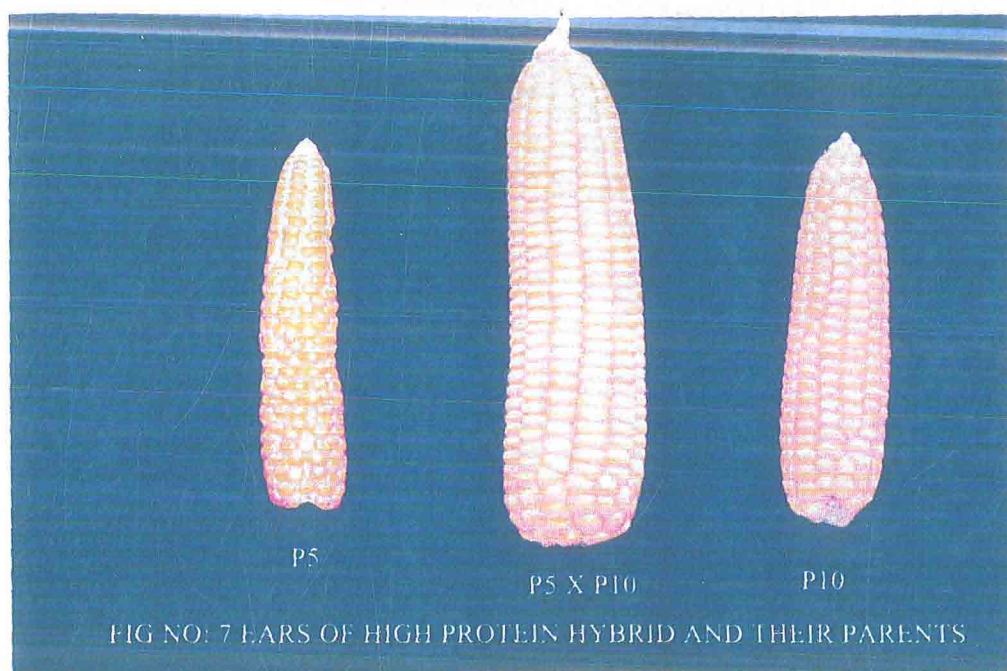




FIG NO: 11 PERFORMANCE OF HIGH PROTEIN HYBRID PLANT (P5 X P10)



FIG NO: 12 PERFORMANCE OF HIGH TRYPTOPHAN HYBRID PLANT (P1 X P10)

parents and best crosses. Among the parents, the best combiners for high oil were P1, P4 and P8 at all the locations. These parents possessed higher oil content and therefore, can be used in improving oil content. (Table 18). The crosses P1 X P8, P4 X P6, P7 X P8, P1 X P2, P1 X P3, P3 X P5, P7 X P8, P2 X P10 were best specific crosses at all the locations. The cross P4 X P8 has both of the parents as good general combiners but with negative *sca* effects. Therefore, there is a good scope for selection from segregating generations in isolating progenies with high oil per cent. Such improvement in oil content has been reported by Alexander (1997) in maize (Fig. 10 and 14).

For oil yield / ha P5, P8 had higher mean values and were also good general combiners in addition to P2 and P1 during *Kharif* and *Rabi* at Palem. The parents P5 also contributed maximum favourable genes for oil yield at all locations. Many crosses exhibited significant *sca* P1 X P10, P4 X P6, P2 X P10, P2 X P8, P1 X P8, P4 X P5, P2 X P7 which are derived from good combiners can be profitably used in improving the oil yield by exploiting the additive gene action.

Tryptophan, which is an important essential amino acid present in quality protein maize and absent in normal is an important character as far as quality of protein is concerned. To identify potential parent and best crosses, analysis for tryptophan was done. Among the parents P4, P9, P1 and P2 were good general combiners with high tryptophan content at all locations. Thus, these parents can be used in improving the tryptophan content. The crosses P1 X P10, P1 X P3, P1 X P9, P2 X P3, P3 X P4, P4 X P6, P4 X P5 were best specific crosses at all the locations (Table 18). Except P1 X P9, the

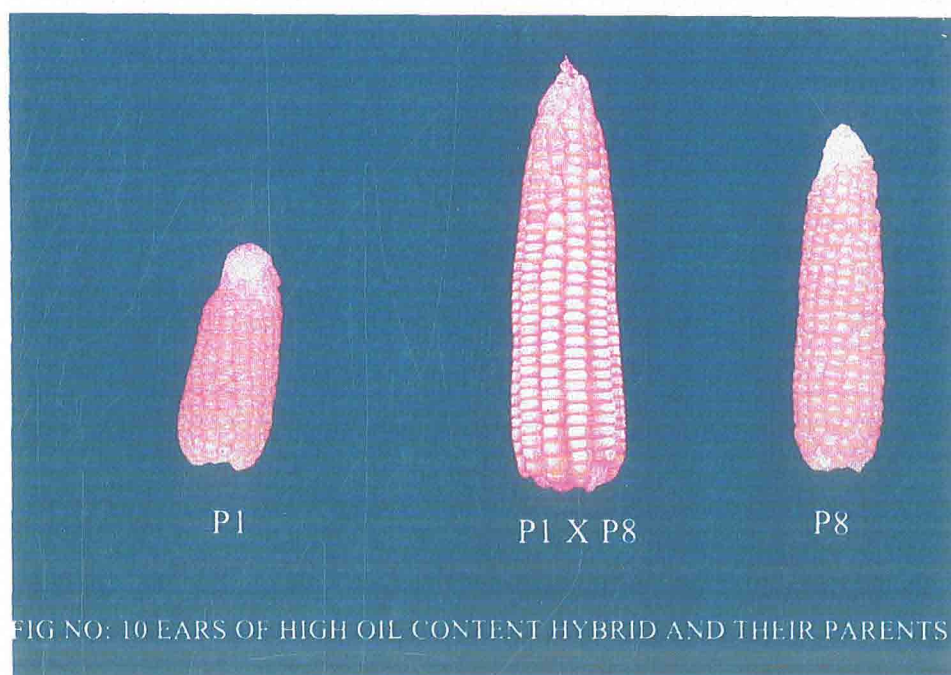
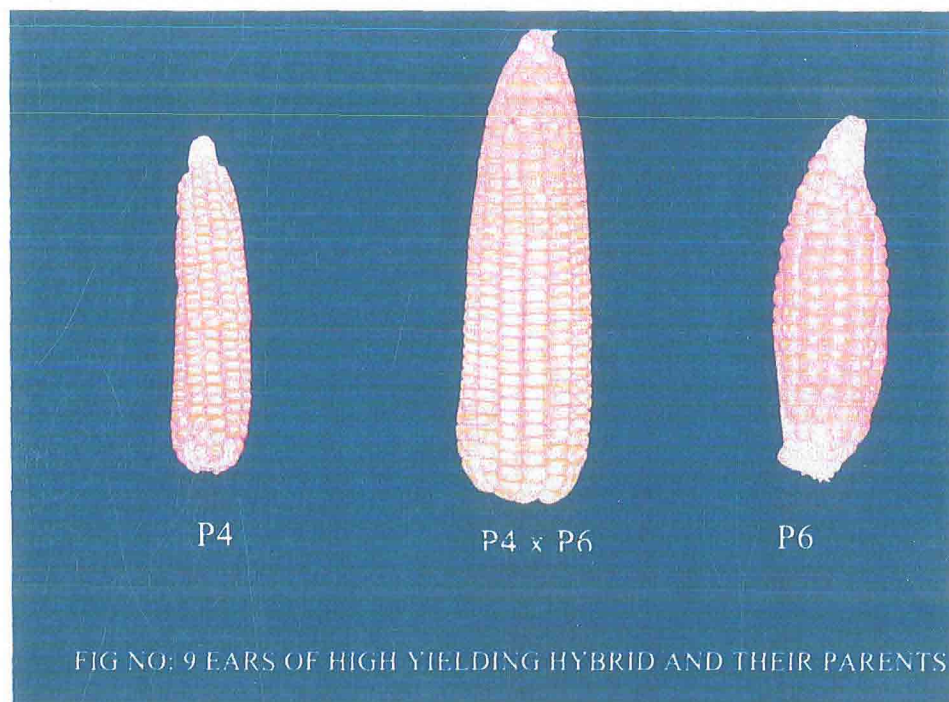




FIG NO: 13 PERFORMANCE OF HIGH YIELDING HYBRID PLANT (P4 X P6)



FIG NO: 14 PERFORMANCE OF HIGH OIL HYBRID PLANT (P1 X P8)

remaining crosses having one good general combiner in their crosses. Hence, they can be used in heterosis breeding programme, whereas selection can be effectively practiced in the cross P1 X P9 to isolate true breeding genotypes from the subsequent generations (Fig.8 and 12)

Grain yield is a complex and is influenced by number of its components apart from biotic and abiotic stresses. Among the ten parental lines P5, P8, P10 have high per se mean values but only P5 and P8 were found to be good general combiner in addition to P2 and P4. The cross combinations P4 X P6, P7 X P9, P1 X P10, P2 X P10, P2 X P7, P2 X P8, P4 X P5 were the best specific crosses. These good combiners can also be intercrossed to develop high yielding composites. The cross combinations P2 X P8, P4 X P5 are derivatives of high x high combiners and selection in these crosses may result useful transgressive segregates for high yield in the future generations (Table 18). Yield improvement can be sought from these crosses by pedigree or simple selection procedure while the remaining hybrids have either one high and one low (or) both the parents with low *gca*, indicating the possibility of obtaining superior crosses even with high x low and low x low *gca* combinations of parents indicating dominance X dominance type of gene action, hence, advance generations of these crosses may also be utilised for production of high yielding homozygous lines with high grain yield. These findings are in consonance with earlier reports (Nawar *et.al.*, 1979; Debnath, 1984 and Reddy, 1998). Lonquist (1949) and Prasad *et.al.* (1988) assessed production of synthetics with lines having good combining ability. In the present study also these hybrids have parents with good

Table No.18 Relative performance of best parents and crosses for grain yield, and quality characters at two locations
(Rajendranagar & Palem) for two seasons (Kharif & Rabi)

Characters	Kharif Rajendranagar	Rabi Rajendranagar	Kharif Palem	Rabi Palem
GRAIN YIELD	2.65	2.89	2.75	2.80
Parents P5				
P8	2.53	2.52	2.52	2.56
P9	2.54	2.42	2.23	2.15
P6	2.14	2.33	2.45	2.30
Crosses P4X P6	4.27	4.39	4.35	4.32
P2 X P8	4.11	4.22	4.32	4.30
P1 X P10	4.04	4.27	4.03	4.12
P2 X P10	4.16	4.29	3.90	4.00
Checks Madhuri	1.99	1.90	2.34	2.52
Shaktiman-2	3.06	3.61	4.01	4.25
OIL %	7.10	7.00	7.14	7.23
Parents P4				
P9	6.80	6.91	7.05	7.08
P1	6.82	6.75	6.49	6.82
P2	6.51	6.75	6.68	6.92
Crosses P1 X P8	7.50	7.94	7.94	8.14
P1 X P10	7.18	7.52	7.50	7.75
P1 X P2	7.13	7.40	7.49	7.70
P2 X P10	7.21	7.42	7.31	7.64
Checks Madhuri	7.20	7.12	7.25	7.02
Shaktiman-2	6.92	6.71	6.72	6.69
TRYPTOPHAN	0.86	0.87	0.87	0.87
Parents P9				
P4	0.82	0.82	0.83	0.83
P2	0.78	0.78	0.78	0.78
Crosses P1 X P9	0.85	0.86	0.86	0.85
P2 X P9	0.82	0.83	0.83	0.83
P3 X P4	0.80	0.81	0.81	0.81
P3 X P9	0.83	0.83	0.84	0.83
Checks Madhuri	0.70	0.70	0.71	0.71
Shaktiman-2	0.81	0.83	0.84	0.86
PROTEIN %	11.10	11.00	11.20	11.20
Parents P9				
P4	11.10	11.20	11.20	11.25
P2	11.10	11.20	10.80	11.14
P1	10.50	10.60	11.18	10.55
Crosses P4X P8	12.00	12.50	12.30	12.31
P5 X P10	11.80	12.01	11.91	11.93
P7 X P9	11.60	11.70	11.62	11.71
P3 X P9	11.60	11.72	11.63	11.70
Checks Madhuri	12.10	12.50	12.31	12.32
Shaktiman-2	11.7	12.01	11.82	11.91

Table No.19 Relative *per se*, Gca, Sca effects and stability parameters
for Grain yield and quality characters.

	Perse	GCA	SCA	bi	S ² di
GRAIN YIELD					
Parents P5	2.77	0.31**		0.13	-0.02
P2	1.58	0.22**		1.11	-0.01
Crosses P4XP6	4.33		1.41**	0.08	-0.03
P1 X P10	4.12		1.66**	-0.13*	-0.01
P4 X P5	4.12		1.05**	-0.20*	-0.03
P2 X P10	4.09		1.40**	-0.76**	-0.02
P2 X P8	4.24		1.20**	0.48	-0.03
PROTEIN					
Parents P4	11.19	0.31**		1.05	-0.02
P5	10.20	0.26**		-0.72	-0.01
P9	11.13	0.33**		-0.31	0.00
Crosses P4 X P8	12.28		1.69**	3.74**	-0.01
P5 X P10	11.91		1.62**	1.62	-0.02
P7 X P9	11.66		1.11**	1.02	-0.02
P3 X P9	11.66		1.04**	1.08	-0.02
P1 X P4	11.02		0.82**	1.50	-0.02
P8 X P10	10.63		0.68**	1.85	-0.02
OIL %					
Parents P4	7.12	0.19**		0.32	-0.03
P1	6.72	0.23**		0.07	0.00
P8	6.63	0.17**		-0.14*	-0.03
Crosses P1 X P8	7.88		0.86**	1.40	-0.02
P4 X P6	7.21		0.79**	0.35	-0.03
P2 X P10	7.39		0.60**	0.99	-0.03
P3 X P5	73.37		0.65**	1.00	-0.03
P7 X P8	7.30		0.65**	0.62	-0.03
P4 X P9	7.28		0.49**	0.92	-0.03
TRYPTOPHAN					
Parents P4	0.83	0.08**		1.26	0.00
P2	0.76	0.05**		0.39	0.00
P1	0.75	0.04**		0.87	0.00
Crosses P1XP10	0.77		0.08**	0.86	0.00
P1 X P3	0.19		0.06**	-1.66**	0.00
P4 X P6	0.73		0.05**	1.00	0.00
P4 X P5	0.72		0.05**	0.74	0.00
P2 X P3	0.80		0.05**	2.02	0.00

combining ability and greater progress can be achieved in production of synthetics (Fig.9 and 13)

The other hybrids viz., P4 XP6, P2X P10, P2X P7 can also be exploited by realizing their high yield potential.

The final selection of parents is mostly influenced by results an grain yield and other characters which have direct bearing on yield (Venkatesh *et.al.*, 2001). Arunachalam and Bandhyopadhyay (1979) and Venkatesh *et. al.*(2001) suggested that the general picture of the combining ability of parents over all the characters is useful to decide the combining ability status of parents. Considering all the locations and all the characters, the parents P4, P5 and P2 can be given the status of good general combiners and genetically worthy parents, as they contributed maximum favourable genes for majority of the traits including yield (Fig.19). The parent P4 was good general combiner for LAI, LDW, SLW, Biomass, Protein content, Seed protein yield, Oil per cent, Tryptophan and Grain yield and also for earliness. P5 was good combiner for LAI, CGR, RGR, SLW, Seed protein yield, Oil yield and Grain yield and P2 was a good combiner for total chlorophyll content, Harvest index, seed protein yield, oil yield, tryptophan and grain yield / plot .(Fig.19). Hence, these high yielding parents with good attributes for different yield components may be intercrossed to pool the genes in desirable direction to improve the yield potential.

Fig. 19 Pictorial presentation of GCA effects of parental lines as good combiners at four locations

	50% tasseling	50% silking	ASI	maturity	Pl.ht.	Ear ht.	LAI	LDW	CGR	RGR	NAR	SLW	biomass
P1	x								*		x	+	
P2							x	x	*			x	
P3	x			x	x	x					+		
P4	x	x		x		x	*	*				+	x
P5							*		*	+	*	*	
P6			NS						+	+	*		
P7													
P8								x					+
P9													x
P10									*		x	+	

Parents	Chlorophyll content	HI	Protein content	Seed Prot. yld	Oil percent	Oil yield	Tryptophan content	Grain yield	Good combiner for characters
P1		+		*		x	*		8
P2	*	*		*		*	*	*	11
P3		x					*	x	8
P4			*	+		+	*	*	13
P5		+	*	*		*			9
P6		x							3
P7									0
P8				+		+			4
P9			*	x			*		4
P10	*			*					5

* Significant combiner at four locations

x Significant combiner at two locations

+ Significant combiner at three locations

5.2 CORRELATION STUDIES

Yield is the ultimate cumulative result of contributions from a number of independent characters. These characters are not only associated with yield but also among themselves. These associations are either positive or negative in nature and therefore selection for one component may bring about a simultaneous change in the other component in favourable or unfavourable direction. However, this mutual association does not take into account the extremely complex relations among various characters, which are related to dependent variables. Hence the path coefficient analysis, a partial regression technique is used to measure direct and indirect effects of one variable upon another.

Phenotypic and genotypic correlations were estimated for the characters studied, followed by path coefficient analysis to find out most important yield contributing characters. Over all interpretation of results indicate that phenotypic and genotypic correlations were in perfect agreement with each other and high magnitude of the latter indicated the masking effect of environment on genotypic correlation.

Grain yield / plot was found to be positively associated with plant height, ear height, LAI, CGR, NAR, SLW, Total biomass at maturity total chlorophyll content, harvest index, seed protein yield/ ha, oil per cent, oil yield / ha at Palem for both the seasons in addition to LDW in *Rabi*. Grain yield / plot was found to be positively associated with LAI, LDW, CGR, NAR, SLW, Total bio mass at maturity, total

chlorophyll content, harvest index, seed protein yield / ha, oil yield/ ha at Rajendranagar during both the seasons in addition to plant height at *Rabi*.

These results were earlier reported in maize by several workers on different characters. Association of grain yield with plant height (Laptev, 1981; Sharma *et.al.*, 1982; Godawat, 1982; Mahajan *et.al.*, 1990; Krishnan and Natarajan, 1995 and Ghorasani *et.al.*, 1997), ear height (Laptev, 1981; Kumar and Kumar, 1987; Gautam *et.al.*, 1988), chlorophyll content (Adhikari *et.al.*, 1989 and Allurwar and Deotale, 1991), LAI (Dornescu, 19801; Li Yuling, 1997; Batnaru, 1995; Zhang and Wang, 1992), total biomass(Jain *et.al.*, 1986, Krishnan and Natarajan, 1995), CGR (Giauffart *et.al.*, 1997), harvest index (Krishnan and Natrajan, 1995), seed protein yield (Proksza and Harmati, 1988)

On the other hand grain yield had highly significant negative correlation with protein content and tryptophan content at all the locations. These results are in consonance with Grebnschikov (1977) and Dudley *et.al.*, (1977). The negative correlation of grain yield with protein content was reported by Matatov and Matatov (1966), Tomzei *et.al.*, (1974) and Umakanth (1993)

Further, negative correlation of yield with days to maturity and ASI was observed in the present investigation. Annapurna (1989), Netaji (1988) and Reddy (1998), also obtained similar results. These results revealed that for improvement of grain yield in maize, it could be advantageous to exercise selection based on plant type which are late

maturing and tall. Since, grain yield was found to have negative correlation with protein, for its improvement plants have to be selected with reasonable level of protein. On the other hand protein content and oil content had positive correlation with each other supported by KrishnamRaju(2002)

Positive correlation of LAI and chlorophyll content with total biomass was observed in the present study, which is in consonance with the earlier reports of Dornescu (1980) and Naresh Kumar and Singh (1996). These results revealed the probable possibility of simultaneous improvement of these traits through appropriate selection.

5.3 PATH COEFFICIENT STUDIES

The grain yield is the ultimate function of its component characters, hence, it is important to study the association of yield attribute to improve grain yield. Although the relationship of grain yield for many agronomic characters is complex, the plant breeder has to find the extent of direct and indirect effects of attributes with yield in addition to simple correlations that could be useful to predict superior combinations. Direct effect of characters may be found through the study of genetic correlation. But path coefficient analysis allows separating the direct effect and their indirect effects through other attributes by appropriating the correlations (Wright, 1921).

The concept of path analysis was originally developed by Wright (1921) and this technique was first used in plant selection by Dewey and Lu (1959). Thereafter many workers reported and utilised these techniques in crop improvement through selection.

Direct and positive effects were exhibited by ASI, ear height, LAI, LDW, CGR, NAR, HI and seed protein yield whereas, direct and negative effects were exhibited by days to maturity, plant height, total chlorophyll content, SLW and protein content on grain yield during *Kharif* at Rajendranagar and Palem.

At Rajendranagar and Palem during *Rabi* direct and positive effects were exhibited by ASI, ear height, LDW, CGR, NAR, seed protein yield, oil per cent, oil yield and tryptophan content and direct and negative effects were exhibited by days to 50 % silking, plant height, total chlorophyll content, Harvest index and protein content on grain yield. So improvement in these characters may bring about change in grain yield. These studies were in agreement with the earlier findings of Sharma and Kumar (1987)

LAI, which is an indirect index of photosynthetic activity and contributes directly to biomass accumulation and grain yield. This indicates that adequate leaf area is required for biomass production and grain yield in any genotype. These results are in consonance with the results of Dornescu (1980) and Li Yuling (1997).

The path analysis revealed that the direct influence of total chlorophyll content on grain yield at *Kharif* Palem was positive and significant. Such correlation with grain yield

was reported by Adhikari *et.al.* (1989), Allurwar and Deotale (1991) and Naresh Kumar and Singh (1996).

Oil is one of the important characters and was found positively and significantly associated with LAI, Chlorophyll, CGR, Protein content, Seed protein yield / ha. The direct effect of oil content on grain yield was on negative side at *Kharif* Palem and positive side at remaining locations.

Protein content showed positive association with days to 50 per cent tasseling, seed protein yield and tryptophan content at all locations and did not exhibit any relationship with other characters.

5.4 STABILITY

Genotype x Environment interactions which commonly occur in plant material are of considerable importance in developing improved varieties and rationalization of policy and procedure in breeding programmes which contribute to further genetic importance in crop plants. Reliability of crop yield has always been a problem and it is a serious problem in underdeveloped countries. However, advanced technologies can help in modifying environmental fluctuations in primitive agriculture has been the development of myriad of locally adapted varieties and for many crops such varieties constitute the primary gene pool. However, this is too expensive technique to be adopted by a scientific breeder. In any case, it is of little help in overcoming season-to-season climate variation

and hence the plant breeder prefers varieties or hybrid of near universal adoption possible.

Such varieties are generally called “well buffered” (Allard and Bradshaw, 1964) and also regarded as possessing high genetic homeostasis (Lerner, 1954)

In the past, the term ‘stable variety’ often has been used to denote a variety that does relatively same over a wide range of environments. It may be inferred from the discussion that a stable variety perform relatively better under adverse conditions and not so well in favourable environments. Hence the definition of stable genotype, according to Eberhart and Russel (1966) is one that shows 1) a high mean yield 2) a regression coefficient (b_i) around unity and 3) a mean square deviation from regression near to zero. According to Langer *et.al.*(1979) the regression coefficient is a measure of response to varying environments. The mean square deviation from linear regression is a true measure of production stability.

In the present study, Eberhart and Russel (1966) model was used for evaluating the stability of 10 parents and 45 crosses for twenty-one characters over four environments.

Grading of environment indicated that the Palem *Kharif* location was best for grain yield but while taking all characters into consideration Palem Rabi was best for all characters. Pooled analysis of variance (Table14) indicated that each genotype differed

significantly from one another for all the characters. In respect of environments also significant differences were observed for all the characters except for ASI, RGR, total chlorophyll content, protein content and tryptophan content. Significant effect of environment was also reported by Cardoso *et.al.* (1997), Gentinetta *et.al.* (1988) and Gautam *et.al.* (1998), Pal and Prodhan (1994) reported significant G X E interaction for yield and yield components except oil content. The mean squares due to genotypes and environments were highly significant, indicating that the variation among genotypes and environments. The genotype environment interaction was also highly significant when tested against pooled error for all the characters except for ASI, LAI, CGR, RGR, NAR, SLW, total biomass, total chlorophyll content, protein content, oil per cent, tryptophan and grain yield which revealed differential behaviour of genotypes to varying environments.

Environment (linear) mean square were significant for all the characters except for ASI, RGR, total chlorophyll content, protein content and tryptophan, while Genotype x Environment (linear) mean squares were significant only for Days to 50 % tasseling, Days to 50 % silking, Days to maturity, Plant height, ear height, LDW, HI, Seed protein yield and Oil yield. The mean squares due to pooled deviations (non-linearity) were significant for all the characters indicating that the parents and hybrids differed considerably for their stability. Mahajan and Khehra (1992) for grain yield, Kumar *et.al.* (1997) observed both linear and non-linear components of G X E interaction for maize oil. The linear components revealed the presence of stability of varieties for all the

characters. A low Genotype x Environment for characters has a practical significance for breeders.

Duration of a variety or a hybrid is an important attribute, which qualifies them to fit in cropping system in order to increase crop intensity. It also helps in escaping terminal drought. Days to 50 per cent tasseling, silking and brown husk, indicates that earliness of a genotype in maize. Most of the hybrids and parental lines exhibited stable performance for earliness. The parents P3 and P4 and cross combinations P2 X P8, P4 X P8 and P8 X P10 were early and possessed desirable stability parameters and may be well suited only to lower environments.

In respect of plant height, no parent was stable and among the hybrids P1 X P2 and P3 X P5 possessed higher mean value and were stable as b_i value is equal to unity, and s^2_{di} value is non significant and found to be stable.

Stability for ear height was observed in parental lines P2 and P4 and hybrids P3 X P8, P2 X P7 with desirable means and specific adaptation to favourable conditions

In respect of LAI, the parents P5 and P6 and crosses P1 X P3, P3 X P5 and P7 X P8 exhibited stable performance with average mean value with unit regression coefficient and s^2_{di} value equal to zero.

As far as CGR is concerned, P1 among parents and P1 X P10, P2 X P3 and P4 X P6 among crosses were found to be stable with unit regression coefficient and S_{2di} values non-significant.

With regard to physiological parameters like RGR, NAR, SLW, P3, P6 and P10 among parents, P6 X P8, P3 X P6, P3 X P7 among crosses were found to be stable and P3 X P7 is suitable for specific adaptation to favourable environmental conditions.

Stability for total biomass was observed in parental lines P4 and P9 and hybrids P1X P4, P2 X P9, P3 X P8 with desirable means and stability parameters and were found to be stable.

The parental lines P1, P2, P10 with average mean values and among crosses P4 X P5, P1 X P9, P1 X P7 were found to be stable for the character chlorophyll content.

No parent was stable as far as harvest index is concerned and among crosses P6 X P7, P4 X P6, P3 X P6 and P1 X P8 were found to be stable.

The linear response of genotype for protein content was non significant. P4 had higher protein content and among hybrids P3 X P4, P4 X P5, P4X P8 with high protein content and were stable over the environments.

Kumar *et.al.* (1997) reported G X E interaction and differential performance of the genotype under different environments for oil content. Considering locations in the present study for oil content, P3 among parents and P3 X P5 among crosses exhibited stable performance.

In respect of tryptophan content, the parent P4, P1 and P9 and crosses P3 X P9 and P4 X P6 with high mean values were found to be stable.

Among the parents P3, P6, P7 registered high grain yield and among crosses P1 X P7, P3 X P4, P3 X P6, P3 X P10, P4 X P10 possessed more than average means and were also found to be stable but these crosses were suitable for specific adaptation to favourable environmental conditions.

As the QPM has added advantage of protein content and quality i.e. tryptophan in addition to grain yield. These characters have to be given importance.

On overall basis P4, P5 and P9 were considered as desirable parents for protein content based on combining ability. P4 was most stable parent for the quality trait (Fig.15a).

Among the crosses P4 X P8, P5 X P10, P7 X P9, P3 X P9, P1 X P4 and P8 X P10 were good specific combiners with high protein content and these were also found to be stable. But P4 X P8 was suited to favourable environmental conditions (Fig.15b).

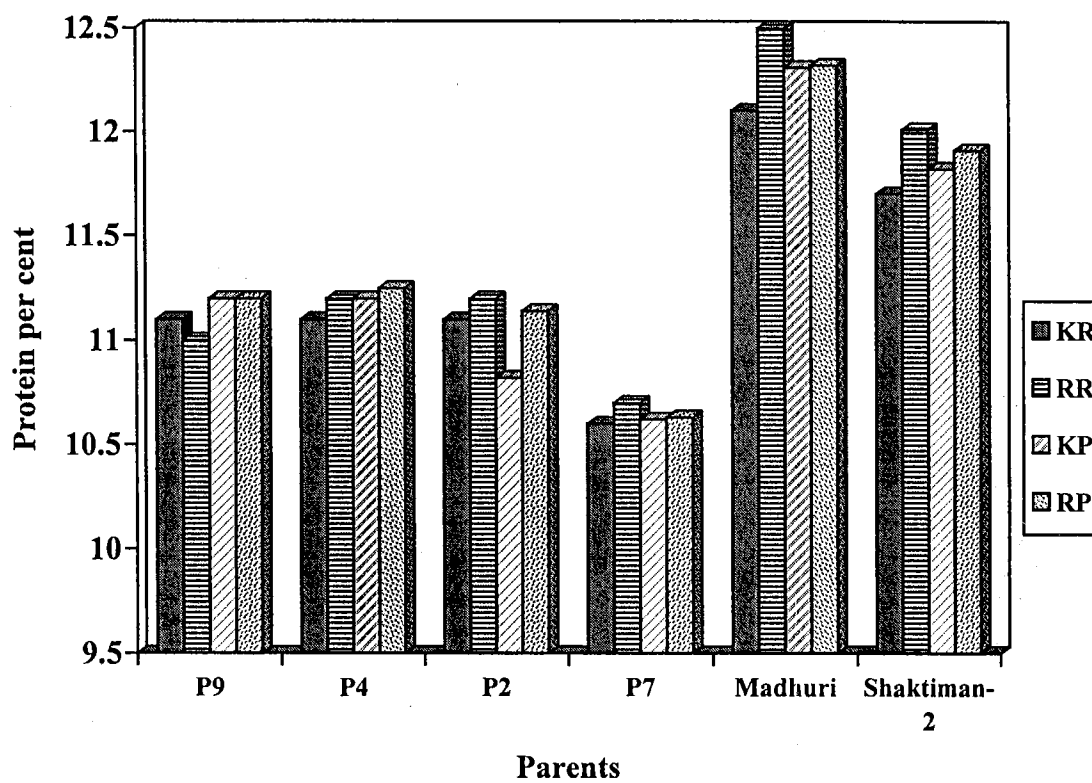


Fig 15 a: Relative performance of superior Parents and Checks with high protein at Kharif Rajendranagar, Rabi Rajendranagar, Kharif Palem and Rabi Palem

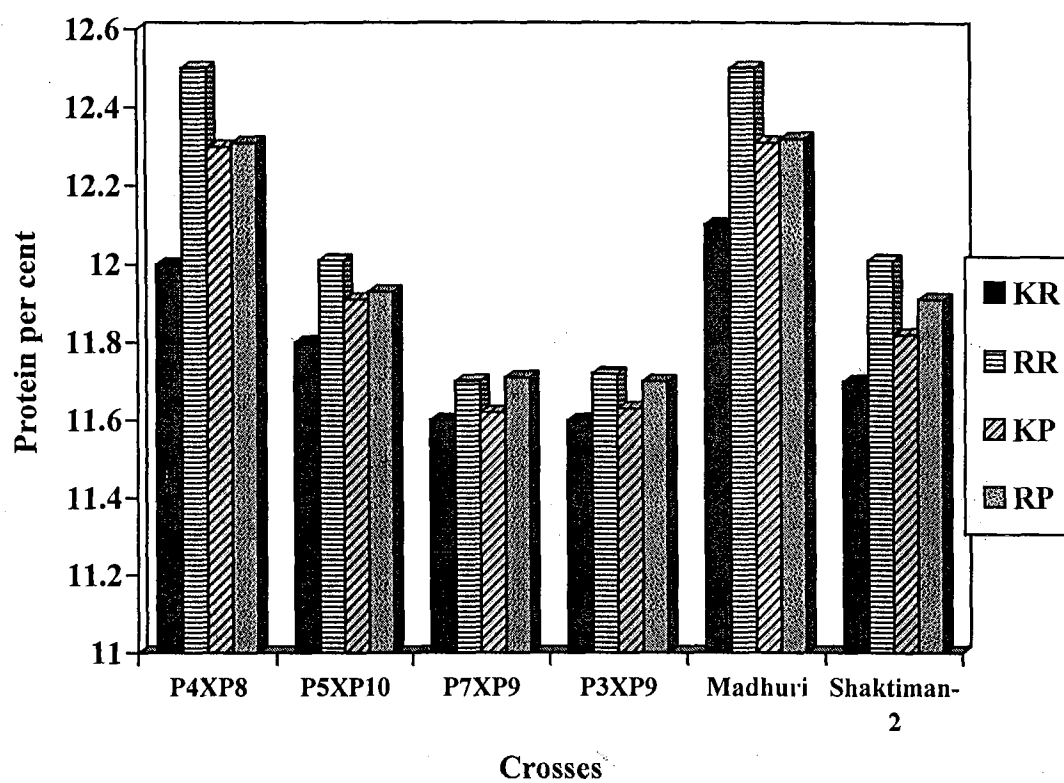


Fig 15b : Relative performance of superior crosses and Checks with High protein at Kharif, Rajendranagar, Rabi Rajendranagar, Kharif Palem and Rabi Palem .

Considering oil per cent P4, P1 and P8 were good general combiners in addition to high to medium oil content and among these P4 and P1 were found to be stable and are well suited to poor environments. Among the crosses P1 X P8, P4 X P6, P2 X P10, P3 X P5, P7 X P8 and P4X P9 were having high oil per cent and were not only good combiners but were also stable in poor environments (Fig.16a & b).

Tryptophan content is an important character as far as QPM is considered, among parents P4, P2 and P1 were good combiners and had high to medium mean value and these were found to be stable over environments. Among the crosses P1 X P10, P1X P3, P4 X P6, P4 X P5 and P2 X P3 had high to medium tryptophan content and were good combiners in addition to stability but P1 X P3 was not stable (Fig 17a & b).. As the QPM has added advantage of protein content and quality i.e. tryptophan in addition to grain yield. These characters have to be given importance.

Considering over locations and in both the seasons P5 and P2 among parents are good combiners for grain yield even though parent P2 is low yielder but it is stable over environments (Fig.18a)

Among the crosses P4 X P6, P1 X P10, P4 X P5, P2 X P10 and P2 X P8 have high *per se* mean values and were very good combiners. But out of these P4 X P6 and P2 X P8 were stable and these have to be tested over environments for further confirmation (Fig.18b)

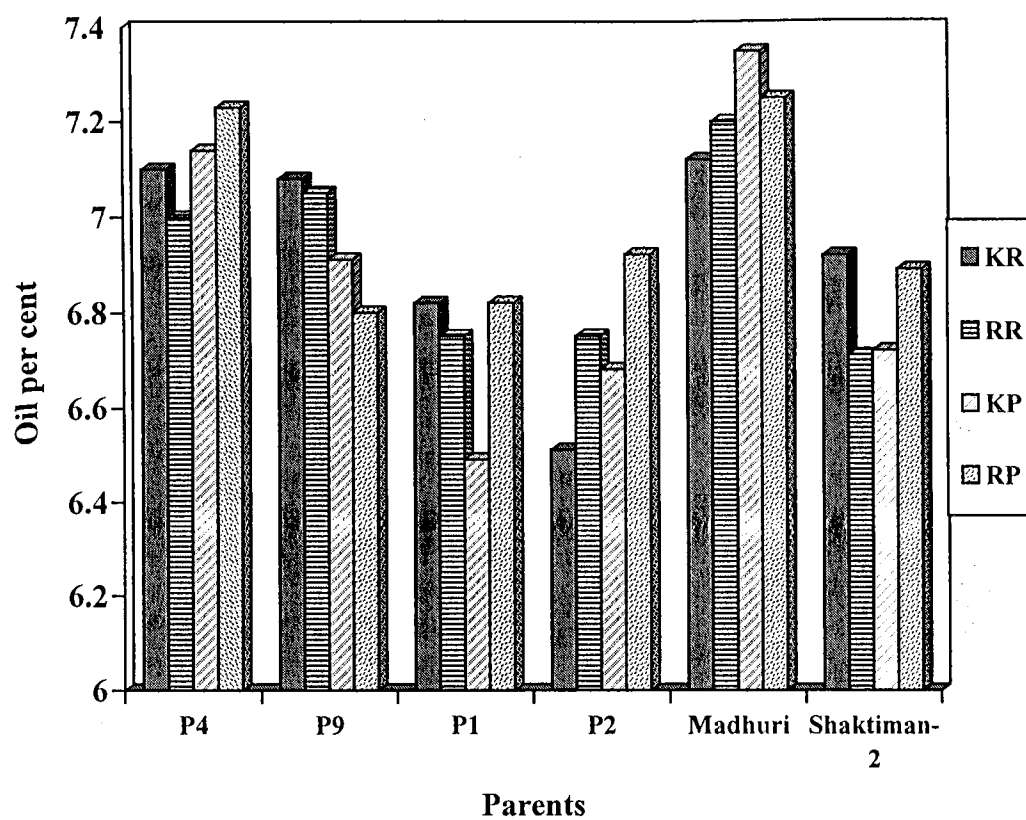


Fig 16a: Relative performance of superior parents and Checks with high oil at Kharif Rajendranagar, Rabi Rajendranagar, Kharif Palem and Rabi Palem.

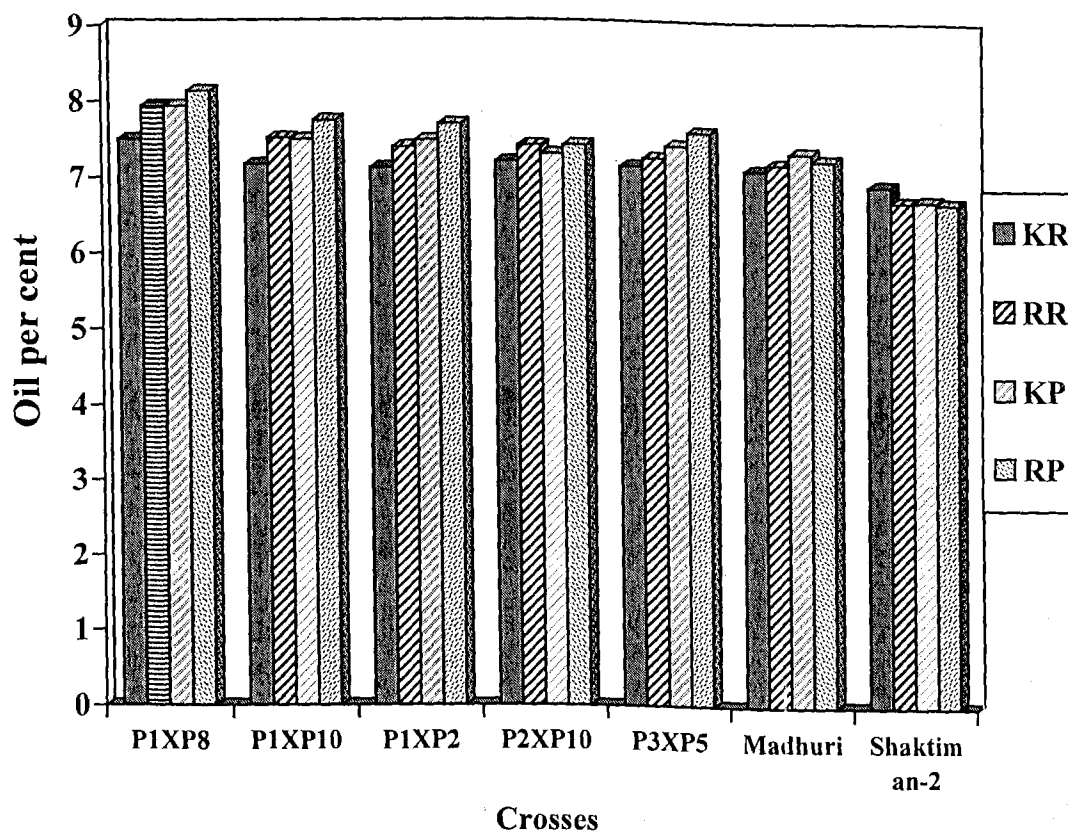


Fig 16b: Relative performance of Superior crosses and Checks with High Oil per cent at Kharif Rajendranagar, Rabi Rajendranagar, Kharif Palem and Rabi Palem.

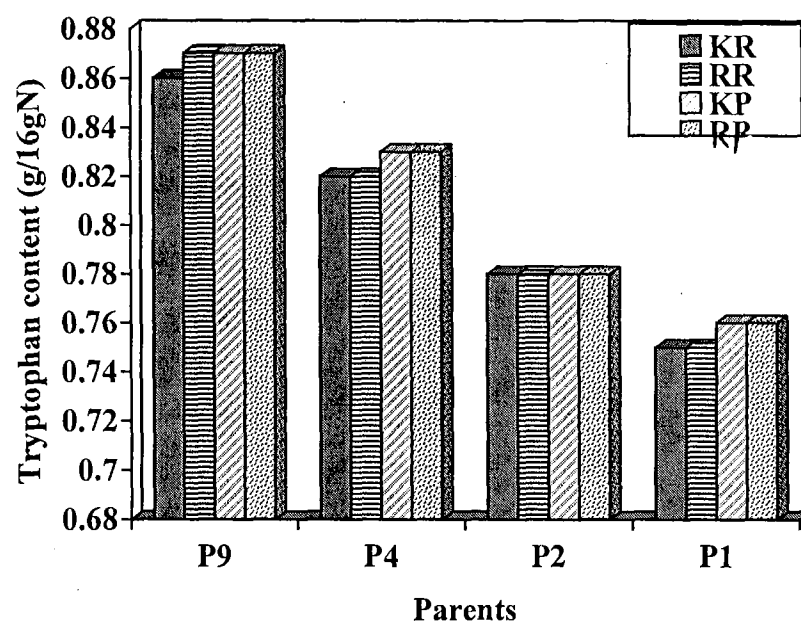


Fig 17a: Relative performance of superior parents with high tryptophan content at Kharif Rajendranagar, Rabi Rajendranagar, Kharif Palem and Rabi Palem

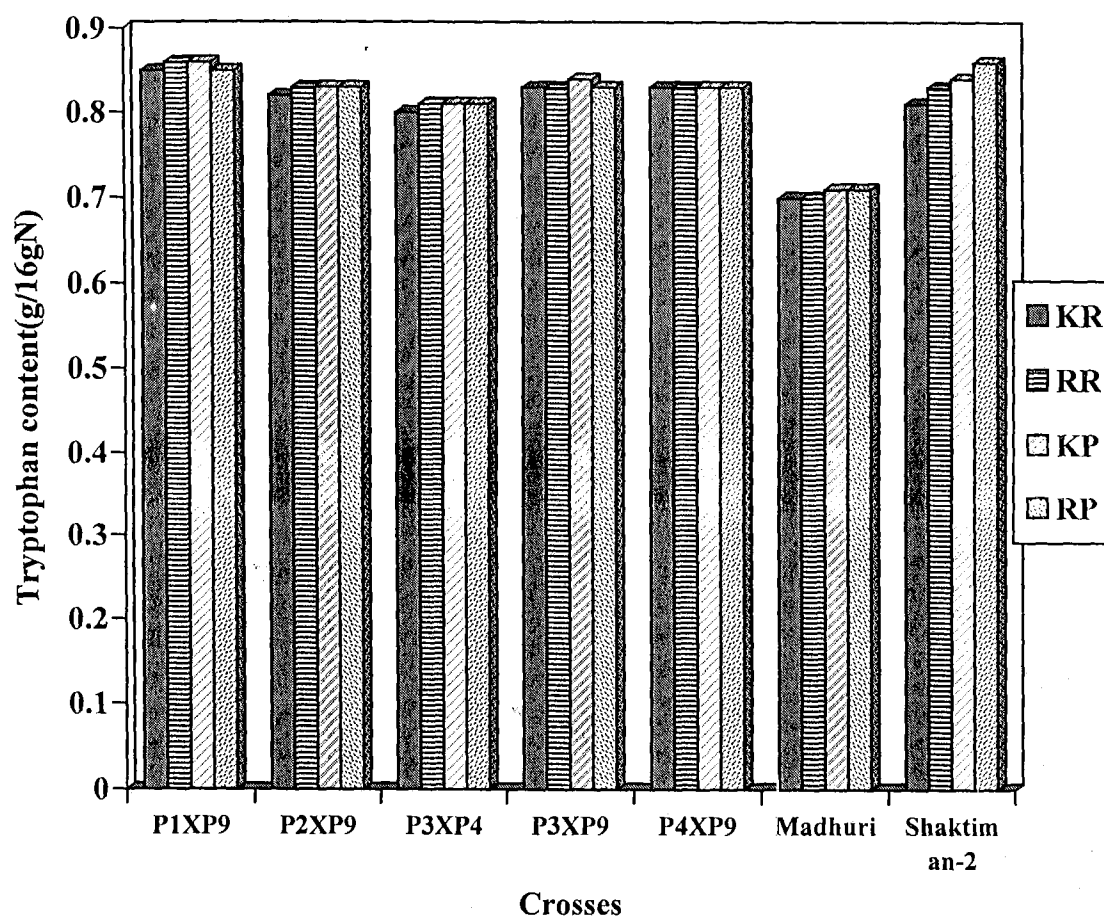


Fig 17b: Relative Performance of Superior Crosses and Checks with High Tryptophan content at Kharif Rajendranagar, Rabi Rajendranagar, Kharif Palem and Rabi Palem.

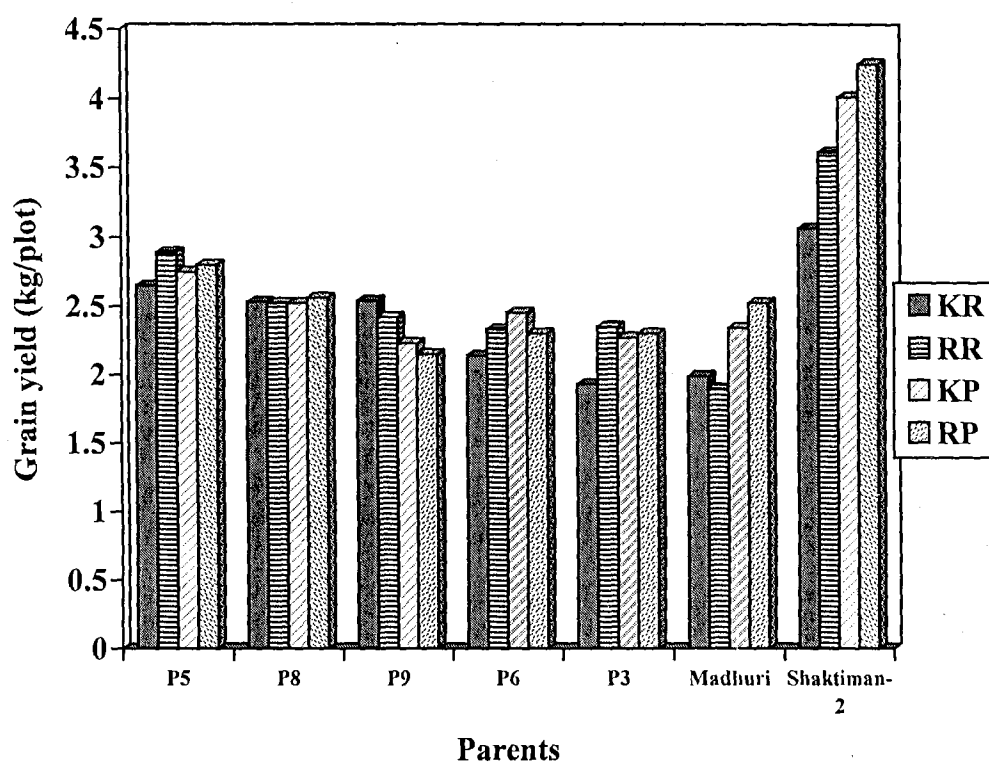


Fig 18a: Relative performance of Superior Parents and Checks with High grain yield at Kharif Rajendranagar, Rabi Rajendranagar, Kharif Palem and Rabi Palem

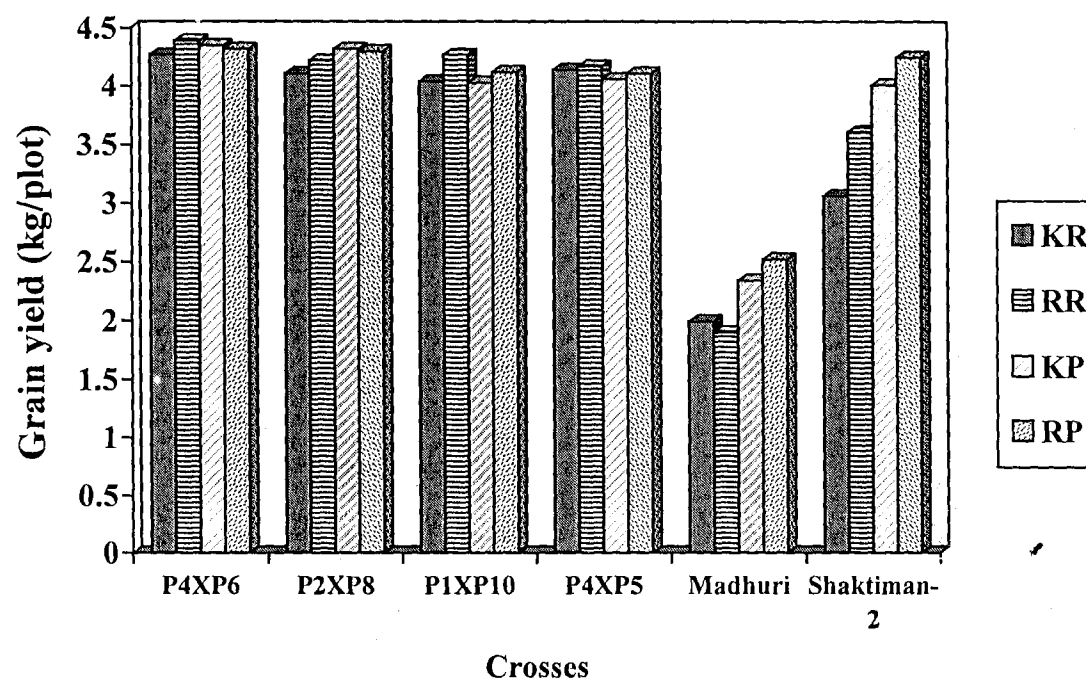


Fig 18b: Relative performance of Superior Crosses and Checks with High grain yield at Kharif Rajendranagar, Rabi Rajendranagar, Kharif Palem and Rabi Palem.

The present study revealed the rate of additive and non-additive gene action in most of the yield and other characters. The preponderance of non-additive gene action is apparent. Hence, a breeder should coin the non-additive gene action through the utilisation of heterosis to realise both the gene action, recurrent selection process i.e. population improvement programmes should be followed to get the elite inbreds in the future breeding programmes and to pyramid the genes into certain individuals.

The parents P4, P5 and P2 were good combiners for most of the characters including yield. These lines can be used as parental donors for yield improvement and the crosses can be exploited in pyramiding genes for higher yield. The crosses P4 X P6, P2 X P8, P2 X P10, P4 X P5 were high yielding and exhibited 15-20% superiority over high yielding check. These crosses have parent with good combining ability and can be further used in production of synthetics.

Besides grain yield, protein content, tryptophan in the protein and oil per cent are also very important. The parents P4, P2, P9 and P1 were good combiners for above characters and introgression of these parents by developing new gene recombination's through recurrent selection in future breeding programmes will bring about change in gene frequencies and may give better lines with high level of protein content, oil per cent and tryptophan content along with yield. The parent P5 can be utilized as donor for improving grain yield and protein content, P4 can be utilized as donor for improving protein content, oil per cent and tryptophan content. The crosses P4 X P6 and P4 X P5

are identified as best crosses for grain yield, oil per cent and tryptophan content hence on multi location testing can be released as single crosses for improving both yield and nutritional quality. The cross P1 X P10 for grain yield and tryptophan content, P2 X P10 for grain yield, oil per cent and tryptophan can be used to generate productive and nutritionally superior new inbreds.

Stability analysis was based on four diversified locations. It is better to test the high yielding hybrids over more locations and different agro climatic situations to find out the real worth of the hybrids before it is released for commercial cultivation.

SUMMARY

CHAPTER-VI

SUMMARY

The present investigation was carried out at two locations for two seasons (*Kharif* and *Rabi*) at Rajendranagar and Palem to understand the nature of gene action and combining ability analysis of physiological parameters and grain yield components. The study was also aimed to understand the correlation and path coefficient between morphological, physiological growth parameters and grain yield along with Genotype x Environment interaction and stability.

The ten parental lines were crossed in diallel fashion to obtain 45 direct single crosses (with out reciprocals). The resulting 45 hybrids along with parents and two checks were grown during *Rabi* 2002 and *Kharif* 2003 both at Rajendranagar and Palem. The data was collected on days to 50 per cent tasseling, days to 50 per cent silking, ASI, days to maturity, plant height, ear height, LAI, LDW, CGR, RGR, NAR, SLW, chlorophyll content, total biomass, harvest index, protein content, seed protein yield, oil per cent, oil yield, tryptophan and grain yield.

The analysis of variance revealed significant differences among the genotypes. The hybrids in general were high yielding, when compared with parents. Combining ability analysis revealed importance of both additive and non-additive gene action in governing most of the characters but non-additive gene action was found to be predominant. Hence, recurrent selection was suggested to improve these characters.

The flowering data indicated that P4 and P3 parents were early and contributed maximum favourable genes for maturity characters. For plant height and ear height, P3 and P10 were good general combiners, considering all the locations, P4 and P5 for LAI, P4, P8, P9 for LDW, P5 for CGR and RGR, P6, P3 for NAR, P4 and P5 for

SLW, P8 and P4 for biomass, P10 and P1 for chlorophyll content, P1 and P8 for harvest index. In respect of grain yield P5, P8 and P2 turned out to be good combiners at all the locations. They were good combiners for most of the other characters and can be given the status of good general combiners.

Among the crosses P1 X P9 and P4 X P9 were early and possessed significant *sca* effects for earliness. The cross combinations P4 X P6 and P3 X P6 for plant height and ear height, P7 X P9 and P4 X P6 for LAI, P2 X P9 and P1 X P3 for LDW, P4 X P6, P2 X P10 for CGR and RGR, P5 X P6 and P1 X P10 for NAR, P2 X P3 and P1 X P9 for SLW, P1 X P10 and P8 X P10 for biomass, P1 X P2 and P3 X P7 for chlorophyll content, P4 X P6 and P7 X P9 were found to be best crosses for harvest index, for seed protein yield P7 X P9, P1 X P10 and P4 X P6 are best specific crosses. P1 X P10, P4 X P6, P2 X P10 for oil yield, P1 X P10, P4 X P6, P4 X P5 for tryptophan content were the best specific crosses involving both the parents or one of the parents as good general combiners. Hence these crosses could be advanced further for isolation of transgressive segregants and also to develop good inbred lines. These crosses exhibited 15-20% superiority over high yielding hybrid check.

Correlation analysis revealed that grain yield had significant positive correlation with LAI, CGR, NAR, total biomass at maturity, total chlorophyll content, harvest index, seed protein yield / ha and oil yield / ha both at Rajendranagar and Palem during both the seasons whereas days to maturity and ASI exhibited significant negative correlations. Grain yield had significant negative correlation with protein content. But protein content and oil content have positive correlation with each other.

Path coefficient analysis revealed that for grain yield, high positive direct effect was exhibited by ASI, ear height, LDW, CGR, NAR, seed protein yield, oil yield and tryptophan. Whereas the characters days to 50 silking, plant height, chlorophyll content, harvest index and protein content recorded negative significant direct effect.

For improvement of grain yield, path coefficient analysis emphasized the need for selection based on plant type with greater protein yield. However, for improving protein content, plant type with greater protein yield, ear height, late tasseling and late maturity, whereas for oil content greater protein yield, protein content and late silking could be preferred.

Hence, while breeding for grain yield in addition to protein and oil content, it could be desirable to target for high yielding lines with average protein and oil contents.

The inter association study revealed high inter correlation among the characters which exhibited significant correlation with yield indicating the scope for their simultaneous importance.

Genotype X Environment studied at four locations *viz.*, Rajendranagar *Kharif*, *Rabi* and Palem *Kharif* and *Rabi* was found to be significant for days to 50 per cent tasseling, days to 50 per cent silking, days to maturity, plant height, ear height, LDW, HI, seed protein yield and oil yield.

The parental lines P3 and P4 exhibited stable performance for earliness, P2 and P4 for ear height, P5 and P6 for LAI, P1 for CGR, P3 and P10 for RGR, NAR, SLW, P4 and P9 for total biomass, P1, P2 and P10 for chlorophyll content, P4 for protein content, P3 for oil per cent, P4, P1 and P9 for tryptophan content possessed higher means, significant bi and non significant S^2 di estimates.

Three parents P3, P6 and P7 recorded higher grain yield at all locations and were found to be stable. Among the hybrids P2 X P8, P3 X P8, P3 X P5, P3 X P6 possessed more than average mean and were stable for grain yield.

As the QPM has added advantage of protein content and quality i.e. tryptophan in addition to grain yield. These characters have to be given importance.

On overall basis P4, P5 and P9 among parents are considered as good for protein content based on combining ability even though P5 parent has medium protein content. Among these P4 is very stable. Among the crosses P4 X P8, P5 X P10, P7 X P9, P3 X P9, P1 X P4 and P8 X P10 are good combiners and have high protein content and these are found to be stable P4 X P8 is suited to specific adaptation to favourable environmental conditions.

Considering oil per cent P4, P1 and P8 are good general combiners in addition to high to medium oil content and among these P4 and P1 are found to be stable and are well suited to lower environments. Among the crosses P1 X P8, P4 X P6, P2 X P10, P3 X P5, P7 X P8 and P4X P9 are having high oil per cent and they are good combiners and are stable and also suitable to lower environments.

Tryptophan content is an important character as far as QPM is considered, among parents P4, P2 and P1 are good combiners and had high to medium *per se* mean value and these are found to be stable over environments. Among crosses P1 X P10, P1X P3, P4 X P6, P4 X P5 and P2 X P3 have high to medium tryptophan content and are good combiners in addition to stability except P1 X P3.

Considering over locations and in both the seasons P5 and P2 among parents are good combiners for grain yield even though parent P2 is low yielder but it is stable over environments.

Among the crosses P4 X P6, P1 X P10, P4 X P5, P2 X P10 and P2 X P8 have high *per se* mean values and are very good combiners. But out of these only P4 X P6 and P2 X P8 are stable and these have to be tested over environments.

The following conclusions can be drawn from the present investigation.

1. The parent P5 can be utilized as donor for improving grain yield and protein content
2. The parent P4 can be utilized as donor for improving protein content, oil per cent and tryptophan content.
3. The crosses P4 X P6 and P4 X P5 are identified as best crosses for grain yield, oil per cent and tryptophan content hence on multi location testing can be released as single crosses for improving both yield and QPM.
4. The cross P1 X P10 for grain yield and tryptophan content, P2 X P10 for grain yield, oil per cent and tryptophan can be used to generate new inbred which will have improvement in three characters. These crosses could be advanced further for isolation of transgressive segregants and also for production of three way cross hybrids.
5. Grain yield had significant positive correlation with LAI, CGR, NAR, total biomass, total chlorophyll content, harvest index, seed protein yield and oil yield. So by improving these physiological characters there is scope for improving grain yield.

The Per se, Gca, Sca effects and Stability parameters of superior crosses in the present investigation for 21 characters at two locations for two seasons are presented in Table 20 (Appendix).

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* Originals not seen

The pattern of Literature cited is in accordance to “The guidelines of Thesis presentation” of Acharya N G Ranga Agricultural University.

APPENDICES

Table No.20 Per se, gca and sca effects and stability parameters of superior crosses in the present investigation for 21 characters at two locations for two seasons.

Cross	Perse of F1		Perse of parents		SCA effect	GCA effects		Stability of F1		Stability of parents		Parent2	
	Parent1	Parent2	Parent1	Parent2		Parent1	Parent2	Bi	S ² di	Parent1	S ² di	Bi	S ² di
Days to 50% Tassling													
P2 XP3	54.58	62.92	59.42		-5.41**	-0.30**	-0.52**	0.85	-0.76	1.03	1.60**	1.04	-0.33
P4 XP9	55.42	57.92	65.67		-4.46**	-2.65**	1.77**	1.33	0.45*	0.90	-0.27	1.25	1.20**
P2 XP5	55.50	62.92	62.92		-5.21**	-0.40	1.27**	0.85	2.24**	1.03	1.60**	1.02	0.04**
Days to 50% Silking													
P2 XP3	56.92	65.50	62.08		-5.55**	-0.22	-0.44**	0.75	-0.51	1.00	0.36	0.98	-0.84
P2 XP5	57.75	65.50	65.00		-5.36**	-0.22	0.70**	0.92	0.92**	1.00	0.36	0.98	4.69**
P1 XP9	57.92	67.00	67.67		-6.30**	-0.16	1.26**	0.89	-0.33	0.99	-0.02	1.23	1.33*
ASIMX P4	1.75	2.50	2.17		-0.25**	0.17*	0.11	-3.76	0.21**	-7.64	0.03	-5.70	-0.20
P3 XP4	1.83	2.67	2.17		-0.50*	0.08	0.11	-0.91	0.14**	-3.88	0.05	-5.70	-0.20
P5 XP8	2.00	2.08	3.33		-0.16*	-0.06	-0.08	0.00	-0.23	-2.85	-0.22	7.52	0.53**
Days to maturity													
P2 XP3	89.25	97.58	95.50		-6.01**	-0.42	-0.67*	0.96	-1.28	0.85	-0.50	0.90	-1.39
P2 XP5	89.50	97.58	97.25		-4.84**	-0.42	1.17**	1.18	1.32**	0.85	-0.50	0.93	6.01**
P1 XP9	90.33	98.50	100.25		-6.67**	-1.08**	1.67**	0.95	-1.19	1.04	-0.62	1.24	0.77*
Plant height													
P2 XP3	192.39	134.38	159.90		3.68**	0.43*	11.18**	-0.83*	522.12**	1.60	227.76**	-1.34**	625.81**
P3 XP5	186.26	159.90	142.27		-6.65**	7.18**	-3.91**	1.20	-10.23	-1.34**	625.81**	0.79	156.54**
P3 XP6	188.80	159.90	135.74		-6.40**	11.18**	-4.82**	3.81**	125.33**	-1.34**	625.81**	0.87	12.68
Ear height P3 X P9	88.72	69.44	75.33		2.09**	5.76**	-5.06**	0.69	-2.89**	-2.33**	12.31**	-1.15**	6.78**
P1 XP2	87.22	59.48	53.94		10.46**	4.05**	1.01	0.68	0.26	-0.82**	3.37**	2.10	-0.63
P3 XP8	85.23	69.44	67.45		12.97**	5.76**	0.99	2.51*	-0.26	-2.33**	12.31*	0.70	0.86
LAI P5 X P6	3.99	1.45	1.10		1.44**	0.39*	-0.22**	0.60	0.33**	1.08*	0.00	1.48	0.00
P2 XP5	3.98	1.93	1.10		0.99**	0.13**	0.39**	0.18	0.01**	-1.80*	0.00**	1.08	0.00
P4 XP6	3.78	1.97	1.10		1.52**	0.48*	-0.22**	2.36	0.12**	4.44**	0.01	1.48	0.00

[illegible]

