

**CHARACTERIZATION OF ASIAN CORE
COLLECTION OF GROUNDNUT
(*Arachis hypogaea* L.)**

MALLIKARJUNA SWAMY, B.P.

**DEPARTMENT OF GENETICS AND PLANT BREEDING
COLLEGE OF AGRICULTURE, RAICHUR
UNIVERSITY OF AGRICULTURAL SCIENCES,
DHARWAD-580 005**

DECEMBER, 2001

**CHARACTERIZATION OF ASIAN CORE
COLLECTION OF GROUNDNUT
(*Arachis hypogaea* L.)**

Thesis submitted to the
University of Agricultural Sciences, Dharwad
in partial fulfilment of the requirements for the
Degree of

**MASTER OF SCIENCE (AGRICULTURE)
IN
GENETICS AND PLANT BREEDING**

By

MALLIKARJUNA SWAMY, B.P.

**DEPARTMENT OF GENETICS AND PLANT BREEDING
COLLEGE OF AGRICULTURE, RAICHUR
UNIVERSITY OF AGRICULTURAL SCIENCES,
DHARWAD-580 005**

DECEMBER, 2001

Released on — — — — —

14 NOV 2003

U. A. S.
University Library
LHARWAD.

Acc. No.

Th-7128

DEPARTMENT OF GENETICS AND PLANT BREEDING
COLLEGE OF AGRICULTURE, RAICHUR
UNIVERSITY OF AGRICULTURAL SCIENCES, DHARWAD

CERTIFICATE

This is to certify that the thesis entitled “**CHARACTERIZATION OF ASIAN CORE COLLECTION OF GROUNDNUT (*Arachis hypogaea* L.)**” submitted by **Mr. MALLIKARJUNA SWAMY B. P.**, for the degree of **MASTER OF SCIENCE (AGRICULTURE) in GENETICS AND PLANT BREEDING**, to the University of Agricultural Sciences, Dharwad, is a record of research work carried out by him during the period of his study in this university, under my guidance and supervision and the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar titles.

RAICHUR

December , 2001

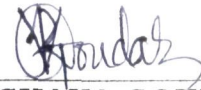


(P. V. KENCHANA GOUDAR)

Major advisor

Approved by :

Chairman:



(P. V. KENCHANA GOUDAR)

Members: 1.

_____ (H. D. UPADHYAYA)

2.

_____ (B. Y. KULLAISWAMY)

3.

_____ (H. L. NADAF)

4.

_____ (V. B. NARGUND)

5.

_____ (SOMASEKHAR)

ACKNOWLEDGEMENT

I think, it is a matter of pleasure to glance back and recall the path travelled during the days of hard work and study. I would consider this work incomplete, if I do not attend to the task of acknowledging the overwhelming help I received during endeavour of mine. Whatever, I write here can only be a deceptive reflection of the tumult of feelings that is in my heart at this moment.

At the outset, I take this opportunity to express my deep sense of gratitude to the chairman of my Advisory committee **Dr. P.V. Kenchanagoudar**, Breeder Class I, Main Research Station, (Oilseeds scheme), University of Agricultural Sciences, Dharwad for his efficient guidance, constant encouragement and above all the great affection offered to me during the course of my study and research. I just find it difficult to forget the ease with which he could induce the confidence and optimism in me through the mildest of his looks, smile and personality. I have immense pleasure to be associated with him during the course of my study.

It is my privilege to express my gratitude and heartfelt thanks to the members of my Advisory Committee, **Dr. H.D. Upadhyaya**, Senior Groundnut Scientist, ICRISSAT, Hyderabad, **Dr. B.Y. Kullaiswamy**, Professor and Head, Department of Genetics and Plant Breeding, College of Agriculture, Raichur, **Dr. H.L. Nadaf**, Groundnut Breeder (NSP and BSP Unit), Main Research Station, University of Agricultural Sciences, Dharwad, **Dr. V.B. Naragund**, Associate Professor, Department of Plant Pathology, College of Agriculture, Raichur, **Mr. Somasekhar**, Associate Professor, Department of Entomology, College of Agriculture, Raichur for their valuable suggestions and encouragement.

I owe my heartfelt thanks and gratitude to Prof. Vijaykumar, Dr. Shankergowd, Dr. Mohan Kumar, Dr. Lokesh, Associate Professors and Dr. Rajesh Patil, Assistant Professor, Subey Singh, Tomer, Senior Scientific Officers, ICRISSAT for their timely suggestions, support, and co-operation.

I would like to thank my classmates, Mukesh, Anand, Ashok, Chauhan, Bisankoppa, Chandrasekhar, Lokesh, Krishnappa, and other staff members for their help and cooperation during my research studies. I would like to thank field assistants Rachanna, Laxmi, Krishna, Sahadev for their help during my research work.

I would like to thank Chidu, Deva, Kumar, Nayeem, Arun, Manju, Prasadi, Suma, Chandra, Suni, Manja, Ashoka, Umesh, Palu, Viru, Ramachandra, Ravindra, Jaikumar,

Kongegowda. Coleman. Raghu, Soma, Girish, Deepak, Mallikarjuna. S.C. Girish, Nagaraj, Mahesh, Nagesh, Shanta for their elderly advice.

It is my esteemed duty to reserve my high regards to my parents, Prabhu Swamy, Smt. Sunandamma. Sisters Nirmala, Veena and Brother-in-law Satish, Papu Rajat, mother-in-law Nagarathnamma, brothers. Gangadhar Swamy and Shivashankar, other family members for their love, affection, inspiration and support during my study.

Finally, I wish to thank whole heartedly ANAND COMPUTERS, Dharwad for timely and neat computer typing work and Mrutyunjaya Binders for their neat binding this manuscript.

Any omission in this brief acknowledgement does not mean lack of gratitude.

December, 2001
Raichur.



(B.P. MALLIKARJUNA SWAMY)

CONTENTS

CHAPTER NO.	TITLE	PAGE NO.
I.	INTRODUCTION	1
II.	REVIEW OF LITERATURE	5
III.	MATERIAL AND METHODS	22
IV.	EXPERIMENTAL RESULTS	37
V.	DISCUSSION	85
VI.	SUMMARY	102
VII.	REFERENCES	105
	APPENDIX	118

LIST OF TABLES

TABLE NO.	TITLE	PAGE NO.
1.	Weather parameters during 20001 rainy and 2000-01 post rainy seasons at Raichur and Kawadimatti	23
2.	Recording of observations in the morphological descriptors	31
3.	Recording of observations in the vegetative and agronomical traits	34
4.	Recording of observations in the reproductive traits	35
5a.	Frequency distribution of various morphological descriptions for groundnut Asian core collection	36
5b.	Frequency distribution of different morphological descriptors	38
6.	Variance component for different vegetative and reproductive traits at Raichur and Kawadimatti during 2000 rainy and 2000-01 post rainy seasons in Karnataka	44
7.	Variance component for different vegetative and reproductive traits at Raichur and Kawadimatti during 2000 rainy and 2000-01 post rainy seasons in Karnataka	45
8.	Variance component for different vegetative and reproductive traits at Raichur and Kawadimatti during 2000 rainy and 2000-01 post rainy seasons in Karnataka	47-48
9.	Mean for different vegetative and reproductive traits at Raichur and Kawadimatti during 2000 rainy and 2000-01 post rainy seasons in Karnataka	50
10.	Median for different vegetative and reproductive traits at Raichur and Kawadimatti during 2000 rainy and 2000-01 post rainy seasons in Karnataka	51
11.	Variance for different vegetative and reproductive traits at Raichur and Kawadimatti during 2000 rainy and 2000-01 post rainy seasons in Karnataka	52

TABLE NO.	TITLE	PAGE NO.
12.	Range for different vegetative and reproductive traits at Raichur and Kawadimatti during 2000 rainy and 2000-01 post rainy seasons in Karnataka	54-56
13.	Co-efficient of variation for different vegetative and reproductive traits at Raichur and Kawadimatti during 2000 rainy and 2000-01 post rainy seasons in Karnataka	57
14.	Heritability and genetic advance for different vegetative and reproductive traits at Raichur and Kawadimatti during 2000 rainy and 2000-01 post rainy seasons in Karnataka	66
15.	Correlation among various vegetative and reproductive traits in groundnut (<i>A. hypogaea</i> spp.) core collection at Raichur during 2000 rainy season (E1)	71
15 Contd..	Correlation among various vegetative and reproductive traits in groundnut (<i>A. hypogaea</i> spp.) core collection at Raichur during 2000-01 post rainy season (E2)	72
15 Contd..	Correlation among various vegetative and reproductive traits in groundnut (<i>A. hypogaea</i> spp.) core collection at Kawadimatti during 2000 rainy season (E3)	73
15 Contd..	Correlation among various vegetative and reproductive traits in groundnut (<i>A. hypogaea</i> spp.) core collection at Kawadimatti during 2000-01 post rainy season (E4)	74
16.	Shannon-Weaver diversity indices for different vegetative and reproductive traits at Raichur and Kawadimatti during 2000 rainy and 2000-01 post rainy seasons in Karnataka	81
17.	Mean minimum and maximum diversity between different environments during 2000 rainy and 2000-2001 post rainy seasons	82
18.	Correlation co-efficients with values more than 0.701 between traits in the core collection	97
19.	Superior germplasm accessions identified for yield attributes at different environments during 2000-2001	100

LIST OF FIGURES

FIGURE NO.	TITLE	BETWEEN PAGES
1.	Weather parameters during the period of experimentation at Raichur	23-24
2.	Weather parameters during the period of experimentation at Kawadimatti	23-24
3.	Plan of layout	24
4.	Per cent frequency of different growth habits in core collection	39-40
5.	Per cent frequency of different branching patterns in core collection	39-40
6.	Per cent frequency of stem colour in core collection	39-40
7.	Per cent frequency of different stem surface nature in core collection	39-40
8.	Per cent frequency of different leaf colour in core collection	40-41
9.	Per cent frequency of leaf surface nature in different botanical varieties	40-41
10.	Per cent frequency of different leaf shapes in core collection	40-41
11.	Per cent frequency of flower colour in different botanical varieties	40-41
12.	Per cent frequency of peg pigmentation in core collection	41-42
13.	Per cent frequency of number of seeds per pod in core collection	41-42
14.	Per cent frequency of different pod beaks	41-42
15.	Per cent frequency of different pod constrictions	41-42
16.	Per cent frequency of different reticulations	42-43
17.	Per cent frequency of different primary seed colour	42-43

LIST OF ABBREVIATIONS

BOT	Botanical variety
bs	Broadsense
CV	Coefficient of variation
DAS	Days after sowing
DCF	Days to cessation of flowering
DIF	Days to initiation of flowering
DM	Days to maturity
E1	Raichur rainy
E2	Raichur post rainy
E3	Kawadimatti rainy
E4	Kawadimatti post rainy
ENT	Entry
FST	<i>Fastigiata</i>
GA	Genetic advance
h ²	Heritability
HYPO	<i>Hypogaea</i>
HYR	Hypogaea runner
HYB	Hypogaea bunch
LLN	Leaflet length
LOC	Location
LPB	Length of the primary branches
LSB	Length of the secondary branches
LWD	Leaflet width
NMP	Number of mature pods per plant
NNCB	Number of nodes on cotyledonary branches
NNMS	Number of nodes on mainstem
NPB	Number of primary branches
NPP	Number of pegs per plant
NSB	Number of secondary branches
OIL	Oil content
PLHT	Plant height
PLN	Pod length
PWD	Pod width
PYP	Pod yield per plant
r	Correlation coefficient
SE	Standard error
SEA	Season
SH	Shelling percentage
SLN	Seed length
SDWT	100-seed weight
SWD	Seed width
TNP	Total number of pods per plant

Introduction

I. INTRODUCTION

Groundnut is one of the principal economic crops of the world. In India, it ranks third among the oilseeds contributing 36 per cent of the total oil seed output (Anon, 2000). It is cultivated in the 96 countries located between 40°N to 40°S with a world production of 33.07 m.t on an area of 22.74 m.ha with a productivity of 1.33 t per ha. Of the total world production, 66.13 per cent is in Asia, 25.13 per cent in Africa, 5.93 per cent in North America, 2.62 per cent in South America and 0.3 per cent in Europe. In Asia, India accounts for 56.75 per cent of the area and 33.37 per cent of the production with a productivity of 0.91 t per ha. Other important Asian countries such as China, Indonesia, Myanmar, Thailand and Vietnam accounts for 41.26 per cent of the area and 64.72 per cent of the production with productivity ranging from 1.14 t per ha in Burma to 2.79 t per ha in China (Anon., 1999). Within India, the principal groundnut growing states are Gujarat, Andhra Pradesh, Karnataka, Tamil Nadu and Maharashtra which accounts for more than 80 per cent of the all India production as well as area.

Arachis hypogaea L. is the only peanut species to be cultivated and widely used directly for food or for its oil. *Arachis* belongs to the family *Fabaceae*, tribe *Aeschynomeneae* and sub-tribe *Stylosanthinae*. It is an allotetraploid ($2n=40$) with two genomes, A and B. It is believed to be originated in the Bolivian region of South America (Gregory and Gregory, 1976). The gene pool of cultivated groundnut is divided into two sub species *fastigiata* and *hypogaea*, with four and two botanical varieties, respectively. The subsp. *fastigiata* comprises varieties *fastigiata*,

peruviana, *aequatoriana* and *vulgaris*, whereas subsp. *hypogaea* includes varieties *hypogaea* and *hirsuta* (Krapovickas and Gregory, 1994).

For a crop improvement programme, it is pre-requisite to maintain the genetic variability to identify the promising genes in the collection and to incorporate the desired genes in the development of promising cultivar. ICRISAT gene bank contains 14880 accessions of cultivated groundnut and 450 accessions of wild *Arachis* species and are available to the national program. These accessions contain a vast reservoir of genetic variability, which would help to broaden the genetic base of the cultivars. The wild *Arachis* species which are not only excellent source of resistance to 'biotic' and 'abiotic' stresses but also provide 'new' gene for yield and yield related attributes (Guok *et al.*, 1986; Halward *et al.*, 1991).

The main aim for conservation of genetic resource is for their utilisation in crop improvement. However, generally the genetic resources are mainly used as a source of resistance to pests and diseases. The lack of information on various desirable traits available in the germplasm, their reaction to 'biotic' and 'abiotic' stresses, adaptation along with their poor agronomic potential hindered their utilisation in crop improvement (Singh and Simpson, 1994). Infact there has been fewer efforts even in identifying germplasm lines for increasing yield potential than for pests and diseases resistance and for nutritional qualities (Halward and Wynne, 1991). The yield and yield related attributes display a large genotype x environment interaction and to identify the desirable parents, it is essential to evaluate the germplasm collections at different locations in replicated trials. This is very costly

exercise and nearly impossible particularly in a view of dwindling resources. To overcome this problem Frankel (1984) proposed the strategy of core collection. A core collection is a fixed set of accessions chosen to be representative of the whole collection, which not only minimises the cost of genetic conservation but also allows rapid evaluation of the germplasm and a better access to the base population.

Frankel and Brown (1984) described the method to select a core collection using information on the origin and characters of the accessions. In setting a core collection the first issue is its size, Brown (1989a) using sampling theory of selectively natural alleles argued that the entries in a core collection should be about ten per cent of the total collection which retains nearly 70 per cent of the alleles of the entire collection. The second issue is the degree of genetic similarity among the accessions and determining groups within the entire collection, hierarchy of grouping within groups as suggested by taxonomy (species, sub species, races) followed by assessing accessions to major geographical groups (country, state), climate or agro-ecological regions. The clustering within the broad genetic group could be done using highly inherited traits. The number of accessions selected from each cluster will depend on the strategy used.

Upadhyaya *et al.* (2001) developed a core collection of groundnut for Asia region from a germplasm collection of 4738 accessions from 21 Asian countries, consisting 267 *fastigiata*, 2414 *vulgaris* and 2057 *hypogaea* types. The germplasm accessions were stratified by country of origin within each of three botanical varieties. Data on 15 morphological descriptor traits : growth habit, branching pattern stem (color, hair), leaf

(color, shape, hair), flower, streak and peg color, pod (beak, constriction, reticulation), seed (per pod; color), were used for clustering by Ward's method (Ward, 1963).

From each cluster 10 per cent accessions were randomly selected to constitute a 504 accessions core subset consisting of 29 accessions of *fastigiata*, 245 of *vulgaris* and 230 of *hypogaea* types. Newman Keul's test for mean (Newman, 1939; Keul, 1952), Levene's test (Levene, 1960) for variance, chi-square test and Wilcoxon's rank-sum nonparametric test (Wilcoxon, 1945) for distribution indicated that the available genetic variation has been preserved in the core subset. The Shanon-Weaver (Shanon and Weaver, 1949) diversity index for different traits was also similar in the entire collection and core subset. High co-occurrence rate (80.7%) and variable rate (116.9%) confirmed that the core subset is representative of entire collection. This core collection provides an effective mechanism for the proper exploitation of groundnut germplasm resources through extensive evaluation (Upadhyaya *et al.*, 2001).

In the present investigation an attempt has been made to characterize Asian core collection of groundnut for morphological, agronomic traits with the following objectives.

Objectives

1. To characterise the Asian core collection for morphological, and agronomic traits.
2. To identify the high yielding, high 100-seed weight, high shelling per cent and early maturing accessions.
3. To study the association between various traits.
4. To assess the diversity.

Review of Literature

II. REVIEW OF LITERATURE

The main aim of genetic resource maintenance and conservation is for their utilization in crop improvement. But the successful utilization of such resources requires the thorough understanding of the desirable traits available in the germplasm accessions. So the reviews pertaining to the different characters is presented in this chapter.

2.1 Morphological descriptor

2.1.1 Growth habit

Upadhyaya *et al.* (2001) compared the entire collection of 14310 accessions comprising 7668 of subsp. *fastigiata* and 6642 of subsp. *hypogaea* with the core collection of 1704 accessions comprising of 916 of subsp. *fastigiata* and 788 of subsp. *hypogaea*, no difference was found with respect to the growth habit both had the mean value of 4.6 for the morphological descriptor.

Upadhyaya *et al.* (2001) reported that among the cultivated peanut germplasm at ICRISAT, Patancheru, maximum number of accessions showed procumbent type of growth habit and erect type was observed in minimum number of accessions while decumbent type was noticed in average number of accessions.

2.1.2 Branching pattern

Gibbons *et al.* (1972) devised a system of classification based on branching pattern, subsp. *hypogaea* is characterized by alternate branching and subsp *fastigiata* sequentially branched.

2.1.3 Stem pigmentation

Bhagat *et al.* (1985) evaluated groundnut germplasm collection of 4030 accessions for nine morphological characters, which consisted of 1290 accessions of var. *vulgaris*, 651 of var. *fastigiata*, 1040 of var. *hypogaea* (bunch) and 1049 of var. *hypogaea* (runner). At maturity 191 accessions of var. *vulgaris*, 128 of var. *fastigiata*, 831 of var. *hypogaea* (bunch) and 1061 accessions of var. *hypogaea* (runner), had no stem pigmentation. While, 1099 accessions of var. *vulgaris*, 523 of var. *fastigiata*, 209 of var. *hypogaea* (bunch) and 33 accessions of var. *hypogaea* (runner) showed stem pigmentation.

2.1.4 Stem surface

Among the cultivated peanut germplasms studied by Upadhyaya *et al.* (2001), stem hair varied between glabrous to wooly, with an intermediate value for the hairy and very hairy type.

2.1.5 Leaf characters

Mital and Mehta (1951) reported that subsp. *hypogaea* var. *hypogaea* was characterized by dark green leaves, while that of subsp. *fastigiata* by light green in colour.

Bunting (1955) observed that variation between shape, size and hairiness between leaflets of the same variety and even of the same plant was as great as any variation which may appear between types. Foliage of subsp. *hypogaea* was dark green in colour and that of subsp. *fastigiata* light green in colour (Gibbons *et al.*, 1972).

Varisai Muhammad *et al.* (1973a) studied 691 genotypes for morphological traits and reported that, leaf colour varied from pale green (A.h. 6742) to dark green (A.h. 7008), light green in A.h.32 and green in

A.h. 7048, a Mexican variety (A.h.7705) showed characteristic bluish green foliage. The leaflet shape varied from oblong elliptic (A.h.35) to elliptic obovate (A.h.6954).

Rajgopal *et al.* (1991) noticed that the average values for all the different leaf characters were highest in var. *fastigiata* and lowest in var. *hypogaea* type, but all characters showed continuous variation.

Among the different leaf characters studied by Chandran and Pandya (2000) in 35 *Arachis* accessions belonging to 13 different species, leaflet shape varied from linear-lanceolate to lanceolate in different wild species and suborbicular in ICG 8209, in others leaflets were either obovate or oblong. Leaves were generally free from hairs except for *A. diogi*, *A. xempff-mercadoi* and *A. duranensis* which had hairs on both the surfaces.

2.1.6 Flower colour

In a comparative study of world collection of 14130 accessions of groundnut with its core collection of 1704 accessions, flower colour showed non-significant difference, both had the mean value of 4.95 for this descriptor (Upadhyaya *et al.*, 2001).

2.1.7 Peg colour

Out of 4030 accessions studied, 21 of var. *vulgaris*, ten of var. *fastigiata*, 100 of var. *hypogaea* (bunch) and 44 of var. *hypogaea* (runner) had no peg pigmentation. While 1269 accessions of var. *vulgaris*, 641 of var. *fastigiata*, 932 of var. *hypogaea* (bunch) and 1005 of var. *hypogaea* (runner) showed peg pigmentation (Bhagat *et al.*, 1985).

Upadhyaya *et al.* (2001) studied the variability in peanut germplasm collection, most of the accessions had peg pigmentation.

2.1.8 Number of seeds

In 75 accessions of groundnut belonging to different sub species, number of seeds per pod varied between 1.5-3.5 with mean value of 2.3 and CV of 20 per cent (Retnal *et al.*, 1990).

Yield components analysis of 125 *fastigiata* bunch type by Pathirana (1993) revealed that the number of seeds per pod varied between 1.1-2.8 with a mean of 1.6. It showed significant association with seed yield ($r = 0.215$) and shelling percentage ($r = 0.417$).

2.1.9 Pod beak

Bhagat *et al.* (1985) evaluated 4030 accessions belonging to four different botanical varieties. In var. *vulgaris*, no pod beak in 244, slight in 810, moderate in 187 and prominent beak in 49 accessions were observed. Among the 651 accessions of var. *fastigiata*, 11 accessions had no beak, 272 had slight, 356 had moderate and 42 accessions had prominent beak. In var. *hypogaea* (bunch) 132 accessions without beak, 635 with slight beak, 237 with moderate and 36 with prominent beak and in case of var. *hypogaea* (runner) 94 accessions without beak, 243 with moderate and 15 with prominent beak was reported from a sub species total of 2089 accessions.

Morphological characterization of 1089 accessions comprising of 578 valencia type (subsp. *fastigiata* var. *fastigiata*) and 511 virginia type (subsp. *hypogaea* var. *hypogaea*) by Rajgopal *et al.* (1997) revealed that in var. *hypogaea* type 310 accessions showed slight beak and 92 accessions had moderate beak. While, in var. *fastigiata* 339 accessions had slight and 130 accessions had moderate beak.

2.1.10 Pod constriction

Esquivel *et al.* (1993) studied 130 accessions of groundnut comprising 84 of var. *fastigiata*, 30 of var. *vulgaris* and 16 of var. *hypogaea* in all the three botanical varieties, predominantly slight constriction was noticed.

As observed by Rajgopal *et al.* (1997) in a germplasm collection of 1089 accessions comprising 578 *fastigiata* and 511 *hypogaea* types. In var. *hypogaea* slight constriction was observed in 309 accessions, moderate constriction in 158 accessions and in var. *fastigiata*, 256 accessions showed slight constriction and in 194 moderate constriction was noticed.

2.1.11 Pod reticulation

Varisai Muhammad *et al.* (1973) observed that in almost all Valencia genotypes pod reticulation was not distinct. While, it was distinct in virginia genotypes.

Diversity estimation in Australian germplasm collection indicated that, it was dominated by slight to moderate reticulation (Harch *et al.*, 1995).

Chandran and Pandya (2000) characterised 35 accessions of *Arachis* in which *A. validata* and *A. monticola* accessions had the prominent reticulation and ICG 8198, ICGS 8205, ICGS 8201, ICGS 8957 had smooth to moderate reticulation.

2.1.12 Primary seed colour

Study conducted by Rajgopal *et al.* (1997) on morphological characterization of 578 accessions of var. *fastigiata* and 511 accessions

of var. *hypogaea* indicated that, as many as 12 primary seed colours were found among the *fastigiata* and ten among *hypogaea* type. The variation in seed colour ranged from off white to blackish purple in 353 (61%), salmon in 91 (15.7%), dark red in 38 (6.6%) and dark purple in 35 (6%), purple was recorded in 32 (5.5%) accessions remaining were represented by rose, light purple, light red, tan, off white and variegated ranging from 0.2-1.6%. On the other hand rose seed colour was predominated in var. *hypogaea* accessions 424 (83.0%), followed by salmon in 44 (8.6%), red in 17 (3.3%) and dark red in nine accessions (1.6%). The other seed colours light red, off white, tan and variegated ranged from 0.2-1.2 per cent.

Upadhyaya *et al.* (2001) studied the primary seed colour in the cultivated peanut germplasm collection, dark purple predominated the collection, with yellow, shades of tan, rose, shades of red, grey and orange, shades of purple in average number of accessions, while off white was the least noticed.

2.2 Vegetative traits

2.2.1 Leaflet length and leaflet width (cm)

Bhagat *et al.* (1985) studied 4030 accessions belonging to three botanical varieties viz., *vulgaris*, *fastigiata* and *hypogaea*. Leaflet length varied from 3.30 to 7.43 cm ($\bar{X} = 5.85$) in var. *vulgaris*, 2.83 to 8.3 cm ($\bar{X} = 6.03$) in var. *fastigiata*, 2.27 to 7.7 cm ($\bar{X} = 4.5$) in var. *hypogaea* (bunch) and 2.50 to 7.53 cm ($\bar{X} = 4.62$) in var. *hypogaea* (runner) and leaflet width varied from 1.5 to 3.8 cm ($\bar{X} = 2.56$) in var. *vulgaris*, 1.6 to 3.4 cm ($\bar{X} = 2.51$) in var. *fastigiata*, 1.13 to 3.3 cm ($\bar{X} = 2.03$) in var.

hypogaea (bunch) and from 1.10 to 3.47 cm ($\bar{X} = 2.04$) in var. *hypogaea* (runner).

Swamy Rao *et al.* (1988) evaluated 208 accessions belonging to two subsp. *hypogaea* and *fastigiata*, in which the leaflet length ranged from 4.05 to 6.40 cm ($\bar{X} = 5.42$) with CV of 8.65 per cent, heritability (bs) of 18.0 per cent and genetic advance of 0.19 while leaf let width varied between 1.85-3.25 cm ($\bar{X} = 2.54$) with CV of 11.13 per cent, heritability (bs) of 14.58 per cent and genetic advance of 0.09.

Upadhyaya *et al.* (2001) found a non-significant difference between entire collection of 14130 accessions and a core collection of 1074 accessions with respect to leaflet length and width.

2.2.2 Plant height (cm)

In a study carried out by Varisai Muhammad *et al.* (1973a) on 691 accessions belonging to different growth habits revealed that plant height exhibited wide range of variation from 16-55 cm in bunch, 10-13 cm in semi spreading, 10-35 cm spreading type and a characteristic tall stature of 41-55 cm was noticed in four accessions viz., A.h. 7205, A.h. 7439, A.h.7559 and A.h.7444.

Swamy Rao *et al.* (1988) studied 208 accessions belonging to two sub species viz., *hypogaea* and *fastigiata* in which plant height varied from 13.90 cm to 32.25 cm ($\bar{X} = 22.23$) with a co-efficient of variation of 10.47 per cent and heritability (bs) of 42.27 per cent and genetic advance of 3.12. They observed that a significant positive genotypic correlation with leaflet length ($r = 0.936$), leaflet width ($r = 0.835$) and pod yield ($r = 0.440$).

Characterization of 35 accessions belonging to 13 different species by Chandran and Pandya (2000) indicated that plant height varied from 7.0 cm (ICG 8164) to 25 cm (ICG 5813) with a mean of 13.3 cm and coefficient of variation of 29.2 per cent.

2.2.3 Number of nodes on the main stem

Among the 35 accessions of *Arachis* belonging to 13 different species, number of nodes on the main stem ranged from 5.0 (ICG 8164) to 17.0 (ICG 8139) with a mean of 9.6 per plant (Chandran and Pandya, 2000).

2.2.4 Number and length of the primary branches

Kulkarni and Albuquerque (1967) reported 89 per cent phenotypic coefficient of variation (PCV) for number of primary branches, while Dixit *et al.* (1970) reported 13.63-21.15 of PCV in subsp. *fastigiata* and 6.25-25.75 in subsp. *hypogaea*. Number of primary branches was positively associated with yield (Khanguru and Sandhu, 1972; Chandola *et al.*, 1973).

In different growth habit groundnut accessions studied by Varisai Muhammad *et al.* (1973a) primary branch length varied between 16-20 cm in erecta, 10-50 cm in bunch type, 16-45 cm in semi spreading and 21-25 cm in spreading type, respectively.

Vindhiyavarman and Raveendran (1989) in a correlation study of 50 accessions (37 *vulgaris*, two *fastigiata* and one *hypogaea*) observed that the number of primary branches were positively associated with number of pods ($r = 0.287$), while, length of the primary branches associated with pod yield ($r = 0.406$).

The variability study of 50 accessions of subsp. *hypogaea* var. *hypogaea* showed a significant variation with range of 5.25 to 8.50 ($\bar{X} = 6.98$), heritability (bs) of 39.96 per cent and genetic advance of 0.84 for the number of primary branches (Vaddoria and Patel, 1990).

2.2.5 Number and length of the secondary branches

As reported by John *et al.* (1954) production of numerous secondary branches is the character of var. *hypogaea*, in contrast to the limited number of secondary branches in var. *fastigiata*.

Dixit *et al.* (1970) recorded 44.44 to 68.08 per cent genotypic coefficient of variation (GCV) in var. *fastigiata* and 32.43 to 35.80 per cent GCV in var. *hypogaea* and a genetic advance of 4.9 to 9.31 for var. *fastigiata* and 4.85 to 9.23 for var. *hypogaea* was noticed.

A significant positive correlation of pod yield with the number of secondary branches was observed in var. *hypogaea* (Tripathi *et al.*, 1974). In contrast to this a negative correlation was observed between pod yield and number of secondary branches (Chandola *et al.*, 1973). While, Gosh and Dasgupta (1975) concluded that high yielding plants tend to produce profuse secondary branches.

Association of different characters studied by Vindhiya varman and Raveendran (1989) in different botanical varieties revealed, that a significant positive genotypic correlation ($r = 0.406$) between number of secondary branches and pod yield. A significant contribution Secondary branches (31%) to the total divergence was reported by Reddy and Reddy (1992).

2.2.6 Length of the cotyledonary branches and number of nodes on it

Study conducted by Chandran and Pandya (2000) in 35 accessions from 13 different species revealed that length of the cotyledonary branches varied from 7.3 (ICG 8126) to 71.5 cm (ICG 8205) with a mean of 33.4 cm and CV of 44.7, while number of nodes varied between 5.0 (ICG 8126) to 28 (ICG 8139) with a mean of 14.6 cm and CV of 30.1.

2.3 Reproductive traits

2.3.1 Days to initiation of flowering

Initiation of flowering varied between 21-26 DAS in bunch type, 21-30 DAS in semi spreading type, 24-29 DAS in spreading and 26-30 DAS in erect type (Varisai Muhammad *et al.*, 1973a).

In groundnut flowering commences from 20-30 days after emergence depending on the environmental conditions, at 30°C they flowered 25 DAS in subsp. *hypogaea* and 24 DAS in subsp. *fastigiata* (Ono, 1979). While, a report of flowering between 24-30 DAS in subsp. *hypogaea* var. *hypogaea* was made by Omaran *et al.* (1980).

2.3.2 Days to cessation of flowering

Shibuya (1935) observed that flowering was ceased between 69 to 73 days after sowing (DAS) in var. *fastigiata* and 75 DAS in var. *hypogaea*. Cessation of flowering 70-75 DAS in var. *hypogaea* was reported by Smith (1950). Divekar (1961) visualized that flowering ceased within 20 days after initiation in var. *vulgaris*.

2.3.3 Days to maturity

Mital and Mehta (1954) noticed that var. *hypogaea* is characterized by medium to late in maturity whereas, var. *fastigiata* late in maturity. In

contrast to this the accessions belonging to both the subspecies matured in 115 DAS (Labana and Mohinder Singh, 1979). While, Rao and Mwenda (1987) observed that most of the genotypes belonging to var. *fastigiata* harvested within 120 DAS. :

Vaddoria and Patel (1987) observed that days to maturity varied from 116 to 137 DAS with mean of 126.90, heritability (bs) of 97.86 per cent and genetic advance of 15.89.

Pathirana (1993) analysed the various yield components in 125 accessions of var. *fastigiata* maturity was varied between 81-123 DAS ($\bar{X} = 104$). Among the Greek groundnuts characterized by Kotzamanidis and Starvoropoulos (1998) Serraiiki, Sakania Sandhu and Paoria were early in maturity.

2.3.4 Number of pegs per plant

Among 206 genotypes belonging to different growth habits studied, A.h.6919 and A.h.811 showed a significant flowering to peg ratio of 61.2 and 60.0, respectively (Varisai Muhammad and Stephendorairaj, 1969).

Bhagat *et al.* (1984) evaluated 51 accessions of two subspecies *hypogaea* and *fastigiata*, in which number of pegs varied from 6.3 to 18.6 in all bunch type of two sub species with a mean of 4.1, 4.0 and 6.7 in var. *vulgaris*, var. *fastigiata* and var. *hypogaea*, respectively whereas, in virginia runner types belonging to subsp. *hypogaea* var. *hypogaea* number of pegs ranged from 6.8 to 17.9 with a mean of 3.75.

Evaluation of 208 accessions belonging to two sub species, *hypogaea* and *fastigiata* revealed that, number of pegs varied from 5.0 to 38.0 ($\bar{X} = 15.77$) with CV of 27.72 per cent and a significant positive

correlation was noticed with number of mature pods ($r = 0.927$), while, negative correlation of ($r = 0.5907$) was observed with peg to pod ratio (Swamy Rao *et al.*, 1988).

2.3.5 Total number of pods

In 315 accessions of var. *vulgaris* a significant positive correlation between number of pods per plant and yield per plant ($r = 0.63$) was observed by Liqo *et al.* (1989) and they suggested that pod yield can be improved by increasing number of pods per plant.

Number of pods per plant in 130 accessions comprising 84 of var. *fastigiata*, 30 of var. *vulgaris* and 16 of var. *hypogaea* varied between 11.00 to 33.80 ($\bar{X} = 20.50$) with CV of 27.64 per cent in var. *hypogaea*, from 9.8 to 60.16 ($\bar{X} = 33.17$) with CV of 31.30 per cent in var. *vulgaris* and 6.0 to 68.0 ($\bar{X} = 31.66$) with CV of 27.89 per cent in var. *fastigiata* (Esquivel *et al.*, 1993).

Among 125 accessions of groundnut belonging to the subsp *fastigiata*, number of pods per plant varied from 11.8 to 37.4 with a mean of 23.5 and a significant association with seed yield ($r = 0.92$) and with shelling percentage ($r = 0.225$) was observed (Pathirana, 1993).

Kotzamanidis and Starvoropoulos (1998) observed that among the different Greek groundnut germplasm lines Trangena, Ispaniki and Proimi-Funtoti showed high pod concentration.

2.3.6 Total number of mature pods

Varisai Muhammad and Stephendorairaj (1969) observed that in 206 genotypes belonging to different growth habits, A.h.7336 and A.h.

811 showed significant total pods to mature pods ratio of 91.7 and 85.7, respectively. While, highest pod number of 44.28 per plant was reported in case of subsp. *hypogaea* var. *hypogaea* (Ali, 1984).

In 50 accessions of var. *hypogaea*, Vaddoria and Patel (1990) reported that number of mature pods ranged from 13.25 to 24.75 ($\bar{X} = 21.31$) with heritability of (bs) 69.87 per cent and genetic advance of 3.68 genetic advance. Katule *et al.* (1992) noticed that A.h. 7149 had the highest number of mature pods.

2.3.7 Pod yield (g)

Phandis *et al.* (1973) held that pod yield was positively correlated with the number of pods per plant.

Bhagat *et al.* (1984) found that among 51 accessions of different botanical varieties pod yield per plant ranged from 2.2 to 8.1 g per plant in all bunch types with mean of 5.7, 4.1 and 4.1 in var. *vulgaris*, var. *fastigiata* and var. *hypogaea*, respectively. On the other hand in runner type belonging to subsp. *hypogaea* var. *hypogaea* it varied from 1.5 to 11.6 with pod yield of 3.6 g per plant.

Correlation study of 50 accessions comprising 37 of var. *vulgaris* two of var. *fastigiata* and 11 of var. *hypogaea* revealed that, pod yield was positively associated with height of the main stem (0.7562) followed by length of the primaries (0.7532) (Vindhya Varman and Raveendran, 1984).

In a collection of 208 accessions from two sub species viz., *hypogaea* and *fastigiata*, pod yield ranged from 1.85 to 11.28 g per plant

($\bar{X} = 6.74$), with a V of 2.09 and heritability (bs) of 13.52 per cent with genetic advance of 0.66 (Swamy Rao *et al.*, 1988).

2.3.8 Shelling percentage

Ramanathan and Raman (1968) reported that shelling out turn is significantly and positively correlated with pod weight, kernel weight and filling of kernels. But Mital and Mehta (1954) did not find any relationship between shelling out turn and seedsize in both the sub species *fastigiata* and *hypogaea*.

Among the groundnut genotypes of different growth habits studied by Varisai Muhammad *et al.* (1973a), shelling percentage ranged from 61.6 to 62.3 per cent in bunch type and 60.0 to 81.5 per cent in semi spreading type and from 62.1 to 83.6 per cent in spreading types. In an evaluation of 672 genotypes comprising 234 of bunch type, 170 of semi spreading type and 268 of spreading type, Natarajan *et al.* (1978) reported that shelling percentage ranged from 61.6 to 62.3 per cent in bunch type, 60.0 to 81.5 per cent in semi spreading, and 62.1 to 83.6 per cent in spreading type, respectively.

2.3.9 Hundred seed weight

Natarajan *et al.* (1978) evaluated 672 accessions having different growth habits, in semi spreading type 100-seed weight range of 29.4 to 80.8 g ($\bar{X} = 51.21$) with CV of 9.98 per cent, from 26.2 to 57.5 g ($\bar{X} = 37.3$) in bunch type with CV of 14.65 per cent and in spreading type it was from 22.9 to 27.3 g ($\bar{X} = 44$) with CV of 9.11 per cent.

Esquivel *et al.* (1993) characterized 130 accessions of different botanical varieties. The 100-seed weight ranged from 33.7 to 92.09

($\bar{X} = 58.12$) with a CV of 32.77 per cent in subsp. *hypogaea* from 33 to 100 g ($\bar{X} = 44.37$) with CV of 28.09 per cent in var. *vulgaris*, and from 24.70 to 81.3 ($\bar{X} = 44.19$) with a CV of 15.17 per cent in var. *fastigiata*.

Holbrook *et al.* (1993) compared the germplasm collection of 7432 accessions with its core collection of 831 accessions for 100 seed weight, non significant difference was observed they had the mean value of 50.81 and 51.46 g, respectively.

2.3.10 Pod length and pod width (cm)

Varisai Muhammad *et al.* (1973a) studied length and width of two kernel pods and it was observed that pods were very small in erecta (<1.5 cm) and semi spreading variety possessed big (2.6-3.0 cm) to very big pods (3.1-4.0 cm).

Retnal *et al.* (1990) evaluated 75 accessions of different sub species and reported that pod length ranged from 1.81 to 5.82 cm ($\bar{X} = 3.14$) with CV of 21.9 per cent, whereas the pod width varied from 0.93 to 1.9 cm ($\bar{X} = 1.36$) with CV of 13.2 per cent.

Chandran and Pandya (2000) characterized 35 wild *Arachis* accessions in which pod length and pod width ranged from 2.86 to 3.6 cm ($\bar{X} = 1.46$) and 0.46 to 1.52 ($\bar{X} = 0.68$) with CV of 43.4, 36.3 per cent, respectively.

2.3.11 Seed length and seed width (cm)

A morphological study of 75 accessions from different botanical varieties by Retnal *et al.* (1990) revealed that seed length varied from 0.97 to 2.07 cm while, seed width ranged from 0.68 to 1.04 cm ($\bar{X} = 0.85$) with a CV of 7.2 per cent.

Report of Esquivel *et al.* (1993) on 130 accessions of peanut belonging to different botanical varieties indicated that seed length varied from 1.02 to 2.01 cm ($\bar{X} = 1.34$) with CV of 12.65 per cent and seed width varied from 0.73 to 1.10 cm ($\bar{X} = 0.83$) with CV of 7.74 per cent .

In a study conducted by Singh *et al.* (1996) the seed length ranged from 0.8 to 1.6 cm ($\bar{X} = 1.13$) with a CV of 1.92 per cent. Whereas, seed width varied between 0.38 to 0.8 cm ($\bar{X} = 0.53$) with CV of 19.2 per cent.

2.3.12 Oil content (%)

Luan and Han (1990) analysed the oil content of 379 different genotypes of which 38 had the oil content of more than 50 per cent and six had more than 53 per cent. An oil content of 42.2-52.3 per cent was reported by Jiao *et al.* (1993). A wide range of 42.5 to 54.5 per cent oil content was noticed by Misra *et al.* (1992). While, in 50 accessions of var. *hypogaea* oil content ranged 46.9 to 49.5 per cent ($\bar{X} = 48.20$) with GCV of 1.28 per cent, heritability (bs) of 84.19 per cent and genetic advance of 1.17 (Vaddoria and Patel, 1990).

Range of variation in cultivated groundnut observed at ICRISAT Centre

Character	Minimum	Maximum	Intermediates
Growth habit	Erect	Procumbent	Decumbent
Branching pattern	Sequential	Alternate	Irregular
Stem pigmentation	Absent	Present	-
Stem hairiness	Glabrous	Woolly	Hairy, very hairy
Peg color	Absent	Present	-
Leaf color	Yellowish green	Dark green	Light green, green
Leaflet length	17 mm	94 mm	Continuous
Leaflet width	7 mm	52 mm	Continuous
Leaflet shape	Cuneate	Lanceolate	Obcuneate, elliptic
Hairiness of leaflet	Sub glabrous	Profuse and long	Scarce and short, scarce and long, profuse and short
No. of seed/pod	1	5	2, 3, 4
Pod beak	Absent	Prominent	Slight moderate
Pod constriction	Absent	Very deep	Slight moderate, deep
Pod reticulation	Smooth	Prominent	Slight, moderate
Pod length	14 mm	65 mm	Continuous
Pod width	7 mm	20 mm	Continuous
Seed color	Off white	Dark purple	Yellow, shades of tan, rose shades of red, grey-orange, shades of purple
Seed length	4 mm	23 mm	Continuous
Seed width	5 mm	13 mm	Continuous
100- seed weight	14 g	136 g	Continuous
Days to maturity	75 days	>155 days	Continuous
Oil content	31.8%	55%	Continuous

(Singh *et al.*, 1992)

Material and Methods

III. MATERIAL AND METHODS

Field experiments were conducted to characterize the Asian core collection of groundnut during 2000 rainy and 2000-2001 post rainy seasons at two locations. The details of the material used and method adopted during the course of investigation are described in this chapter.

3.1 Experimental site

Experiments were conducted at Regional Research Station, Raichur and Agricultural Research Station, Kawadimatti. The soil was red sandy loam with a pH of 6.5-7.0 at Raichur and sandy in Kawadimatti with a pH of 7.0. Geographically both Raichur and Kawadimatti comes under North-Eastern Dry Zone-2 of Karnataka, Raichur is located at 16°15' N latitude and 71°21'E longitude with an altitude of 389 m whereas Kawadimatti is located at 15°45'N latitude 76°52'E longitude with an altitude of 432 m.

3.2 Climatic conditions

During the period of experimentation Raichur received a total rainfall of 622.9 mm and Kawadimatti received 319 mm, with a maximum and minimum mean temperature of 39°C (March), 11°C (December) and 38.3°C (March), 14.3°C (December), respectively at Kawadimatti and Raichur. The weather parameters during the period of experimentation are presented in Table 1, Fig. 1 and 2.

3.3 Experimental material

The material for the present investigation comprised of 504 germplasm accessions of Asian core collection of groundnut (*Arachis*

Table 1 : Weather parameters during 20001 rainy and 2000-01 post rainy seasons at Raichur and Kawadimatti

Month	Raichur			Kawadimatti		
	Rainfall (mm)	Temperature (°C)		Rainfall (mm)	Temperature (°C)	
		Maximum	Minimum		Maximum	Minimum
June, 2000	125.80	34.3	23.2	12.5	34.0	22.0
July,	117.80	31.7	23.4	41.3	34.0	21.0
August	180.70	32.2	22.3	65.7	33.6	21.0
September	87.40	32.8	22.2	73.5	33.2	20.0
October	111.20	32.4	21.1	101.0	32.0	18.0
November	0.00	31.9	18.9	0.0	31.8	16.0
December	0.00	30.6	14.3	0.0	31.0	11.0
January, 2001	0.00	31.6	16.5	0.0	33.0	13.0
February	0.00	36.0	17.4	0.0	38.0	13.0
March	0.00	38.3	22.4	0.0	39.0	17.0
April	0.00	38.6	23.5	25.0	39.0	21.0
May	0.00	33.5	21.6	0.0	35.0	24.0
June	0.00	33.2	22.5	0.0	33.0	24.0
July	0.00	33.0	20.3	0.0	29.0	20.0

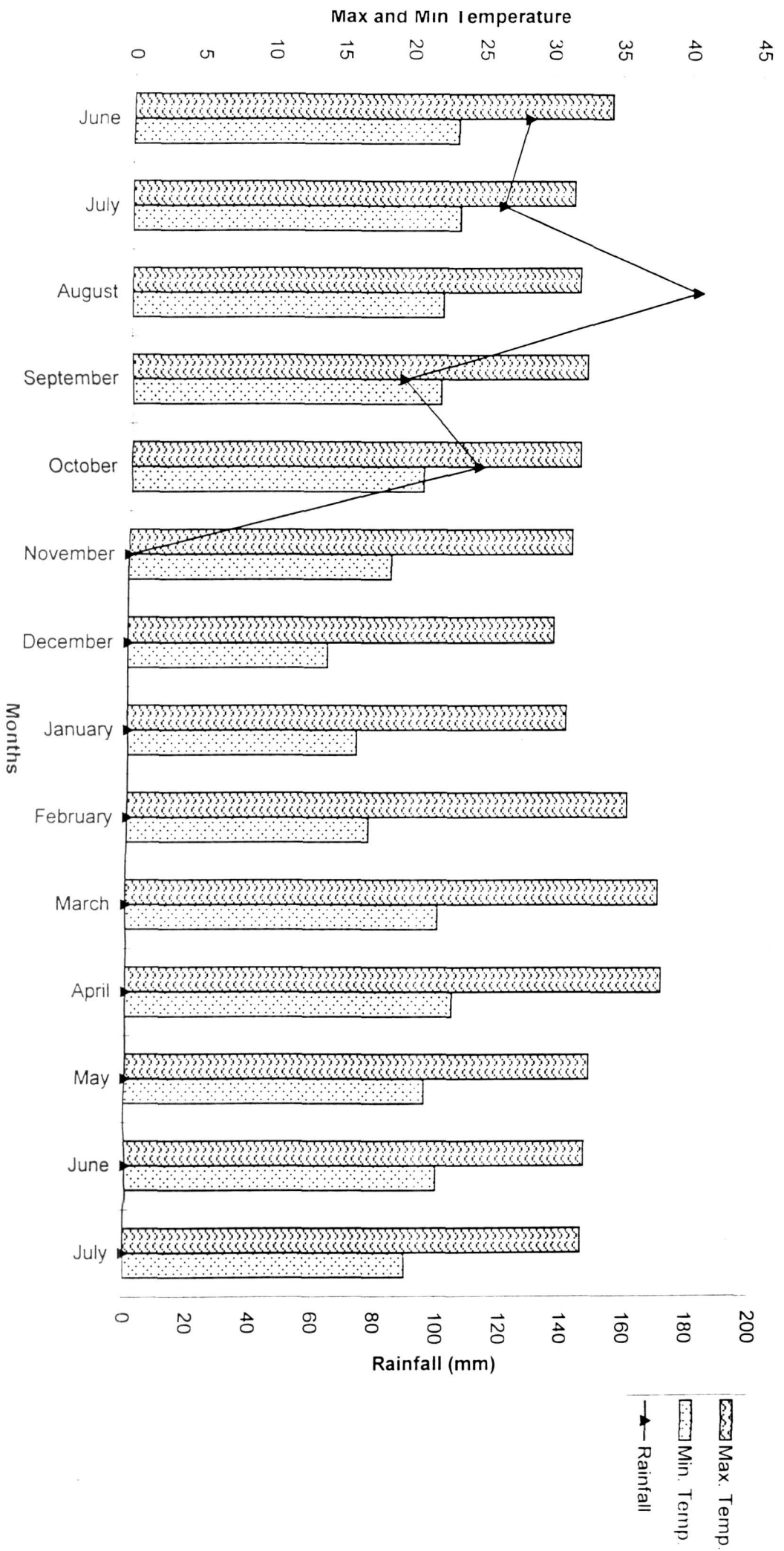


Fig. 1. Weather parameters during the period of experimentation at Raichur.

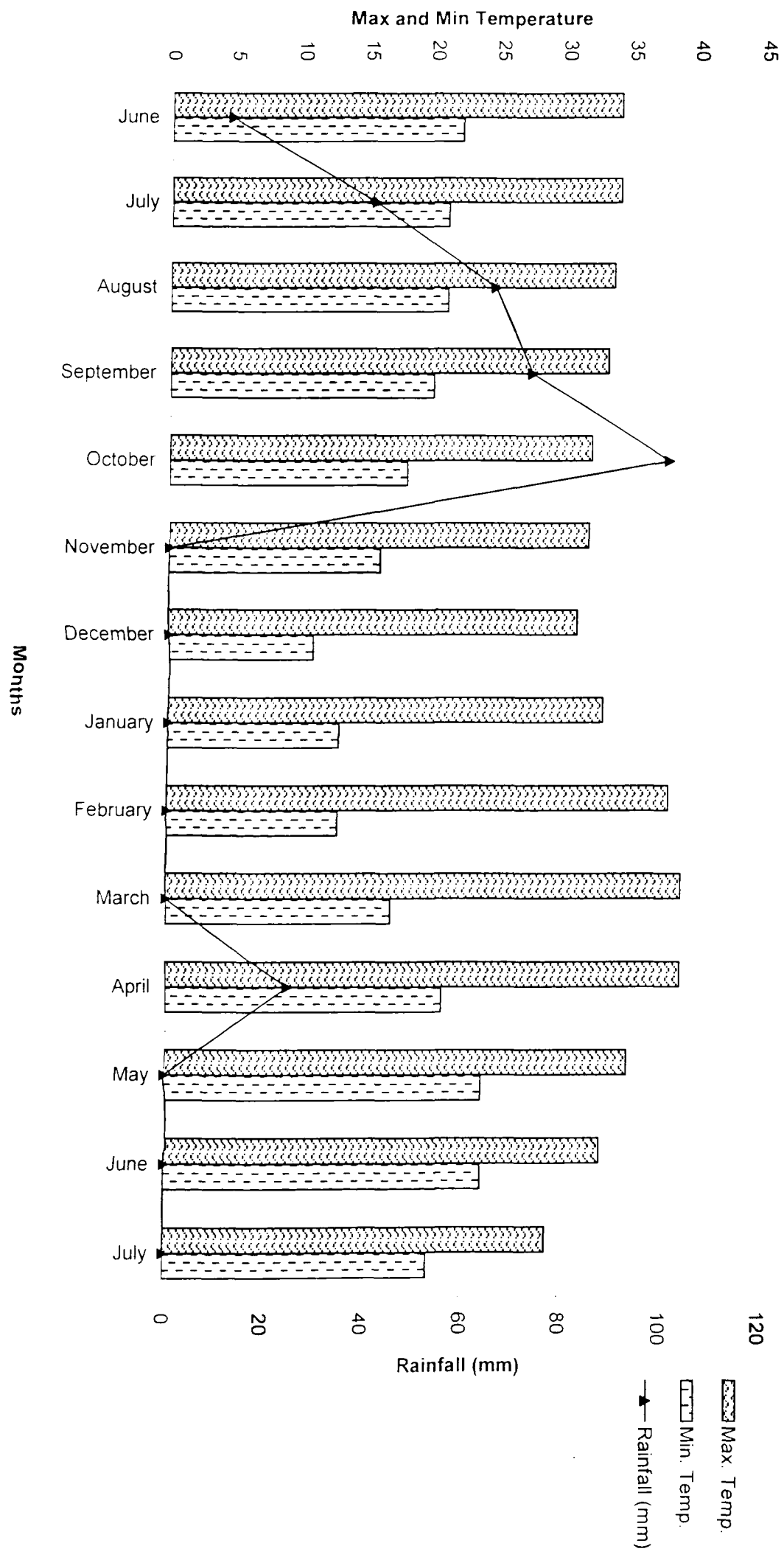


Fig. 2. Weather parameters during the period of experimentation at Kawadimatti.

hypogaea L.) (Upadhyaya *et al.*, 2001) and four checks viz., S 230, Gangapuri, ICGS 44 and ICGS 76. The core collection comprised of 29 accessions of var. *fastigiata*, 230 accessions were of var. *hypogaea*, and 245 of var. *vulgaris* type. The material was obtained from the Genetic Resource Unit of ICRISAT.

3.4 Design and layout

The experiment was laid out in augmented design with block size of 18 m x 4 m. There were 14 blocks with an area of 1260 m². The checks were repeatedly used after every ten accession in such a way that each appeared only once in each block.

Blocks	Entries
14	560 ← 521
13	481 → 520
12	480 ← 441
11	401 → 440
10	400 ← 361
9	321 → 360
8	320 ← 281
7	241 → 280
6	240 ← 201
5	161 → 200
4	160 ← 121
3	81 → 120
2	80 ← 41
1	1 → 40

Fig. 3. Plan of layout.

3.5 Cultural operations

3.5.1 Land preparation

Land was ploughed with tractor after harvest of the previous crop and harrowed twice to crush the clods and smoothed to get a fine tilth.

3.5.2 Manure and fertilizer application

10-12 tonnes of farm yard manure , 25 Kg N, 75 Kg P_2O_5 and 25 kg K_2O of Ammonium sulphate, single super phosphate and muriate of potash, respectively was applied at the time of sowing in band placement, 5 cm away and 5 cm deep from the seedline, 500 Kg of gypsum per ha was applied at the time of pegging.

3.5.3 Seeds and sowing

The seeds were treated with 0.2 per cent ethryl to overcome possible effects of seed dormancy. Shallow furrows were opened at 40 cm apart with the help of pick-axe. The seeds were dibbled (hand sown) uniformly in the furrows and was covered with moist soil immediately after sowing, sowing was taken up on 19.7.2000 and 8.8.2000 of rainy season at Kawadimatti and Raichur, respectively. While, in post-rainy season sowing was taken up on 26.1.2000 and 3.2.2000 at Raichur and Kawadimatti, respectively.

3.5.4 After care

The optimum plant population was maintained by taking up gap filling within two weeks after sowing. Hand weeding was carried out twice at 20 and 35 DAS. Earthing up was taken up to make provision for easy penetration of the pegs into soil and for better pod development, sorghum

extract spray was taken against bud necrosis, monocrotophos- 1.0 ml per litre against thrips and aphids, Bavistin 0.5 g per litre against leaf spot disease were taken.

3.5.5 Irrigation

Immediately after sowing irrigation was given and further irrigations were given based on the rainfall and the availability of water. In rainy season three irrigations were given and in post-rainy season eight irrigations were given.

3.6 Harvesting

Crop was harvested when the plants in an accession attained the maturity as indicated by the Hull scrape method.

3.7 Collection of data

Observations were recorded on 38 characters in all the entries (Table 2).

3.8 Sampling procedure

In all the entries five random competitive plants were used for recording the observations such as morphological (Table 2), vegetative (Table 3) and reproductive traits (Table 4).

3.9 Statistical analysis

3.9.1 Range

It is a simple measure of variability. The difference between the maximum and minimum value observed for a character, Range (Panse and Sukhatme, 1967).

3.9.2 Mean

It is a measure of central tendency. The arithmetic average of the number of observations.

$$\bar{X} = \frac{\sum x_i}{n}$$

Where,

$$\bar{X} = \text{Mean}$$

$\sum x$ = sum of all the observation

n = number of observation.

3.9.3 Test of mean

Means of the different character at different environments and botanical variety wise over the environments and across the botanical varieties were compared using Newman Keul's test (Newman, 1939; Keul, 1952).

3.9.4 Median

It is the central most value, when the observations are arranged ascendingly or in descending order.

3.9.5 Test of median

Median test was performed to know the deviations of the quantitative characters over the environments and also botanical variety wise over the environments and also across the botanical varieties.

3.9.6 Variance

It is a measure of deviations from the mean. The arithmetic average of the squared deviations taken from the mean is called as variance.

$$\text{Variance} = \frac{\sum (X_i - \bar{X})^2}{n-1}$$

Variances of all the quantitative characters over the environments and botanical variety wise over the environments and across the botanical varieties were compared using Levene's test of homogeneity of variance (Levene, 1960). The test gives an idea about the significant difference of variances at different environments. This was done by using Statsoft Statistical programme (Anon., 1997).

3.9.8 Co-efficient of variation

It is estimated as the ratio between standard deviation to mean expressed as percentage.

$$CV = \frac{\sigma}{\bar{X}} \times 100$$

Where,

σ = Phenotypic standard deviation

\bar{X} = Mean.

3.9.9 Analysis of variance

Variance component were estimated for all the traits at four environments separately, in combination and considering botanical varieties also using Residual Maximum Likelihood (REML) analysis (Robinson, 1987) in Genstat computer program (Anon., 1993).

3.9.10 Estimation of genetic parameters

In order to assess and quantify the genetic variability of the groundnut various genetic parameters were estimated which are given below.

3.9.10.1 Heritability

Heritability in broadsense was calculated as ratio between genotypic variance to phenotypic variance.

$$h^2_{bs} (\%) = \frac{V_g}{V_p} \times 100$$

Where,

V_g = Genotypic variance

V_p = Phenotypic variance

3.9.10.2 Genetic advance

It was calculated using the model given by Johnson *et al.* (1955).

$$GA = h^2 \times K \times \sigma_p$$

Where,

h^2 = heritability estimate

K = Selection differential equal to 2.06 at 5% selection intensity (Lush, 1949).

σ_p = Phenotypic standard deviation.

3.9.11 Estimation of correlation co-efficient

Correlation is a measure of relationship between the variables and was computed using the formula.

$$r = \frac{\text{Cov}(x,y)}{\sqrt{v(x) \cdot v(y)}}$$

Where,

r = correlation coefficient

$\text{cov}(x, y)$ = covariance of the characters x and y .

$v(x)$ and $v(y)$ = variance of the characters x and y .

3.9.12 Diversity estimation

Diversity was computed by Shanon-Weaver diversity index method (Shanon and Weaver, 1949) which was estimated as

$$H^1 = - \sum_{i=1}^n P_i \times \log_e P_i / \log_e n$$

Where,

n = number of phenotypic classes for a trait.

P_i = Proportion of the total number of entries in the *i*th class.

A lower Shannon Weaver diversity index (H¹) indicates an extremely unbalanced frequency and a lack of genetic diversity. On the other hand, a higher diversity index indicates the presence of genetic diversity.

Table 2 : Recording of observations in the morphological descriptors
(Anon, 1992)

Sl. No.	Traits	Recording of observation	Classified as
1.	Growth habit	Recorded at poding stage	1. Procumbent-1 2. Procumbent-2 3. Decumbent-1 4. Decumbent-2 5. Decumbent-3 6. Erect 7. Others
2.	Branching pattern	Determined based on the (n+1) cotyledonary branches at poding stage	1. Alternate 2. Sequential 3. Irregular with flowers on main stem 4. Irregular without flowers on main stem 5. Others
3.	Stem colour	It was recorded on mature plants	0 Absent + Present
4.	Stem surface	Recorded based on the observation of main axis	1. Glabrous 3. Sub-glabrous, hairs in one or two rows along the main stem 5. Moderately hairy, three or four rows along the main stem 7. Very hairy, most of the stem surface covered with hairs 9. Woolly
5.	Leaf colour	Recorded based on the visual observation at 60 DAS	1. Yellow/yellow-green 2. Light green 3. Green 4. Dark green 5. Bluish green 6. Others
6.	Leaf shape	Recorded based on the visual observation of 3 rd apical leaflet 60 DAS	1. Cuneate 2. Obcuneate 3. Elliptic 4. Oblong-elliptic 5. Narrow-elliptic 6. Wide-elliptic 7. Suborbicular 8. Orbicular 9. Ovate 10. Obovate 11. Oblong

			13. Lanceolate 14. Linear lanceolate 15. Other
7.	Leaf surface	Recorded using lense from the 3 rd apical leaflet at 60 DAS	1. Almost glabrous on both the surfaces 2. Almost glabrous above, hairs below 3. Almost glabrous above, hairs and/or bristles below 4. Almost glabrous below, hairs above 5. Almost <i>glabrous below</i> , hairs and bristles above 6. Hairs on both surfaces, without bristles 7. Hairs on both surfaces, with bristles atleast on one surface 8. Wooly without bristles 9. Wooly with bristles atleast on one surface 10. Others
8.	Flower colour	Recorded from fresh, fully opened flowers	1. White 2. Lemon yellow 3. Yellow 4. Orange-yellow 5. Orange 6. Dark orange 7. Garnet/brick red 8. Others
9.	Peg colour	Recorded from the freshly developed pegs	0 Absent + Present
10.	Number of seeds	Recorded from the randomly selected well developed pods	1. 2-1 2. 2-3-1/2-1-3 3. 3-2-1/3-1-2 4. 2-3-4-1/2-4-3-1/2-3-1-4/2-4-1-3/2-1-3-4/2-1-4-3-5/3-2-4-1/3-2-1-4 5. 3-4-2-1/3-4-1-2 6. 4-3-2-1/4-2-3-1 7. 4-3-1-2/4-2-1-3 8. 3 or 4 seeds with occasional 5 seeded pods 9. Other
11.	Pod beak	Recorded from the well developed and well cleaned pods	0 Absent 3 Slight 5 Moderate

			7 Prominent 9 Very prominent
12.	Pod constriction	Recorded from well developed and well cleaned pods	0 None 3 Slight 5 Moderate 7 Deep 9 Very deep
13.	Pod reticulation	Recorded from the well developed and well cleaned pods	0 None 3 Slight 5 Moderate 7 Prominent 9 Very prominent
14.	Primary seed colour	Primary or major colour of the seeds recorded within one month of harvest after complete drying of mature, wrinkle free seeds	1. White 2. Off-white 3. Yellow 4. Very paletan 5. Paletan 6. Light tan 7. Tan 8. Dark ten 9. Greyed orange 10. Rose 11. Salmon 12. Light red 13. Red 14. Dark red 15. Purplish red/red purple 16. Light purple 17. Purple 18. Dark purple 19. Very dark purple 20. Other

Table 3 : Recording of observations in the vegetative and agronomical traits

Sl. No.	Trait	Recording of observation
1.	Leaf let length (cm) (LLN)	Ten apical leaflets at the third node were used for the measurement and the average was taken at 60 DAS
2.	Leaflet width (cm) (LWD)	Recorded at 60 DAS, ten apical leaflets from the 3 rd node were measured at the widest point and average was taken
3.	Plant height (cm) (PLHT)	Plant height was measured from the bottom to the tip of the plant at physiological maturity
4.	Number of primary branches (NPB)	Number of primary branches were counted and recorded at physiological maturity
5.	Length of the primary branches (cm) (LPB)	It was taken at physiological maturity
6.	Number of secondary branches (NSB)	Number of secondary branches were counted and recorded at physiological maturity
7.	Length of the secondary branches (cm) (LSB)	It was measured at physiological maturity
8.	Number of nodes on the main stem (NNMS)	Nodes on the main stem were counted and recorded at physiological maturity
9.	Length of the cotyledonary branches (cm) (LCB)	Length of the cotyledonary lateral branches were measured at physiological maturity
10.	Number of nodes on the cotyledonary branches (NNCB)	Nodes on the cotyledonary branches were counted and recorded at maturity

Table 4 : Recording of observations in the reproductive traits

Sl.No.	Trait	Recording of observation
1.	Days to initiation of flowering (DIF)	Number of days required for first flowering in any plant within a line was recorded based on the visual observation
2.	Days to cessation of flowering (DCF)	Days to termination of the flowering was recorded based on the daily observation
3.	Days to maturity (DM)	Days to physiological maturity was recorded based on the visual observation as indicated by yellowing of the leaves and prominent lines on the seeds
4.	Number of pegs per plant (NPP)	Total number of pegs were counted and recorded at physiological maturity
5.	Total number of pods (TNP)	Total number of pods were counted and recorded at harvest
6.	Number of well developed pods (NMP)	Number of well developed pods were recorded at harvest
7.	Pod length (cm) (PLN)	Ten well cleaned and well developed pods were used to measure the pod length and the average was taken
8.	Pod width (cm) (PWD)	Ten well cleaned and well developed pods were measured at the widest point and average was taken
9.	Shelling percentage (SH)	Hundred grams of pods were weighed and shelled, kernels were weighed Weight of the kernel $SP(\%) = \frac{\text{Weight of the kernel}}{\text{Weight of the pods}} \times 100$
10.	Seed length (cm) (SLN)	Ten sound kernals were measured for seed length and average was taken
11.	Seed width (cm) (SWD)	Ten sound kernels were measured at widest point and average was taken
12.	100-seed weight (g) (SDWT)	Hundred sound kernels were counted and used for weighment
13.	Yield per plant (g) (PYP)	Pods of randomized selected five plants was weighed and average was taken
14.	Oil content (%) (OIL)	Oil content of each accession was estimated using 20 g of seeds by Nuclear Magnetic Resonance method (NMR) at RRS Raichur

Table 5a : Frequency distribution of various morphological descriptions for groundnut Asian core collection

Descriptor	Classification	Botanical variety			Total
		<i>Fastigiata</i> (FST)	<i>Hypogaea</i> (HYPO)	<i>Vulgaris</i> (VUL)	
1. Growth habit	1		140		140
	3		5		5
	4		59	3	62
	5		17		17
	6	29	9	242	280
2. Branching pattern	1		229	1	230
	2	29	1	244	274
3. Stem colour	1	6	229	239	474
	2	23	1	6	30
4. Stem surface	1		1	2	3
	3	22	218	231	471
	5	7	11	12	30
5. Leaf colour	2	29	3	232	264
	3		226	13	239
	4		1		1
6. Leaf surface	1	29	230	245	504
7. Leaf shape	3	29	229	245	503
	13		1		1
8. Flower colour	5	29	230	245	504
9. Peg colour	1		2		2
	2	29	228	245	502
10. Number of seeds per pod	1	2	112	242	356
	2	1	113	3	117
	3	26	5		31
11. Pod beak	1		8	6	14
	3	18	95	123	236
	5	11	113	100	224
	7		14	16	30
12. Pod constriction	1		2		2
	3	29	204	50	283
	5		22	190	212
	7		2	5	7
13. Pod reticulation	3	18	8	9	35
	5	9	210	231	450
	7	2	12	5	19
14. Primary seed colour	1		1		1
	2		2		2
	7	4	200	224	428
	9		9		9
	12		1		1
	13	23	9	19	51
	14		8	1	9
	17	1		1	2
18	1			1	

Experimental Results

IV. EXPERIMENTAL RESULTS

To study the variability present and to determine the effect of environment on the characterization, Asian core collection of groundnut was planted at two locations for two seasons. Data on 12 morphological and 24 agronomic traits were collected and analysed. Results of the analysis are presented here based on the two trait groups.

4.1 Characterization of morphological traits

4.1.1 Frequency distribution

4.2 Characterization of vegetative and reproductive traits

4.2.1 Variability and related components

4.2.2 Genetic parameters

4.2.3 Correlation coefficients

4.2.4 Diversity estimation.

4.1 Characterization of morphological traits

4.1.1 Frequency distribution

Data on 12 morphological traits were collected, based on the morphological descriptor (Anon, 1992). Each trait was scored and grouped into different classes. The frequency of each group was calculated botanical variety wise and their per cent frequency was estimated. The results are presented in the Table 5b.

4.1.1.1 Growth habit

There are seven classes for growth habit of which only six classes were observed in the Asian core collection (Fig.4). All the 29 (100%) accessions of *fastigiata*, nine accessions of *hypogaea* (39%) and 280

Table 5b : Frequency distribution of different morphological descriptors

Sl. No.	Descriptor	Classification	Bot var			Total
			<i>Fastigiata</i> (FST)	<i>Hypogae</i> (HYPO)	<i>Vulgaris</i> (VUL)	
1.	Growth habit	1	-	140 (60.8)	-	140 (27.77)
		3	-	5 (2.17)	-	5 (0.99)
		4	-	59 (25.65)	3 (1.12)	62 (12.30)
		5	-	17 (7.39)	-	17 (3.37)
		6	29 (100)	9 (3.91)	242 (98.7)	280 (55.50)
2.	Branching pattern	1	-	229 (99.50)	1 (0.48)	230 (45.63)
		2	29 (100)	1 (0.43)	244 (99.5)	274 (54.36)
3.	Stem colour	1	6 (20.6)	229 (99.50)	239 (97.5)	474 (94.00)
		2	23 (79.3)	1 (0.43)	6 (2.4)	30 (5.95)
4.	Stem surface	1	-	1 (0.43)	2 (0.8)	3 (0.59)
		3	22 (75.8)	218 (94.98)	231 (94.4)	471 (93.45)
		5	7 (24.1)	11 (4.70)	12 (4.8)	30 (5.90)
5.	Leaf colour	2	29 (100)	3 (1.30)	232 (94.6)	264 (52.380)
		3	-	226 (98.20)	13 (5.3)	239 (47.42)
		4	-	1 (0.40)	-	1 (0.19)
6.	Leaf surface	1	29 (100)	230 (100.0)	245 (100.0)	504 (100.0)
7.	Leaf shape	3	29 (100)	229 (99.50)	245 (100.0)	503 (99.80)
		13	-	1 (0.40)	-	1 (0.190)
8.	Flower colour	5	29 (100)	230 (100.0)	245 (100.0)	504 (100.0)
9.	Peg colour	1	-	2 (0.80)	-	2 (0.39)
		2	29 (100)	228 (99.13)	245 (100.0)	502 (99.60)
10.	No, seeds/pod	1	2 (6.89)	112 (48.69)	242 (98.7)	356 (70.60)
		2	1 (3.40)	113 (49.13)	3 (1.2)	117 (23.21)
		3	26 (89.6)	5 (2.17)	-	31 (6.15)
11.	Pod beak	1	-	8 (3.40)	6 (2.4)	14 (2.77)
		3	18 (62.0)	95 (41.30)	123 (50.2)	236 (46.82)
		5	11 (37.93)	113 (49.13)	100 (40.8)	224 (44.44)
		7	-	14 (6.00)	16 (6.5)	30 (5.95)
12.	Pod constriction	1	-	2 (0.86)	-	2 (0.39)
		3	29 (100)	204 (88.60)	50 (20.40)	283 (56.15)
		5	-	22 (9.50)	190 (77.50)	212 (42.06)
		7	-	2 (0.86)	5 (2.00)	7 (0.13)
13.	Pod reticulation	3	18 (62.00)	8 (3.40)	9 (3.60)	35 (6.94)
		5	9 (31.00)	210 (91.30)	231 (94.20)	450 (89.28)
		7	2 (6.80)	12 (5.20)	5 (2.04)	19 (3.76)
14.	Primary seed colour	1	-	1	-	1 (0.19)
		2	-	2	-	2 (0.39)
		7	4 (13.79)	200 (86.90)	224 (91.40)	428 (84.9)
		9	-	9 (3.90)	-	9 (1.78)
		12	-	1 (0.43)	-	1 (0.19)
		13	23 (79.3)	9 (3.91)	19 (7.70)	51 (10.11)
		14	-	8 (3.40)	1 (0.4)	9 (1.78)
		17	1 (3.4)	-	1 (0.4)	2 (0.39)
	18	1 (3.4)	-	-	1 (0.19)	

Figures in parentheses indicate per cent frequency.

(55.5%) of *vulgaris* exhibited erect type growth habit. While 59 (25.65%) of *hypogaea* and three accessions of *vulgaris* (1.12%) showed decumbent-2 type growth habit. Variety *hypogaea* is the only variety in the core collection which displayed all six types of growth habits observed, decumbent-1 type in 140 (60.8%) accessions, procumbent-1 in five accessions (2.17%) and 17 (7.39%) with decumbent-3 type.

4.1.1.2 Branching pattern

Among the different type of branching patterns, alternate and sequential type were observed in the core collection (Fig.5), out of which sequential type was observed in all *fastigiata*, one *hypogaea* (0.43%) and 244 (97.5%) accessions of *vulgaris*. While alternate type was exhibited by 229 (99.5%) of *hypogaea* and one accession of *vulgaris* (0.48%).

4.1.1.3 Stem colour

Both presence or absence of pigmentation was noticed in the core collection (Fig. 6) but maximum number of accessions showed absence of stem colour (six of *fastigiata*, 229 of *hypogaea* and 239 of *vulgaris*). Whereas a few accessions, six of *vulgaris* (20.6%) and one of *hypogaea* (0.43%) with considerably number of *fastigiata* 23 (79.3%) showed stem colour.

4.1.1.4 Stem surface nature

Out of the five classes, three were observed in the core collection glabrous type was observed in one of *hypogaea* (0.43%) and two accessions of *fastigiata* (0.8%), glabrous type with hairs in one or two rows along the main stem maximum number of accessions were grouped, consisting of all the three types with a contribution of 75.8 per cent from

Fig 4. Per cent frequency of different growth habits in core collection

1. Procumbent-1
3. Decumbent -1
4. Decumbent -2
5. Decumbent -3
6. Erect

Fig 5. Per cent frequency of different branching patterns in core collection

1. Alternate
2. Sequential

Fig. 6. Per cent frequency of stem colour in core collection

1. Absent
2. Present

Fig.7. Per cent frequency of different stem surface nature in core collection

1. Glabrous
3. Sub-glabrous with 1 or 2 rows of hairs
5. Moderately hairy with 3 or 4 rows of hairs

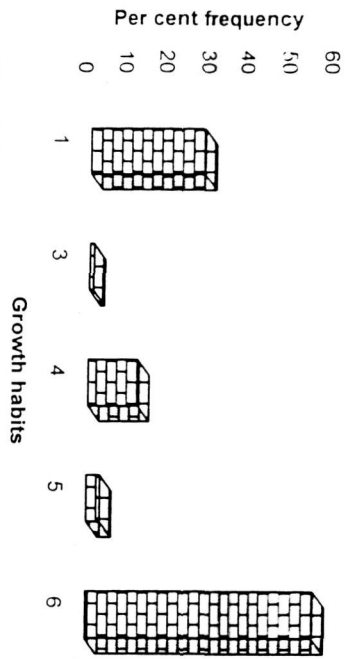


Fig. 4. Per cent frequency of different growth habits in core collection.

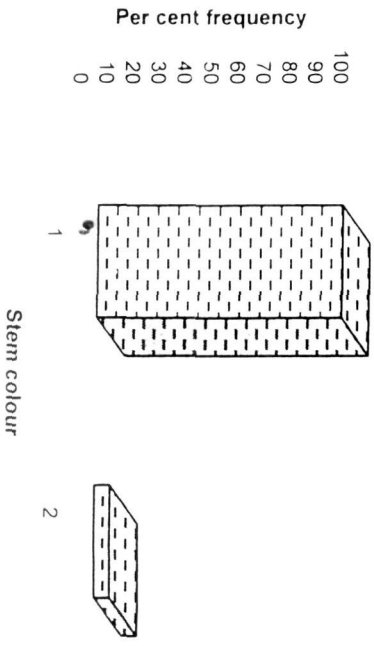


Fig. 6. Per cent frequency of stem colour in core collection.

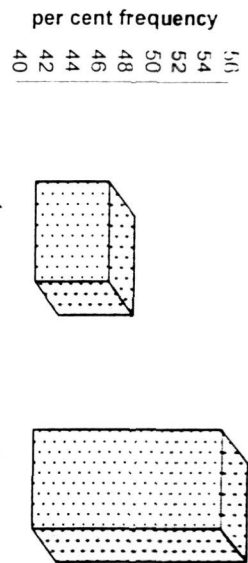


Fig. 5. per cent frequency of different branching patterns in core collection

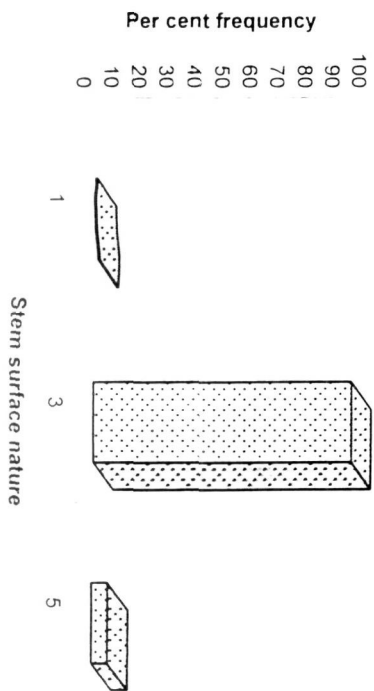


Fig. 7. Per cent frequency of different stem surface nature in core collection.

fastigiata, 94.98 per cent from *hypogaea* and 94.4 per cent from *vulgaris*, respectively. While for a unique type of stem surface with hairy, very hairy, with hairs covering almost all the surface was recorded in seven of *fastigiata* (24.1%) and 11 of *hypogaea* (4.7%) and 12 of *vulgaris* accessions (4.8%) (Fig. 7).

4.1.1.5 Leaf colour

In the Asian core collection of 504 accessions, only three type of colours out of six were observed. All accessions of *fastigiata* displayed light green colour, while three (1.3%), 226 (98.2%) and one accession (0.4%) of *hypogaea* exhibited light green, green and dark green foliage colour, respectively. In *vulgaris* light green foliage was observed in 232 (94.6%) accessions and green colour in 13 (5.3%) accessions (Fig.8).

4.1.1.6 Leaf surface nature

All accessions of three different botanical varieties to an extent of 100 per cent showed almost glabrous type of leaf surface on both the sides (Fig.9).

4.1.1.7 Leaf shape

Only two types of leaf shape were observed in the core collection (Fig.10). All accessions of *fastigiata*, *vulgaris* and except one accession of *hypogaea* all exhibited elliptic type of leaf shape. Only one accession exhibited lanceolate type in *hypogaea*.

4.1.1.8 Flower colour

Almost all accessions of core collection belonging to three different botanical varieties exhibited orange type of flower colour (Fig.11).

Fig 8. Per cent frequency of different leaf colour in core collection

2. Light green
3. Green
4. Dark green

Fig 9. Per cent frequency of leaf surface nature in different botanical varieties

1. *Fastigiata*
 2. *Hypogaea*
 3. *Vulgaris*
- (All are almost Glabrous)

Fig. 10. Per cent frequency of different leaf shapes in core collection

3. Elliptic
13. Lanceolate

Fig.11. Per cent frequency of flower colour in different botanical varieties

1. *Fastigiata*
 2. *Hypogaea*
 3. *Vulgaris*
- (Flower colour is orange in all groups)

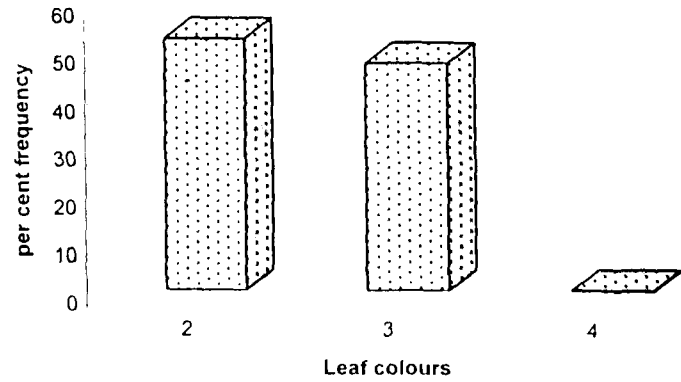


Fig. 8. Per cent frequency of different leaf colours in core collection.

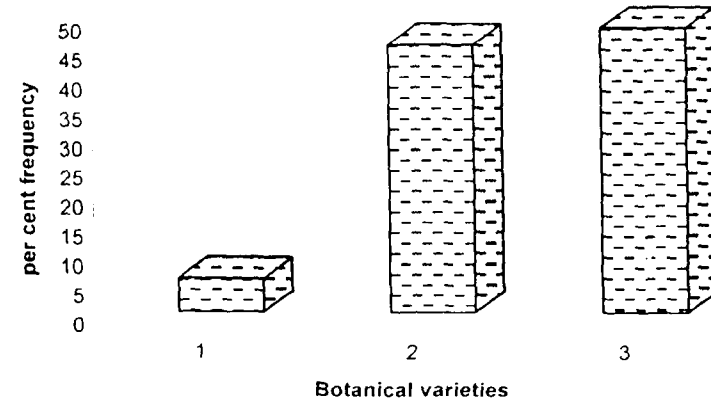


Fig. 9. Per cent frequency of leaf surface nature in different botanical varieties.

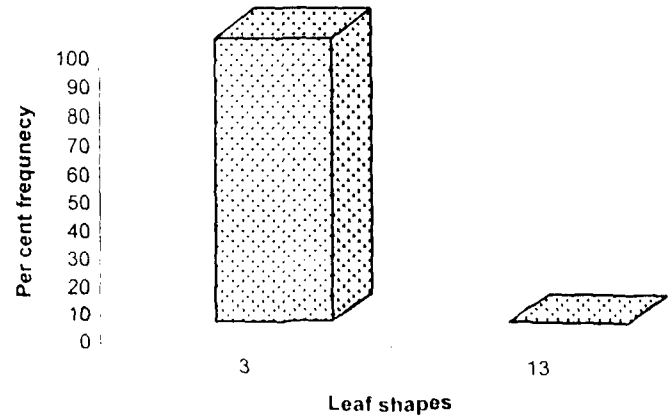


Fig. 10. Per cent frequency of different leaf shapes in core collection

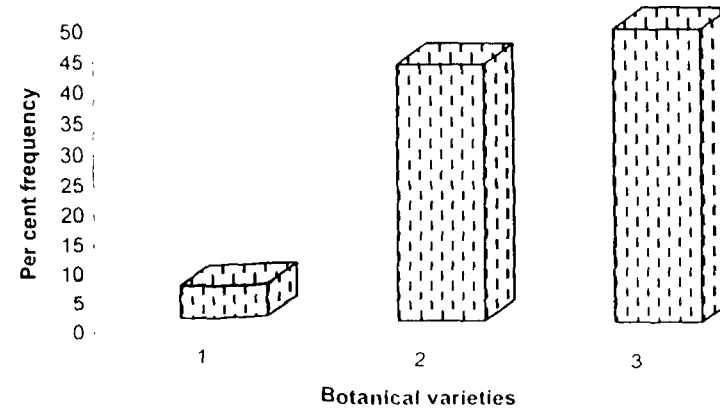


Fig. 11. Per cent frequency of flower colour in different botanical varieties.

4.1.1.9 Peg pigmentation

There were two classes of peg colour, either absence or presence of pigmentation. Only two accessions of *hypogaea* (0.8%) had no colour, remaining accessions of *hypogaea* 228 (99.13%) and all accessions of *fastigiata* and *vulgaris* purely had peg colour (Fig.12).

4.1.1.10 Number of seeds per pod

There are ten classes for number of seeds per pod but in the core collection only three classes were observed (Fig.13). Class-1 with 2-1 seeds and class-2 with 2-3-1/2-1-3 seeds dominated the core collection, being present in two (6.89%), 112 (48.69%) and 242 (98.7%) of *fastigiata*, *hypogaea* and *vulgaris*, respectively for class-1 one of *fastigiata* (3.4%), 113 (49.13%) of *hypogaea* and three of *vulgaris* (1.2%) for class-2. But maximum number of *fastigiata* fell into the group-3 (3-2-1/3-1-2 seeded) with five accessions from *hypogaea* (2.17%).

4.1.1.11 Pod beak

Among the three botanical varieties, *fastigiata* showed slight to moderate pod beak with 18 (62.0%) and 11 (37.93%) accessions for each group. While, *hypogaea* and *vulgaris* observed over four groups, eight accessions of *hypogaea* (3.4%) and six of *vulgaris* (2.4%) had no beak, 95 (41.3%) with slight, 113 (49.3%) with moderate and 14 (6.0%) with prominent beak was observed in *hypogaea* and 123 (50.2%) with slight, 100 (40.8%) with moderate, and 16 (6.5%) with prominent beak was noticed in *vulgaris* accessions (Fig.14).

4.1.1.12 Pod constriction

All the 29 accessions of *fastigiata*, 204 (88.6%) of *hypogaea*, and 50 (20.4%) of *vulgaris* exhibited slight constriction followed by moderate in 22 (9.5%) of *hypogaea* and 190 (77.5%) of *vulgaris*. The remaining accessions prominent and none type (Fig.15).

Fig 12. Per cent frequency of peg pigmentation in core collection

1. Absent
2. Present

:

Fig 13. Per cent frequency of number of seeds per pod in core collection

1. 2-1
2. 2-3-1/2-1-3
3. 3-2-1/3-1-2

Fig. 14. Per cent frequency of different pod beaks

1. Absent
3. Slight
5. Moderate
7. Prominent

Fig.15. Per cent frequency of different pod constrictions

1. None
3. Slight
5. Moderate
7. Prominent

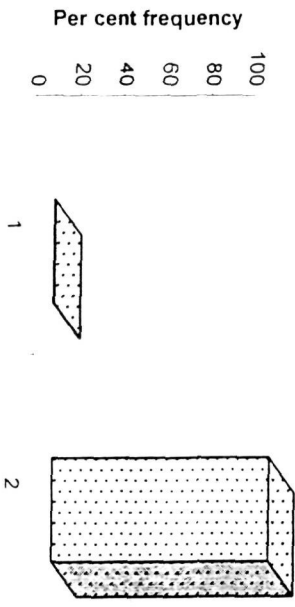


Fig. 12. Per cent frequency of peg pigmentation in core collection.

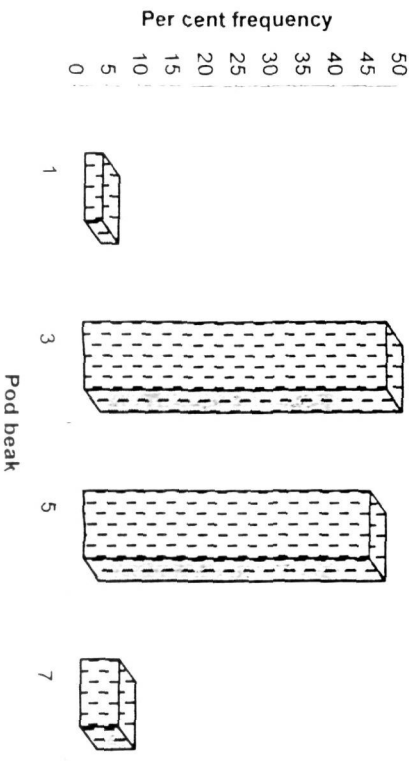


Fig. 14. Per cent frequency of different pod beaks.

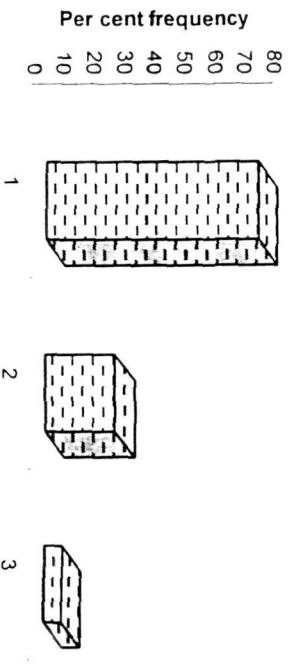


Fig. 13. Per cent frequency of number of seeds per pod in core collection.

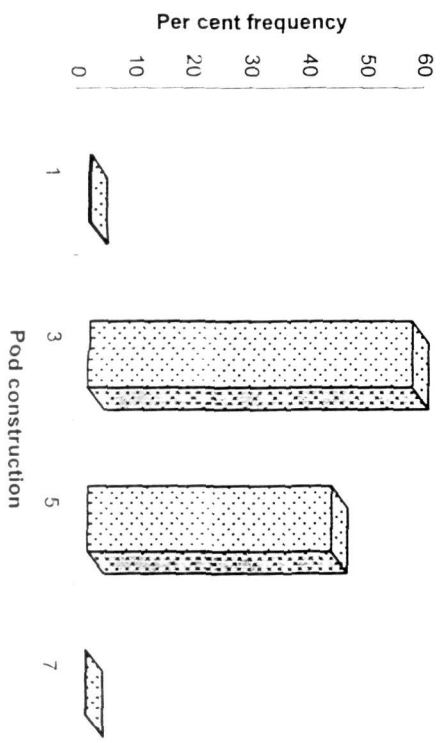


Fig. 15. Per cent frequency of different pod constrictions.

4.1.1.13 Pod reticulation

Among the different classes of reticulation, slight type was observed in 18 (62.0%) of *fastigiata*, eight of *hypogaea* (3.4%) and nine of *vulgaris* (3.6%). Moderate type was recorded in nine of *fastigiata* (3.4%), 210 (91.3%) of *hypogaea* and 231 (94.2%) of *vulgaris* type. While, two (6.8%), 12 (5.2%) and five (2.04%) accessions of *fastigiata*, *hypogaea* and *vulgaris*, respectively had prominent reticulation (Fig.16).

4.1.1.14 Primary seed colour

Of the 20 groups of seed colour (IBPGR and ICRISAT), only four classes were observed in *fastigiata* type, having tan in four (13.79%), red in 33 (79.3%), purple in one (3.4%), and dark purple in one (3.4%) accessions. Five different seed colours were observed in *hypogaea* type, dominated by tan colour in 200 (86.9%) accessions, followed by greyed orange and red in nine accessions (3.9%), dark red in eight accessions (3.4%) and light red in one accession (0.43%). Out of 245 *vulgaris* accessions, 224 (91.4%) displayed tan colour followed by red in 19 (7.7%) accessions, dark red and purple each in one accession (0.43%) only (Fig.17).

4.2 Characterization of vegetative and reproductive traits

4.2.1 Variability and related components

4.2.1.1 Variance component

Variance component estimated using REML method indicated that out of 24 traits, three traits (PLHT, DCF and DM) at E1, five traits (PLN, SWD, SDWT, DCF and DM) at E2, five traits (PWD, DIF, DCF, DM and PYP) at E3 and three traits at E4 (PLN, DCF and DM) exhibited highly

Fig 16. Per cent frequency of different reticulations

3. Slight
5. Moderate
7. Prominent

Fig 17. Per cent frequency of different primary seed colour

1. White
2. Off white
7. Tan
9. Grey orange
12. Light red
13. Red
14. Dark red
17. Purple
18. Dark purple

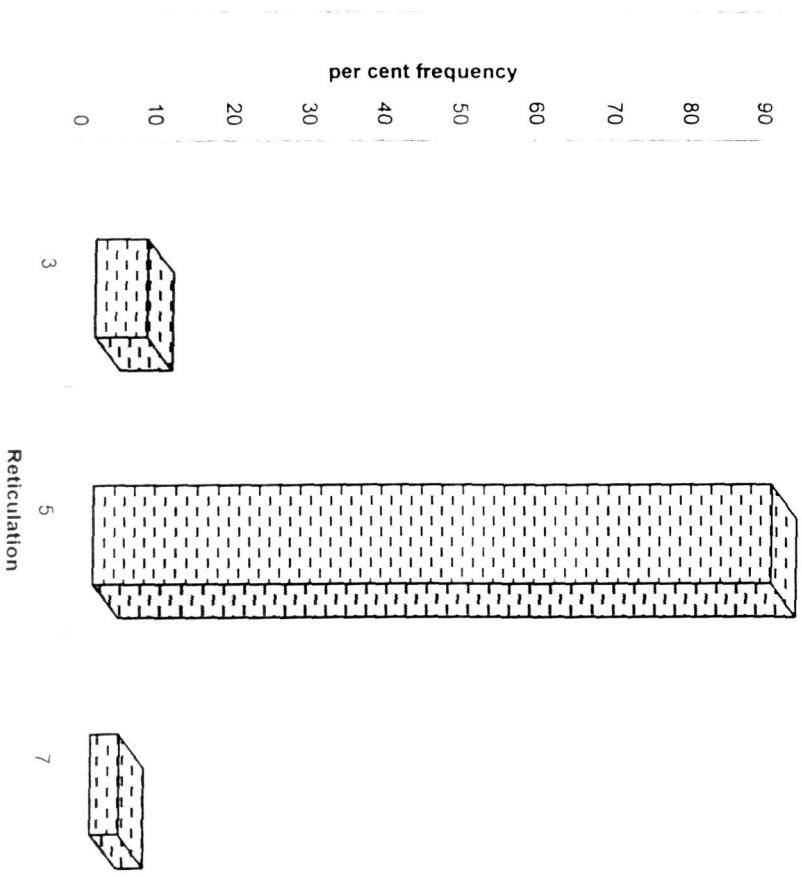


Fig. 16. Per cent frequency of different reticulations.

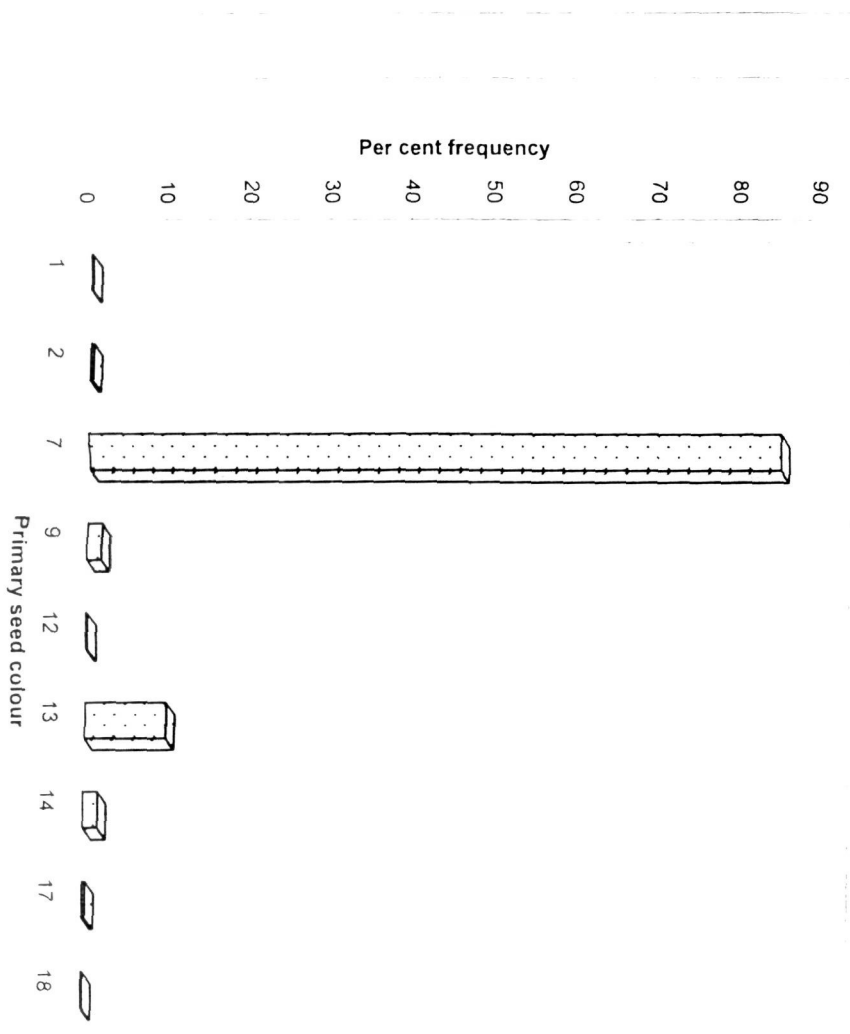


Fig. 17. Per cent frequency of different primary seed colour

significant variance. While, traits PLN, SWD at E1, PWD and OIL at E2, TNP, NMP, NPP, PLN and SDWT at E3 and PLHT, PWD, LLN and OIL at E4 were significant (Table 6).

Estimation of variance component over four environments revealed that, among three individual sources of variation season (SEA) was highly significant for six traits (PLHT, SH, SDWT, LLN, PYP and OIL), location (LOC) for nine traits (LPB, NNMS, SH, SDWT, DIF, DCF, DM, PYP and OIL) and entries (ENT) found significant for all traits except two traits (NSB and LSB).

Among the two factors interactions SEA X LOC variance was significant in seven traits out of which six traits (SH, LLN, DIF, DCF, DM and OIL) were highly significant and one trait (NSB) was significant. SEA X ENT interactions were found significant for 13 traits in which three were (PLHT, NNMS and NPP) significant and remaining 10 were (TNP, SH, SDWT, LLN, LWD, DIF, DCF, DM, PYP and OIL) highly significant. Similarly, LOC X ENT. was significant over 15 traits, in which except NSB all other 14 traits were highly significant (PLHT, NPB, LPB, NNMS, LCB, NNCB, NMP, NPP, SH, SDWT, DCF, DM, PYP and OIL) (Table 7).

The three factors interactions SEA X LOC X ENT were significant for 18 traits, with significance for two traits (NSB and PWD) and highly significant for remaining traits. SEA X LOC X REP was highly significant for one trait (PLN) and significant for 20 traits.

Variance component estimated considering botanical variety as a source of variation revealed that, for season (SEA) 10 traits were highly significant (PLHT, LPB, LCB, NNCB, SH, SLN, SDWT, LLN, PYP and OIL) and significant for two traits (NSB and LSB). For location (LOC) 10 traits

Table 6 : Variance component for different vegetative and reproductive traits at Raichur and Kawadimatti during 2000 rainy and 2000-01 post rainy seasons in Karnataka

Traits	PLHT	NPB	LPB	NNMS	LCB	NNCB	TNP	NMP	NPP	PLN	PWD
Environment											
E1	10.05**	0.133	0.001	0.237	2.50	0.85	7.58	5.97	7.80	0.42*	0.0002
E2	4.06	0.001	0.424	1.004	3.85	1.32	4.87	2.24	6.26	0.054**	0.004*
E3	1.61	0.142	2.080	0.067	0.89	0.36	4.18*	2.79*	7.10*	0.032*	0.005**
E4	4.16*	0.073	0.032	0.249	5.63	1.49	5.28	2.19	6.58	0.046**	0.004*

Traits	SH%	SLN	SWD	SDWT	LLN	LWD	DIF	DCF	DM	PYP	OIL
Environment											
E1	8.82	0.003	0.0017*	4.85	0.036	0.007	0.649	12.75**	6.63**	1.10	-
E2	8.27	0.002	0.002**	17.47**	0.012	0.002	0.323	11.09**	7.05**	0.557	1.748*
E3	11.15	0.002	0.001	17.45*	0.026	0.005	1.292**	17.42**	7.14**	1.792**	-
E4	8.18	0.0019	0.00056	2.79	0.054*	0.0054	0.077	17.59**	8.05**	1.114	1.448*

** Variance component/SE ≥ 3 , highly significant. * Variance component/SE ≥ 2 , significant.

E1 – Raichur rainy, E2 – Raichur post rainy, E3 – Kawadimatti rainy, E4 – Kawadimatti post rainy

PLHT – Plant height (cm), NPB – Number of primary branches, LPB – Length of the primary branches (cm), NNMS – Number of nodes on main stem, LCB – Length of the cotyledonary branches (cm), NNCB – Number of nodes on cotyledonary branches, TNP – Total number of pods, NMP – Number of mature pods, NPP – Number of pegs per plant, PLN – Pod length (cm), PWD – Pod width, SH% – Shelling per cent, SLN – Seed length (cm), SWD – Seed width (cm), LLN – Leaf length (cm), LWD – Leaf width (cm), DIF – Days to initiation of flowering, DCF – Days to cessation of flowering, DM – Days to maturity, PYP – Pod yield per plant (g), OIL – Oil content (%).

Table 7 - Variance component for different vegetative and reproductive traits at Raichur and Kawadimatti during 2000 rainy and 2000-01 post rainy seasons in Karnataka

Source	LEH	LWD	PLHT	NPB	LPB	NSBA	LSB	NNMS	LCB	NNCB	NPP	ENT
SEA	1.48E-09**	3.50E-10	2.24E-08**	0.4486	0.9422	0.8475	0.7135	0.5135	0.5523	0.2099	8.7854	2.8614
LOC	4.94E-10	2.61E-03	2.3120	5.89E-02	9.33E-08**	3.82E-02	4.57E-08	3.20E-09**	10.2814	2.4512	2.3255	2.0371
ENT	9.1732**	2.15E-02**	8.3712**	0.1433*	1.7699**	0.7047	6.13E-09	1.1686**	9.8666**	4.7456**	6.3897**	4.7810**
SEA LOC	1.14E-09**	3.40E-10	7.6082	1.19E-02	0.1310	9.70E-09**	1.36E-06	0.4011	1.899	2.1878	0.8897	0.6911
SEA ENT	2.87E-09	2.62E-09	2.8960*	7.70E-02	0.5307	7.79E-02	1.2783	0.3832*	2.2732	0.9375	4.2425**	1.9559
LOC ENT	3.04E-10	5.30E-11	7.99E-08**	1.07E-09**	1.50E-08**	3.09E-09**	7.32E-09	3.07E-09**	1.84E-06**	1.04E-06**	0.1397	1.32E-07**
SEA LOC ENT	9.69E-10	2.56E-09	4.60E-02	7.62E-08**	2.29E-08**	9.70E-09**	0.1756	2.06E-07**	1.69E-06**	1.05E-06**	1.61E-06**	1.31E-06**
SEA LOC REP	0.1070	2.34E-02	5.0153*	0.2522*	4.6474*	0.4172	0.3176	0.6610*	10.6638*	7.3328*	5.5718*	4.2119*
SOURCE	NPP	PLN	PWD	SH	SIDVT	SLN	SAVD	DIF	DCF	DM	PYP	OIL
SEA	17.4444	2.41E-03	6.40E-11	1.70E-07**	2.88E-07**	1.52E-04	5.54E-05	3.9886	59.2912	57.7948	2.43E-08**	9.34E-02**
LOC	3.7975	1.95E-03	4.53E-10	1.13E-07**	2.17E-07**	5.36E-10	3.93E-11	2.22E-08**	2.58E-07**	1.40E-07**	1.32E-08**	9.34E-09**
ENT	7.5819**	4.78E-02**	5.08E-03**	33.65**	22.9187**	9.00E-03**	1.54E-03	3.42E-09**	113.225**	115.065**	0.9083*	3.2693**
SEA LOC	0.6832	7.42E-04	8.14E-04	3.67E-05**	0.3969	1.19E-10	6.62E-06	1.77E-08**	3.60E-08**	4.92E-07**	2.0538*	9.34E-05**
SEA ENT	5.9959*	5.19E-03	2.30E-04	8.78E-08**	1.19E-06**	5.09E-11	1.48E-11	2.5693**	3.14E-08**	3.21E-06**	9.05E-08**	0.6882**
LOC ENT	5.34E-08**	6.17E-03	2.08E-11	1.42E-07**	8.50E-07**	4.53E-11	9.18E-12	1.425E-03	2.72E-08**	5.75E-08**	1.45E-08**	9.34E-09**
SEA LOC ENT	2.24E-06**	3.94E-04	2.26E-11*	2.60E-04**	3.64E-08**	1.25E-11	1.37E-05	3.02E-02	2.58E-07**	1.40E-07**	1.00E-07**	9.34E-05**
SEA LOC REP	9.2682*	1.59E-03**	2.29E-03	5.5107*	9.4979*	1.16E-02*	7.28E-04	2.1846*	53.1937*	24.9438*	3.4646*	0.6041*

** Variance component/SE ≥ 3 , highly significant. * Variance component/SE ≥ 2 , significant. SEA - Season, LOC - Location, ENT - Entry.

PLHT - Plant height (cm), NPB - Number of primary branches, LPB - Length of the primary branches (cm), NNMS - Number of nodes on main stem, LCB - Length of the cotyledonary branches (cm), NNCB - Number of nodes on cotyledonary branches, TNP - Total number of pods, NMP - Number of mature pods, NPP - Number of pods per plant, PLN - Pod length (cm), PWD - Pod width, SH% - Shelling per cent, SLN - Seed length (cm), SWD - Seed width (cm), LLN - Leaf let length (cm), LWD - Leaf let width (cm), DIF - days to initiation of flowering, DCF - Days to cessation of flowering, DM - Days to maturity, PYP - Pod yield per plant (g), OIL - Oil content (%).

(LPB, NNMS, SH, SDWT, LLN, DIF, DCF, DM, PYP and OIL) were highly significant, while LSB was significant. Botanical variety (BOT) was highly significant for SH and PYP and significant for NSB and LSB.

Similarly, entries were significant for 19 traits except for NPB, LPB, NSB and PYP, in which except for LSB, NNMS, TNP and PWD all others were highly significant. In two factors interaction SEA X LOC was significant and highly significant for two and four traits respectively (NSB, LSB and SH, DCF, DM, OIL). SEA X BOT interactions were highly significant for seven traits (NNMS, SH, NMP, SDWT, LWD, DM and OIL), SEA X ENT significant in one trait (NSB) and highly significant in eight traits (SH, SDWT, LNN, DIF, DCF, DM, PYP AND OIL). LOC x BOT were significant in two traits (NSB and LSB) and highly significant in 14 traits. LOC X ENT was significant in 19 traits and BOT X ENT found significant over all the traits except LWD (Table 8).

Among three factors interaction SEA X LOC X BOT for 17 traits, SEA X LOC X ENT for 19 traits, and all traits for SEA X BOT x ENT, LOC X BOT X ENT interaction were significant (Table 8).

In four factor interaction all traits were significant for SEA X LOC X BOT X ENT interaction and 20 traits for SEA X LOC X BOT x REP interaction (Table 8).

4.2.1.2 Mean

Means of different vegetative and reproductive traits (Table 9) were compared using Newman Keul's test. Environment wise means differed significantly for all the traits except shelling percentage. Means of same botanical variety at four environments were also compared, in *fastigiata*

Table 8. Variance component for different vegetative and reproductive traits at Raichur and Kawadimatti during 2000 rainy and 2000-01 post rainy seasons in Karnataka

Source	11N	1WD	PH HT	NPH	LPB	NSB	LSB	NNMS	LCB	NINCB	TNP	NNP
SEA	5.93E-09**	6.81E-11	4.95E-08**	0.4429	1.67E-08**	4.00E-09**	2.30E-09*	0.4420	3.41E-08**	6.62E-08**	8.9843	3.0644
LOC	9.66E-09**	1.96E-11	1.3096	2.78E-02	1.95E-08**	8.54E-02	1.21E-09*	2.38E-08**	9.5938	2.3055	1.9108	1.5778
POI	0.2980	4.00E-02	11.3958	0.2708	1.4933	4.62E-08**	2.4E-09*	0.7080	4.4312	2.7580	10.6574	6.0802
ENI	6.92E-02**	9.37E-03**	4.7670**	3.85E-02	0.7424	0.4378	2.97E-08*	0.7108*	5.9103**	2.6797**	3.2618*	2.4675**
SEA.LOC	3.96E-03	3.99E-04	5.5797	5.38E-02	0.2252	1.03E-09**	3.12E-08*	0.4590	4.0117	3.2440	1.2014	0.4446
SEA.POI	4.90E-10	9.47E-10**	0.1369	1.10E-03	0.8633	0.5360	0.4713	2.22E-07**	5.48E-02	0.4219	0.3791	1.00E-06**
SEA.ENI	9.35E-09**	1.06E-10	1.8758	4.45E-02	1.36E-02	2.53E-09	1.427	0.1755	1.5866	0.3240	1.9916	0.7335
LOC.POI	7.93E-04	1.12E-03	7.07E-07**	3.16E-08**	8.91E-08**	7.37E-09*	7.01E-10*	2.91E-08**	2.26E-08**	1.98E-08**	1.17E-06**	6.59E-07**
LOC.ENI	3.84E-10	1.17E-10**	1.03E-07**	1.19E-09**	3.92E-08**	2.13E-09*	6.31E-10*	9.42E-09**	5.71E-08**	4.40E-08**	1.73E-07**	1.69E-08**
POI.ENI	4.87E-02**	6.97E-03	2.4379**	6.26E-02**	1.1678**	0.1512*	2.97E-04*	0.4200**	3.8749**	2.1249**	2.6279**	2.0144**
SEA.LOC.BOT	3.83E-09**	1.10E-03	5.86E-08**	2.26E-09**	1.20E-08**	1.16E-09*	1.05E-10*	2.18E-07**	6.02E-08**	1.08E-06**	1.01E-07**	0.3050
SEA.LOC.ENI	4.21E-10	1.46E-10**	9.35E-07**	3.67E-09*	3.48E-08**	1.82E-09*	1.34E-09*	8.51E-09**	5.59E-08**	4.78E-08**	5.28E-08*	5.58E-08**
SEA.BOT	9.35E-05**	1.06E-04**	1.1617**	5.75E-02**	0.2267**	0.1356*	2.94E-04*	0.2243**	1.2268**	0.4615**	1.9488**	1.0914**
LOC.BOT	1.05E-04**	8.81E-05**	9.19E-03**	4.22E-03**	3.92E-02**	0.1403*	4.20E-02*	1.44E-02**	5.71E-02**	4.40E-02**	0.1132**	8.14E-02**
SEA.LOC.BOT	4.21E-03**	1.46E-04**	9.35E-03**	3.67E-03**	0.4610**	6.04E-04*	0.8933*	8.51E-03**	5.59E-02**	4.78E-02**	5.28E-02**	5.58E-02**
SEA.LOC.BOT.REP	3.04E-02*	2.91E-03*	6.1592**	0.1783*	2.9461**	0.3435*	0.9212	0.8203*	12.6956**	3.9226*	2.338*	2.1161*

Table 8 Contd ...

Source	NPP	PLN	PWD	SH	SHAW	SLN	SWD	DIF	DCF	DM	PYP	OIL
SEA	1777	4.63E-03	0.04E-11	2.70E-06**	1.54E-06**	9.13E-10**	4.27E-05	4.7718	36.6422	0.70	7.49E-07**	8.99E-02**
LOC	3129	4.41E-03	5.01E-11	4.09E-07**	2.01E-07**	1.98E-11	2.52E-11	9.50E-08**	2.11E-07**	27.06**	2.25E-08**	1.14E-09**
POI	138602	5.51E-02	4.40E-03	3.79E-07**	1.3189	1.13E-02	2.59E-04	2.1741	1.28.739	0.99	3.66E-08**	0.1061
ENT	34451	2.80E-02**	3.34E-03**	23.5195**	14.3483**	5.12E-03**	8.02E-04*	2.17E-09**	14.4492**	9.67**	0.1301	2.8949**
SEALOC	12719	1.63E-03	5.56E-04	5.69E-08**	1.1002	5.20E-11	3.68E-11	0.1928	1.66E-06**	2.23E-07**	2.1286	1.17E-03**
SEALOC	08600	3.27E-03	1.40E-05	1.49E-07**	8.63E-08**	6.10E-04	1.79E-11	1.3670	0.2056	2.02E-06**	1.0466	6.84E-02**
SEALENT	30936	2.07E-03	9.27E-12	1.22E-07**	1.57E-06**	5.80E-11	2.03E-11	1.7964**	4.70E-08**	1.42E-06**	3.29E-08**	0.3238**
LOCBOI	292E-07**	3.01E-03	7.52E-12	2.53E-07**	3.01E-08**	3.62E-06	1.27E-11	0.1286	3.05E-08**	1.20E-07**	0.3648	8.99E-09**
LOCENT	380E-08**	2.76E-03	1.06E-11	2.12E-07**	1.45E-06**	4.75E-11	1.70E-11	4.71E-08**	4.71E-08**	1.41E-06**	5.20E-08**	5.43E-08**
POIENT	33979**	1.01E-02**	1.91E-03**	9.5422**	8.4319**	2.74E-03**	7.06E-04**	0.2205**	8.3181**	4.8772**	0.7046**	0.3238**
SEALOCBOI	237E-06**	1.51E-09**	4.61E-04	1.9944	2.88E-08**	4.76E-11	1.78E-04	9.15E-02	2.23E-08**	9.22E-08**	1.99E-07**	8.99E-05**
SEALOCENT	989E-08**	1.13E-10	3.59E-11	3.21E-06**	1.31E-07**	3.24E-11	1.88E-11	1.58E-07**	1.17E-06**	2.02E-07**	1.18E-08**	5.43E-04**
SEALOCBOIENT	2.5644**	3.54E-03**	2.39E-04**	1.1650**	1.57E-02**	5.80E-05**	2.05E-05**	0.5181**	1.74E-02**	1.0094**	0.1426**	0.3238**
LOCBOIENT	91159**	3.85E-01**	1.42E-04**	0.2123**	1.48E-02**	4.75E-05**	1.70E-05**	3.14E-03*	0.2051**	0.4785**	5.20E-02**	5.43E-04**
SEALOCBOIENT	9.89E-02**	1.13E-03**	3.59E-05**	3.21E-02**	1.3069**	4.00E-03**	1.88E-04**	1.58E-03**	1.17E-02**	2.02E-03**	0.2654**	5.43E-04**
SEALOCBOIREF	45290*	2.48E-03	2.06E-04	4.2519**	8.8088**	1.13E-02*	4.94E-04*	1.2670**	70.331**	35.7075**	1.6897*	0.6834*

** Variance component/SE ≥ 3, highly significant.

* Variance component/SE ≥ 2, significant.

BOT - Botanical variety

SEA - Season, LOC - Location, ENT - Entry
 PLHT - Plant height (cm), NPB - Number of primary branches, LPB - Length of the primary branches (cm), NNMS - Number of nodes on main stem, LCB - Length of the cotyledonary branches (cm), NPB - Number of nodes on cotyledonary branches, TNP - Total number of pods, NMP - Number of mature pods, NPP - Number of pods per plant, PLN - Pod length (cm), PWD - Pod width, SH% - Shelling per cent, SLN - Seed length (cm), SWD - Seed width (cm), LLN - Leaf let length (cm), LWD - Leaf let width (cm), DIF - days to initiation of flowering, DM - Days to cessation of flowering, PYP - Pod yield per plant (g), OIL - Oil content (%).

14 traits, in *hypogaea* 22 traits and 20 traits in *vulgaris* differed significantly. Comparison of means of different botanical variety across the environment revealed that except for number of secondary branches, length of the secondary branches and shelling percentage all traits were significant (Table 9).

4.2.1.3 Median

Median test performed was significant for all the traits except shelling percentage and oil content at four different environments (Table 10). While in the comparison of same botanical variety at four different environments, 11 traits for *fastigiata*, 23 for *hypogaea* and 13 traits for *vulgaris* exhibited significant difference. In the botanical variety comparison except NSB, LSB and SLN all other traits were found significant for the median test.

4.2.1.4 Variance

Variance of different traits were compared using Levene's test of homogeneity of variance, environment wise variance except for LWD, NPB, LCB, PWD, SWD and OIL differed significantly, while in the comparison of same botanical variety at different environments, *fastigiata* for three, *hypogaea* for 15 traits and *vulgaris* for 14 traits found to be differed significantly. But, in the botanical variety comparison 18 traits were heterogeneous (Table 11).

4.2.1.5 Range and co-efficient of variation

At all four environments, botanical varieties-wise and across the botanical varieties, range and co-efficient of variation were estimated both of them displayed wide range of variation for all the traits (Table 12 and 13).

Table 9 : Mean for different vegetative and reproductive traits at Raichur and Kawadimatti during 2000 rainy and 2000-01 post rainy seasons in Karnataka

Sl No	Environments										FST					HYPO					VUL					Hot comparison				
	E1	E2	E3	E4	E1	E2	E3	E4	E1	E2	E3	E4	E1	E2	E3	E4	E1	E2	E3	E4	E1	E2	E3	E4	FST	HYPO	VUL	FST	HYPO	VUL
1.	5.60 ^a	5.54 ^a	5.38 ^b	5.54 ^a	6.04 ^a	6.05 ^a	5.89 ^a	6.11 ^a	5.06 ^a	5.02 ^a	4.80 ^b	5.02 ^a	6.05 ^a	5.97 ^{ba}	5.88 ^b	5.97 ^{ba}	6.02 ^a	6.02 ^a	5.97 ^{ba}	5.88 ^b	6.05 ^a	5.97 ^{ba}	5.88 ^b	5.97 ^{ba}	6.02 ^a	4.98 ^b	5.97 ^a	6.02 ^a	4.98 ^b	5.97 ^a
2.	2.29 ^b	2.29 ^b	2.41 ^{ba}	2.35 ^a	2.52 ^a	2.40 ^b	2.54 ^a	2.51 ^a	2.14 ^a	2.10 ^a	2.15 ^a	2.14 ^a	2.39 ^d	2.46 ^c	2.64 ^a	2.52 ^b	2.49 ^a	2.49 ^a	2.49 ^a	2.64 ^a	2.39 ^d	2.46 ^c	2.52 ^b	2.49 ^a	2.49 ^a	2.13 ^b	2.51 ^a	2.49 ^a	2.13 ^b	2.51 ^a
3.	29.06 ^a	28.79 ^a	22.32 ^c	28.06 ^b	35.12 ^a	32.54 ^a	33.06 ^a	30.32 ^a	27.51 ^a	26.57 ^b	21.51 ^c	26.35 ^b	29.82 ^a	30.44 ^a	21.80 ^b	29.42 ^a	32.76 ^a	32.76 ^a	29.42 ^a	21.80 ^b	29.82 ^a	30.44 ^a	29.42 ^a	29.82 ^a	32.76 ^a	25.48 ^c	27.87 ^a	25.48 ^c	27.87 ^a	
4.	2.23 ^c	3.34 ^a	2.00 ^b	2.79 ^b	1.64 ^b	2.89 ^d	1.29 ^b	2.75 ^a	2.85 ^c	3.55 ^a	2.45 ^b	3.29 ^b	1.64 ^b	3.12 ^a	1.57 ^c	2.23 ^b	2.26 ^b	2.26 ^b	2.23 ^b	1.57 ^c	1.64 ^b	3.12 ^a	2.23 ^b	2.26 ^b	3.04 ^a	2.11 ^b	3.04 ^a	2.11 ^b	2.11 ^b	
5.	8.51 ^b	7.70 ^c	9.13 ^a	6.43 ^d	5.52 ^a	6.77 ^a	5.83 ^a	5.40 ^a	11.47 ^a	7.79 ^c	10.14 ^b	7.68 ^a	5.66 ^b	7.68 ^a	8.17 ^a	5.14 ^b	5.87 ^b	5.87 ^b	5.14 ^b	8.17 ^a	5.66 ^b	7.68 ^a	5.14 ^b	5.87 ^b	9.26 ^a	6.59 ^b	9.26 ^a	6.59 ^b	6.59 ^b	
6.	1.73 ^b	3.39 ^a	1.60 ^b	3.04 ^a	-	-	-	-	1.73 ^b	3.44 ^a	0.50 ^c	3.04 ^a	-	4.00 ^a	2.86 ^a	-	1.00 ^a	1.00 ^a	2.86 ^a	1.73 ^b	3.44 ^a	0.50 ^c	3.04 ^a	-	4.00 ^a	2.67 ^a	3.00 ^a	2.67 ^a	3.00 ^a	
7.	6.41 ^a	4.58 ^b	5.36 ^{ba}	4.61 ^b	-	-	-	-	6.41 ^a	4.50 ^b	5.25 ^a	4.61 ^b	-	6.00 ^a	5.50 ^a	-	6.00 ^a	6.00 ^a	5.50 ^a	6.41 ^a	4.50 ^b	5.25 ^a	4.61 ^b	-	6.00 ^a	5.04 ^a	5.57 ^a	5.04 ^a	5.57 ^a	
8.	15.56 ^b	16.11 ^a	14.18 ^c	16.08 ^a	17.65 ^a	17.42 ^a	16.67 ^a	16.48 ^a	15.37 ^a	15.66 ^a	13.75 ^b	15.72 ^a	15.49 ^b	16.38 ^a	14.30 ^c	16.38 ^a	17.05 ^a	17.05 ^a	14.30 ^c	15.49 ^b	16.38 ^a	14.30 ^c	16.38 ^a	15.49 ^b	17.05 ^a	15.12 ^c	15.64 ^a	15.12 ^c	15.64 ^a	
9.	35.60 ^a	35.75 ^a	28.42 ^c	32.81 ^b	36.98 ^a	34.51 ^a	35.61 ^a	32.01 ^a	38.39 ^a	37.32 ^a	31.70 ^c	33.97 ^b	32.79 ^b	34.41 ^a	24.45 ^c	31.81 ^b	34.78 ^a	34.78 ^a	24.45 ^c	32.79 ^b	34.41 ^a	24.45 ^c	31.81 ^b	32.79 ^b	34.78 ^a	35.35 ^a	36.87 ^b	35.35 ^a	36.87 ^b	
10.	28.53 ^a	28.73 ^a	24.01 ^c	27.54 ^b	26.50 ^b	27.36 ^a	25.55 ^c	26.20 ^a	31.82 ^a	30.27 ^b	27.31 ^d	29.18 ^c	25.65 ^b	27.43 ^a	20.69 ^c	26.14 ^b	26.40 ^b	26.40 ^b	20.69 ^c	25.65 ^b	27.43 ^a	20.69 ^c	26.14 ^b	25.65 ^b	26.40 ^b	29.65 ^a	24.98 ^c	29.65 ^a	24.98 ^c	
11.	18.00 ^b	21.10 ^a	14.13 ^d	19.78 ^b	9.96 ^c	16.83 ^a	9.12 ^c	14.44 ^b	20.61 ^b	22.99 ^a	16.70 ^b	21.13 ^b	16.47 ^b	19.82 ^a	12.30 ^c	19.13 ^b	12.59 ^c	12.59 ^c	12.30 ^c	16.47 ^b	19.82 ^a	12.30 ^c	19.13 ^b	16.47 ^b	12.59 ^c	20.36 ^a	16.93 ^b	20.36 ^a	16.93 ^b	
12.	13.76 ^b	15.26 ^a	10.30 ^c	14.02 ^b	6.47 ^c	12.09 ^a	6.64 ^c	9.65 ^b	15.90 ^a	16.83 ^{ba}	11.82 ^c	15.20 ^b	12.60 ^c	14.15 ^a	9.30 ^d	13.43 ^b	8.71 ^c	8.71 ^c	9.30 ^d	12.60 ^c	14.15 ^a	9.30 ^d	13.43 ^b	12.60 ^c	8.71 ^c	14.94 ^a	12.37 ^b	14.94 ^a	12.37 ^b	
13.	22.49 ^c	27.27 ^a	18.02 ^d	25.37 ^b	12.79 ^c	22.32 ^a	11.43 ^c	18.81 ^b	25.48 ^a	29.17 ^c	21.39 ^d	26.89 ^b	20.81 ^c	26.06 ^a	15.62 ^d	24.71 ^b	16.34 ^c	16.34 ^c	15.62 ^d	20.81 ^c	26.06 ^a	15.62 ^d	24.71 ^b	20.81 ^c	16.34 ^c	25.73 ^a	21.80 ^b	25.73 ^a	21.80 ^b	
14.	2.67 ^a	2.54 ^b	2.70 ^a	2.67 ^a	2.92 ^b	2.70 ^a	3.22 ^a	2.96 ^b	2.87 ^a	2.70 ^b	2.86 ^a	2.80 ^a	2.46 ^a	2.38 ^b	2.49 ^a	2.51 ^a	2.95 ^a	2.95 ^a	2.49 ^a	2.46 ^a	2.38 ^b	2.49 ^a	2.51 ^a	2.46 ^a	2.95 ^a	2.81 ^b	2.46 ^a	2.81 ^b	2.46 ^a	
15.	1.18 ^a	1.13 ^b	1.15 ^b	1.20 ^a	1.23 ^a	1.21 ^a	1.27 ^a	1.27 ^a	1.26 ^a	1.18 ^d	1.20 ^c	1.23 ^b	1.11 ^b	1.08 ^c	1.10 ^b	1.17 ^a	1.25 ^a	1.25 ^a	1.10 ^b	1.11 ^b	1.08 ^c	1.10 ^b	1.17 ^a	1.11 ^b	1.25 ^a	1.22 ^b	1.11 ^b	1.22 ^b	1.11 ^b	
16.	65.53 ^a	64.58 ^a	64.58 ^a	64.16 ^a	63.09 ^a	63.41 ^a	66.25 ^a	61.27 ^a	64.50 ^b	63.93 ^a	67.38 ^b	63.65 ^b	66.79 ^a	65.34 ^a	61.72 ^b	64.99 ^a	63.51 ^a	63.51 ^a	61.72 ^b	64.50 ^b	63.93 ^a	67.38 ^b	63.65 ^b	66.79 ^a	65.34 ^a	64.87 ^a	64.71 ^a	64.87 ^a	64.71 ^a	
17.	1.30 ^a	1.28 ^b	1.32 ^a	1.28 ^b	1.20 ^b	1.23 ^b	1.30 ^a	1.21 ^b	1.47 ^a	1.36 ^c	1.48 ^a	1.39 ^b	1.15 ^b	1.20 ^a	1.18 ^a	1.18 ^a	1.23 ^b	1.23 ^b	1.18 ^a	1.47 ^a	1.36 ^c	1.48 ^a	1.39 ^b	1.15 ^b	1.20 ^a	1.43 ^a	1.18 ^a	1.43 ^a	1.18 ^a	
18.	0.78 ^a	0.75 ^b	0.77 ^{ba}	0.77 ^a	0.73 ^b	0.74 ^b	0.81 ^a	0.73 ^b	0.81 ^a	0.75 ^a	0.80 ^b	0.80 ^a	0.76 ^a	0.76 ^a	0.74 ^b	0.75 ^{ba}	0.75 ^b	0.75 ^b	0.74 ^b	0.81 ^a	0.75 ^a	0.80 ^b	0.80 ^a	0.76 ^a	0.75 ^{ba}	0.79 ^a	0.75 ^b	0.79 ^a	0.75 ^b	
19.	35.77 ^b	36.49 ^b	37.64 ^a	35.37 ^c	34.49 ^b	39.32 ^a	42.35 ^a	30.14 ^c	38.12 ^b	38.50 ^b	40.15 ^a	37.68 ^b	33.70 ^a	34.24 ^a	34.71 ^a	33.80 ^a	36.58 ^b	36.58 ^b	34.71 ^a	38.12 ^b	38.50 ^b	40.15 ^a	37.68 ^b	33.70 ^a	34.24 ^a	38.61 ^a	34.11 ^c	38.61 ^a	34.11 ^c	
20.	29.50 ^b	32.03 ^a	29.10 ^c	32.26 ^a	27.21 ^c	29.79 ^a	25.48 ^d	28.62 ^b	31.20 ^d	32.60 ^b	31.66 ^c	33.24 ^a	28.17 ^b	31.76 ^a	27.11 ^c	31.76 ^a	27.78 ^a	27.78 ^a	27.11 ^c	28.17 ^b	32.60 ^b	31.66 ^c	33.24 ^a	28.17 ^b	31.76 ^a	32.17 ^a	29.70 ^b	32.17 ^a	29.70 ^b	
21.	97.22 ^a	86.96 ^b	98.88 ^a	86.46 ^b	80.28 ^c	74.72 ^b	82.07 ^a	73.41 ^b	83.41 ^a	77.54 ^b	84.87 ^a	75.49 ^b	112.30 ^b	97.34 ^c	114.15 ^b	98.40 ^c	77.62 ^c	77.62 ^c	114.15 ^b	83.41 ^a	77.54 ^b	84.87 ^a	75.49 ^b	112.30 ^b	97.34 ^c	80.33 ^b	105.55 ^a	80.33 ^b	105.55 ^a	
22.	132.75 ^b	142.91 ^a	132.27 ^b	143.99 ^a	121.00 ^c	124.69 ^a	120.76 ^c	124.90 ^a	122.65 ^b	132.57 ^a	122.87 ^b	133.14 ^a	143.72 ^c	154.86 ^b	142.54 ^c	156.54 ^a	122.84 ^c	122.84 ^c	142.54 ^c	122.65 ^b	132.57 ^a	122.87 ^b	133.14 ^a	143.72 ^c	154.86 ^b	127.81 ^a	149.41 ^a	127.81 ^a	149.41 ^a	
23.	10.01 ^a	6.85 ^b	6.94 ^b	7.31 ^b	7.61 ^a	6.43 ^{ba}	5.12 ^b	8.02 ^a	11.49 ^a	6.66 ^c	9.59 ^b	8.89 ^b	8.89 ^a	7.08 ^b	4.65 ^d	5.73 ^c	6.79 ^b	6.79 ^b	4.65 ^d	8.89 ^a	6.66 ^c	9.59 ^b	8.89 ^b	8.89 ^a	7.08 ^b	9.61 ^a	6.59 ^b	9.61 ^a	6.59 ^b	
24.	-	46.01 ^a	-	45.88 ^a	-	45.07 ^a	-	44.72 ^a	-	45.68 ^a	-	45.52 ^a	-	46.43 ^a	-	46.36 ^a	44.90 ^c	44.90 ^c	45.52 ^a	45.68 ^a	-	45.52 ^a	-	46.43 ^a	44.90 ^c	45.60 ^b	46.40 ^a	45.60 ^b	46.40 ^a	

E1 - Raichur rainy, E2 - Raichur post rainy, E3 - Kawadimatti rainy, E4 - Kawadimatti post rainy, FST - *Festuca*, HYPO - *Hypogaea*, VUL - *Vidgarrs*.

PHH - Plant height (cm), NPB - Number of primary branches, LPH - Length of the primary branches (cm), NNMS - Number of nodes on main stem, LCB - Length of the cotyledonary branches (cm), NNGB - Number of nodes on cotyledonary branches, TNP - Total number of pods, NMP - Number of mature pods, NPP - Number of pegs per plant, PIN - Pod length (cm), PWD - Pod width, SLP₀ - Spelling per cent, SLN - Seed length (cm), SWD - Seed width (cm), LLN - Leaf length (cm), LWD - Leaf width (cm), DIF - days to initiation of flowering, DCF - Days to cessation of flowering, DM - Days to maturity, PYP - Pod yield per plant (g), OIL - Oil content (%)

Table 11 : Variance for different vegetative and reproductive traits at Raichur and Kawadimatti during 2000 rainy and 2000-01 post rainy seasons in Karnataka

Sl No.	Traits	Environments				T.S.	FST				T.S.	HYPO				T.S.	VUL				T.S.	FST	HY	VU	TS
		E1	E2	E3	E4		E1	E2	E3	E4		E1	E2	E3	E4		E1	E2	E3	E4					
1	LLN	0.567	0.417	0.521	0.51	**	0.36	0.162	0.22	0.331	NS	0.318	0.205	0.237	0.297	*	0.331	0.183	0.22	0.25	**	0.27	0.274	0.25	NS
2	LWD	0.079	0.06	0.107	0.08	NS	0.054	0.026	0.018	0.046	NS	0.012	0.020	0.045	0.035	NS	0.081	0.043	0.05	0.06	**	0.038	0.036	0.069	**
3	PHH	27.98	31.12	33.10	20.71	**	63.18	61.00	81.02	36.01	NS	23.69	17.20	21.93	14.48	NS	20.97	31.99	23.41	19.81	*	62.41	21.72	36.39	**
4	PHB	1.15	1.85	1.42	1.65	NS	0.99	0.646	0.12	0.81	NS	1.01	2.28	1.11	1.24	**	0.71	1.31	1.17	0.97	NS	1.11	1.59	1.42	NS
5	LPB	26.46	9.61	20.19	10.13	**	9.31	3.53	18.05	8.35	NS	21.67	9.82	17.12	12.35	**	11.86	9.98	20.85	4.35	**	9.03	18.58	13.15	**
6	NNB	1.35	2.02	5.25	1.47	**	1.35	1.96	0.28	1.11	NS	1.35	1.96	0.28	1.11	NS	1.35	1.96	0.28	1.11	*	2.28	2.28	7.42	*
7	LSB	6.41	0.95	5.91	2.81	**	0.11	0.88	7.35	2.81	**	0.11	0.88	7.35	2.81	**	0.11	0.88	7.35	2.81	*	3.78	3.78	4.28	NS
8	NNMS	3.75	6.87	6.07	3.818	**	10.08	1.79	9.12	4.36	NS	2.83	6.88	5.81	4.25	NS	3.41	6.69	5.05	3.14	**	7.12	5.59	5.24	NS
9	LCB	46.31	19.01	48.13	31.71	NS	62.31	17.16	97.07	33.25	**	15.00	15.33	30.22	33.99	*	30.52	48.78	27.61	33.98	**	61.71	15.61	19.57	NS
10	NNCB	30.99	22.61	27.57	22.06	**	18.02	21.94	19.85	19.92	NS	32.31	23.50	15.99	23.83	**	12.32	17.81	17.98	16.08	NS	19.81	26.55	22.55	NS
11	INP	46.31	42.05	29.19	30.60	**	8.98	13.09	10.22	23.77	*	51.98	17.95	36.25	36.37	*	26.26	32.96	12.35	20.61	**	23.79	49.00	31.70	**
12	NAP	35.00	27.30	19.28	22.96	**	5.72	10.39	7.20	20.77	**	11.13	30.48	27.49	25.97	**	17.70	21.66	8.21	16.60	**	16.21	35.56	19.45	**
13	SPP	59.16	55.75	41.06	43.65	**	17.11	16.90	14.40	27.25	NS	61.47	61.99	53.88	50.34	NS	39.76	46.91	16.75	31.82	**	38.23	64.76	50.21	**
14	PHN	0.15	0.11	0.18	0.12	**	0.11	0.15	0.12	0.11	NS	0.155	0.10	0.13	0.106	*	0.06	0.068	0.06	0.08	*	0.16	0.129	0.07	**
15	PWD	0.017	0.01	0.013	0.01	NS	0.008	0.011	0.006	0.009	NS	0.014	0.017	0.011	0.013	NS	0.009	0.009	0.009	0.011	NS	0.009	0.015	0.01	**
16	SH	99.93	62.20	80.16	65.01	**	53.19	65.71	72.93	82.79	NS	78.33	60.25	75.89	62.06	*	104.7	63.00	69.67	64.35	**	70.07	71.11	78.61	**
17	SHN	0.04	0.025	0.04	0.02	**	0.008	0.008	0.009	0.007	NS	0.035	0.021	0.029	0.024	**	0.017	0.017	0.016	0.013	NS	0.009	0.03	0.016	**
18	SWD	0.006	0.005	0.007	0.007	NS	0.001	0.001	0.001	0.001	NS	0.001	0.006	0.006	0.008	NS	0.001	0.005	0.006	0.005	NS	0.005	0.007	0.005	**
19	SDWT	55.94	50.02	68.96	40.11	**	69.99	27.13	46.09	18.89	NS	51.86	60.16	70.95	40.58	**	46.01	33.60	51.14	32.28	**	58.88	57.33	41.55	**
20	PH	6.91	5.37	10.26	7.59	**	3.95	3.95	1.04	4.01	NS	4.96	5.37	6.03	6.46	NS	4.02	4.60	3.30	6.33	**	6.64	6.32	8.91	**
21	PLN	157.82	208.19	371.63	272.15	**	105.20	50.06	99.35	61.65	NS	232.99	179.91	248.07	248.06	**	61.14	115.51	71.16	135.6	NS	90.35	241.22	115.46	**
22	DM	205.51	258.12	180.82	251.46	**	55.5	97.93	56.47	101.66	NS	156.19	151.18	115.95	151.81	**	46.98	67.34	52.38	57.87	NS	79.73	176.31	93.55	**
23	PYP	18.06	10.23	18.13	13.68	**	8.18	7.11	8.92	12.71	NS	21.60	8.42	20.16	16.48	**	11.96	12.28	4.60	8.38	NS	19.28	19.08	11.81	**
24	DB	5.44	5.44	5.44	4.95	NS	7.06	7.06	7.06	6.13	NS	6.06	6.06	6.06	6.06	NS	4.09	4.09	4.09	3.29	**	6.51	6.172	3.69	**

Note : TS - Test of significance. NS - Non significant. ** Significant at 1% * Significant at 5%

11 Raichur rainy. E2 Raichur post rainy. E3 Kawadimatti rainy. E4 Kawadimatti post rainy. FST - Fastigata. HYPO - Hypogaea. VU - Vulgaris.

PHH - Plant height (cm), NPB - Number of primary branches, LPH - Length of the primary branches (cm), NNSM - Number of nodes on main stem, LCB - Length of the cotyledonary branches (cm), NNCB - Number of nodes on cotyledonary branches, TNP - Total number of pods, NMP - Number of mature pods, NPP - Number of pods per plant, PLN - Pod length (cm), PWD - Pod width, SH% - Shelling per cent, SHN - Seed length (cm), SWD - Seed width (cm), LLN - Leaf length (cm), LWD - Leaf width (cm), DIF - days to initiation of flowering, DCF - Days to cessation of flowering, DM - Days to maturity, PYP - Pod yield per plant (g), DB - Oil content (%).

4.2.1.5.1 Leaflet length (cm) (LL)

A wide variation was observed at all the four environments with a range of 3.66-7.66, 3.83-7.03, 3.22-7.09 and 3.92-7.74 at E1, E2, E3 and E4, respectively with a co-efficient of variation of 13.45, 11.66, 13.40 and 12.88, accordingly. In E1 var. *fastigiata* (5.06-6.92), E3 var. *hypogaea* (3.22-7.09) and E1 var. *vulgaris* (3.78-7.44) showed highest range, with a maximum CV of 9.93 (E1), 10.86 (E4) and 9.50 (E1) respectively. Among botanical varieties *hypogaea* had wide range of 3.22-7.20 with CV. of 10.52.

4.2.1.5.2 Leaflet width (cm) (LW)

A wide range of 1.26-3.16 at E1, 1.78-2.97 at E2, 1.38-3.81 at E3 and 1.78-3.22 at E4 were observed with CV. of 12.33, 10.94, 13.58 and 12.47, respectively. Botanical variety wise *fastigiata* exhibited wide variation of 2.37-2.89, *hypogaea* of 1.30-3.81 and *vulgaris* 1.91-3.19 at E3 with maximum CV, of 9.21 (E1), 9.86 (E3) and 11.93 (E1) per cent, respectively. Among botanical varieties *hypogaea* had highest range (1.26-3.81) and *vulgaris* had highest CV (10.50%).

4.2.1.5.3 Plant height (cm) (PLHT)

Variation of 15.2-59.6 (E1), 16.2-52.8 (E2), 9.00-50.6 (E3) and 16.2-46.6 (E4) were observed for plant height, with a CV of 18.20, 19.38, 25.78 and 16.23 per cent, respectively. At E3 for *fastigiata* (14.0-50.6), at E1 for *hypogaea* (19.4-59.6) and at E2 for *vulgaris* (17.2-52.8) wide range was noticed and maximum CV were 27.72 (E3), 21.77 (E3) and 22.19 (E3) per cent, respectively. Similarly, among botanical varieties *hypogaea* had wide range (11.2-59.6) and highest CV of 24.11 per cent was recorded in *fastigiata* (Table 12 and 13).

Table 12 : Range for different vegetative and reproductive traits at Raichur and Kawadimatti during 2000 rainy and 2000-01 post rainy seasons in Karnataka

Sl. No	Traits	Environments				EST			
		E1	E2	E3	E4	E1	E2	E3	E4
1.	LLN	3.66-7.76	3.83-7.03	3.22-7.09	3.92-7.75	4.78-7.76	5.06-6.92	4.48-6.67	4.90-7.74
2.	LWD	1.26-3.16	1.78-2.97	1.30-3.81	1.78-3.22	2.20-3.16	2.12-2.71	2.37-2.89	2.16-3.18
3.	PLHT	15.20-59.60	16.2-52.8	9.00-50.60	16.20-46.60	24.60-51.40	15.20-46.80	14.00-50.60	19.3-40.8
4.	NPB	1.00-7.40	1.00-10.00	0.20-8.20	1.00-10.80	1.00-4.20	2.90-4.80	1.00-2.00	1.00-5.20
5.	LPB	1.00-32.70	1.70-22.00	1.66-27.30	1.70-20.60	1.80-11.50	2.80-11.66	1.66-17.40	1.80-10.80
6.	NSB	1.00-5.00	2.00-7.00	0.00-9.00	2.00-6.00	0.00	0.00-1.00	0.00	0.00
7.	LSB	2.00-12.00	2.00-6.00	2.00-10.00	2.00-8.00	0.00	0.00-6.00	0.00	0.00
8.	NNMS	8.33-25.80	10.20-39.30	7.50-26.00	10.20-26.80	11.80-25.80	13.20-22.20	10.00-22.40	13.20-20.50
9.	LCB	18.5-58.80	18.50-61.60	15.30-54.00	18.50-60.20	26.10-52.80	24.50-49.60	21.80-54.00	20.40-45.80
10.	NNCB	13.50-47.4	17.80-51.20	8.50-43.20	17.80-50.20	17.00-34.60	19.80-38.20	17.00-34.00	20.20-38.60
11.	TNP	4.60-50.6	5.30-43.00	4.00-33.20	5.30-40.80	4.60-17.40	9.80-23.80	4.60-20.30	5.30-23.50
12.	LMP	2.20-45.00	2.00-34.00	2.00-30.20	2.00-30.0	2.20-12.00	5.60-17.60	3.80-17.30	2.00-18.00
13.	NPP	7.20-56.20	9.40-53.20	7.00-48.60	9.40-50.60	7.20-24.60	14.20-29.00	7.00-25.60	9.40-27.00
14.	PLN	1.84-4.30	1.80-3.70	1.80-4.60	1.80-3.90	2.20-3.50	1.92-3.32	2.45-3.83	2.24-3.80
15.	PWD	0.90-1.78	0.94-1.70	0.82-1.64	0.94-1.80	1.04-1.40	0.95-1.40	1.10-1.40	1.03-1.41
16.	SH	41.80-81.00	50.20-80.00	50.00-82.40	50.20-81.00	51.80-76.00	50.60-76.60	51.40-79.00	50.30-76.60
17.	SLN	0.89-2.00	0.90-1.83	0.88-2.05	0.98-1.98	1.00-1.38	1.02-1.39	1.12-1.45	0.99-1.32
18.	SWD	0.60-1.22	0.56-1.20	0.05-1.04	0.57-1.23	0.64-0.94	0.64-0.86	0.66-0.90	0.62-1.02
19.	SDWT	20.3-63.8	18.80-63.60	20.30-68.10	22.30-60.80	20.60-63.20	28.30-52.10	30.20-52.40	22.50-39.6
20.	DIF	20.00-36.00	27.00-39.00	23.00-37.00	25.00-38.00	22.00-32.00	27.00-36.00	23.00-30.00	25.00-36.00
21.	DCF	60.00-123.0	50.0-100.0	60.00-125.0	45.00-112.0	70.00-115.0	69.00-103.0	70.00-117.0	68.00-103.0
22.	DM	102.0-152.0	110.0-162.0	103.0-158.0	110.0-166.0	116.0-159.0	120.0-159.0	116.0-152.0	119.0-161.0
23.	PYP	2.08-27.12	2.09-22.75	2.00-23.00	2.03-25.3	2.81-14.94	2.73-13.00	2.20-18.60	3.58-19.82
24.	OIL	-	34.00-50.00	-	35.00-49.00	-	38.00-50.00	-	39.00-48.00

Table 12 Contd...

Sl No	Traits	HYPO				VUL			
		E1	E2	E3	E4	E1	E2	E3	E4
1.	LLN	3.66-7.20	3.83-7.03	3.22-7.09	3.92-6.68	3.78-7.44	4.49-6.95	4.28-7.04	4.08-7.14
2.	LWD	1.26-2.96	1.77-2.68	1.30-3.81	1.78-2.74	1.74-3.04	1.81-2.97	1.91-3.91	1.94-3.22
3.	PLHT	19.40-59.60	14.4-41.6	11.20-35.50	18.3-40.8	15.2-49.4	17.2-52.8	9.00-44.40	16.2-46.60
4.	NPB	1.00-7.40	1.00-10.00	0.20-6.00	1.20-10.80	1.00-6.20	1.00-7.60	0.20-8.20	1.00-6.70
5.	LPB	3.00-32.70	2.80-21.38	2.20-21.93	1.70-20.60	1.00-22.66	2.00-22.0	1.75-27.30	1.80-14.70
6.	NSB	1.00-5.00	1.00-7.00	0.00-1.00	2.00-6.00	0.00	0.00-4.00	1.00-9.00	0.00
7.	LSB	2.00-12.00	2.00-6.00	2.00-10.00	2.00-8.00	0.00	0.00-6.00	2.00-9.00	0.00
8.	NNMS	11.20-23.20	10.40-39.30	7.50-26.00	10.40-26.80	8.33-23.80	10.00-28.00	8.20-23.80	10.20-23.60
9.	LCB	18.50-58.80	17.50-61.20	18.33-48.60	18.50-60.20	15.50-53.90	15.80-61.60	15.30-53.50	19.82-55.80
10.	NNCB	13.50-47.40	17.00-51.20	17.00-43.20	17.80-50.20	17.20-37.00	17.60-41.40	8.50-34.40	18.20-41.80
11.	TNP	7.40-50.60	6.60-43.00	5.33-35.20	8.80-40.80	5.50-33.20	6.80-35.20	4.00-26.25	9.20-32.30
12.	LMP	4.40-45.00	4.00-34.00	2.50-30.20	4.30-30.60	3.50-24.00	3.60-32.00	2.00-21.00	3.60-29.60
13.	NPP	10.80-56.20	10.00-53.20	7.00-48.60	12.60-50.60	8.60-39.00	11.80-48.40	7.00-28.30	12.80-41.60
14.	PLN	2.00-4.30	1.80-3.70	1.80-4.60	1.80-3.90	1.84-3.36	1.54-3.35	1.99-3.10	1.90-3.56
15.	PWD	1.00-1.78	0.84-1.70	0.90-1.64	1.00-1.80	0.90-1.65	0.80-1.40	0.82-1.50	0.94-1.50
16.	SH	41.80-81.40	50.60-81.00	50.00-82.40	50.20-81.60	50.60-82.60	50.40-79.40	50.0-82.40	50.30-80.20
17.	SLN	0.90-2.00	0.90-1.83	1.02-2.05	1.05-1.98	0.89-1.63	0.93-1.70	0.88-1.66	0.92-1.53
18.	SWD	0.63-1.22	0.56-1.04	0.62-1.04	0.55-1.23	0.60-1.00	0.60-1.20	0.50-0.99	0.57-1.02
19.	SDWT	20.60-63.80	18.60-63.60	20.3-68.1	22.7-60.80	20.30-56.30	21.20-56.50	22.00-61.20	22.30-49.80
20.	DF	20.00-36.00	28.00-38.00	23.00-37.00	28.00-38.00	22.00-35.00	27.00-39.00	24.00-37.00	25.00-38.00
21.	DCF	60.00-114.0	50.00-110.00	60.00-120.0	45.00-112.0	73.00-123.0	57.00-109.0	63.00-125.0	70.00-112.0
22.	DM	102.0-149.0	110.00-160.00	103.0-143.0	110.0-166.0	115.0-152.0	120.0-162.0	108.0-158.0	120.0-166.0
23.	PYP	2.56-27.20	2.30-17.22	2.04-23.00	2.87-25.30	2.08-18.20	2.09-22.75	2.00-15.22	2.03-17.30
24.	OIL	-	36.00-50.00	-	35.00-49.00	-	34.00-49.00	-	38.00-49.00

Table 12 Contd ...

Sl.No	Traits	Bot comparison		
		FST	HYP0	VUL
1.	LLN	4.48-7.76	3.22-7.20	3.78-7.44
2.	LWD	2.12-3.18	1.26-3.81	1.74-3.22
3.	PLHT	14.00-51.40	11.20-59.60	9.00-52.80
4.	NPB	1.00-5.20	0.20-10.80	0.20-8.20
5.	LPB	1.66-17.11	1.70-32.70	1.00-27.30
6.	NSB	-	0.00-7.00	1.00-9.00
7.	LSB	-	2.00-12.00	2.00-9.00
8.	NNMS	10.00-25.80	7.50-39.30	8.20-28.00
9.	LCB	20.40-54.00	17.50-61.20	15.30-61.60
10.	NNCB	17.00-38.60	13.50-51.20	8.50-41.80
11.	TNP	4.60-23.80	5.33-50.60	4.00-35.20
12.	LMP	2.00-18.00	2.50-45.00	2.00-32.00
13.	NPP	7.00-29.00	7.00-56.20	7.00-48.40
14.	PLN	1.92-3.83	1.80-4.60	1.54-3.56
15.	PWD	0.95-1.41	0.84-1.80	0.80-1.65
16.	SH	50.30-79.0	41.80-81.40	50.00-81.00
17.	SLN	0.99-1.45	0.90-2.05	0.88-1.70
18.	SWD	0.62-1.02	0.56-1.23	0.50-1.20
19.	SDWT	20.60-63.20	18.60-68.10	20.30-61.20
20.	DIF	22.0-36.00	20.00-38.00	22.00-39.00
21.	DCF	68.00-117.0	45.0-120.00	57.00-125.0
22.	DM	116.0-145.0	102.0-166.0	108.0-166.0
23.	PYP	2.20-19.82	2.04-27.12	2.00-22.75
24.	OIL	38.00-50.00	35.00-50.00	34.00-49.00

PLHT - Plant height (cm), NPB - Number of primary branches. LPB - Length of the primary branches (cm). NNMS - Number of nodes on main stem. LCB - Length of the cotyledonary branches (cm), NNCB - Number of nodes on cotyledonary branches. TNP - Total number of pods, NMP - Number of mature pods. NPP - Number of pegs per plant, PLN - Pod length (cm), PWD - Pod width. SH% - Shelling per cent. SLN - Seed length (cm). SWD - Seed width (cm), LLN - Leaf let length (cm), LWD - Leaf let width (cm). DIF - days to initiation of flowering, DCF - Days to cessation of flowering. DM - Days to maturity. PYP - Pod yield per plant (g). OIL - Oil content (%).

Table 13 : Co-efficient of variation for different vegetative and reproductive traits at Raichur and Kawadimatti during 2000 rainy and 2000-01 post rainy seasons in Karnataka

Sl. No.	Traits	Environments												EST												HYPO												VUI												Hot comparison		
		Raichur rainy				Raichur post rainy				Kawadimatti rainy				Kawadimatti post rainy				F2			HYPO			VUI			Hot comparison																									
		F1	F2	F3	F4	F1	F2	F3	F4	F1	F2	F3	F4	F1	F2	F3	F4	F1	F2	F3	F4	F1	F2	F3	F4	EST	HYPO	VUI	EST	HYPO	VUI																					
1	L.N	13.45	11.66	13.40	12.88	9.93	6.65	8.13	9.42	11.13	9.01	10.14	10.86	9.50	7.17	8.05	8.37	10.52	8.63	10.52	8.18	8.63	10.52	8.18	8.63	10.52	8.18	8.63	10.52	8.18	8.63	10.52																				
2	LWD	12.33	10.94	13.58	12.47	9.21	6.75	5.32	8.52	9.52	6.66	9.86	8.76	11.93	8.44	8.76	10.11	8.84	7.83	8.84	10.50	8.84	7.83	8.84	10.50	8.84	7.83	8.84	10.50	8.84	7.83	8.84	10.50																			
3	PHI	18.20	19.38	25.78	16.23	22.63	24.00	27.72	19.80	17.69	15.61	21.77	14.45	15.36	18.58	22.19	15.13	19.51	24.11	19.51	21.64	19.51	24.11	19.51	21.64	19.51	24.11	19.51	21.64	19.51	24.11	19.51	21.64																			
4	NPB	50.10	40.81	57.67	41.87	60.88	27.82	27.09	33.35	35.85	42.61	43.04	33.87	51.60	37.09	71.24	44.20	41.52	46.76	41.52	56.40	41.52	46.76	41.52	56.40	41.52	46.76	41.52	56.40	41.52	46.76	41.52	56.40																			
5	LPB	60.46	40.29	49.24	49.52	55.64	27.76	72.90	53.55	43.31	40.23	41.14	45.76	60.83	41.14	55.91	40.59	46.57	51.19	46.57	55.08	46.57	51.19	46.57	55.08	46.57	51.19	46.57	55.08	46.57	51.19	46.57	55.08																			
6	NSB	67.28	41.96	43.30	35.28	-	-	-	-	67.28	40.73	106.90	35.28	-	-	-	-	-	-	-	90.85	-	-	-	-	-	-	-	-	-	-	-	-																			
7	LSB	39.61	21.32	45.49	36.58	-	-	-	-	39.61	20.91	51.66	36.58	-	-	-	-	-	-	-	37.16	-	-	-	-	-	-	-	-	-	-	-	-																			
8	NNMS	12.46	16.28	17.38	12.15	17.99	12.58	18.13	12.67	10.96	16.76	17.59	13.13	11.92	15.80	15.73	10.82	15.64	15.66	15.66	14.71	15.66	15.73	10.82	15.66	15.73	10.82	15.66	15.73	10.82	15.66	15.73	10.82																			
9	LCB	19.12	19.58	24.41	17.96	21.35	19.90	27.67	18.02	17.47	18.04	17.35	17.16	16.85	20.30	21.50	18.19	19.11	22.59	22.59	22.81	19.11	22.59	22.59	19.11	22.59	22.59	19.11	22.59	22.59	19.11	22.59	22.59	19.11																		
10	NNCB	19.51	16.55	21.88	17.06	16.02	17.12	17.44	17.03	17.87	16.04	14.65	16.73	13.69	15.40	20.49	15.34	17.38	16.87	16.87	19.01	16.87	15.40	20.49	15.34	16.87	15.40	20.49	15.34	16.87	15.40	20.49	15.34	16.87																		
11	INP	37.82	30.73	38.24	27.97	30.09	21.50	34.73	33.77	35.97	30.12	36.06	28.54	31.11	28.96	28.58	23.73	34.19	38.75	38.75	33.25	34.19	28.96	28.58	23.73	38.75	34.19	28.96	28.58	23.73	38.75	34.19	28.96																			
12	NNB	42.99	34.25	42.62	34.17	36.97	26.79	40.42	47.23	41.93	32.80	44.34	33.53	33.39	32.90	30.89	30.34	39.92	46.21	46.21	35.66	39.92	32.90	30.89	30.34	46.21	39.92	35.66	39.92	35.66	39.92	35.66	39.92	35.66																		
13	NPP	34.20	27.38	36.83	26.04	32.33	18.42	33.22	27.75	30.77	26.99	34.32	26.39	30.30	26.29	26.21	22.83	31.28	37.85	37.85	32.50	31.28	26.29	26.21	22.83	37.85	31.28	32.50	31.28	32.50	31.28	32.50	31.28	32.50																		
14	PLN	14.60	13.28	14.24	13.17	11.45	14.69	11.05	12.81	13.72	11.92	12.84	11.62	10.27	10.96	10.06	11.75	12.80	13.80	13.80	10.86	12.80	10.96	10.06	11.75	13.80	12.80	13.80	12.80	13.80	12.80	13.80	12.80	13.80																		
15	PWD	10.93	10.95	9.98	9.54	7.19	8.47	6.05	7.35	9.30	11.04	8.78	9.32	8.61	8.84	8.74	9.10	9.95	7.48	7.48	9.33	9.95	8.84	8.74	9.10	7.48	9.95	9.95	7.48	9.95	9.95	7.48	9.95	9.95																		
16	SH	14.55	12.21	13.87	12.57	11.56	12.79	12.89	14.85	13.72	12.14	12.93	12.38	15.32	12.15	13.52	12.34	13.00	13.18	13.18	13.70	13.00	12.15	13.52	12.34	13.18	13.00	13.18	13.00	13.18	13.00	13.18	13.00	13.18	13.00																	
17	SLN	17.02	12.33	15.67	13.30	7.58	7.31	7.30	7.12	12.77	10.73	11.59	11.18	11.37	10.89	10.83	9.79	12.12	7.89	7.89	10.80	12.12	10.89	10.83	9.79	7.89	12.12	10.80	12.12	10.80	12.12	10.80	12.12	10.80	12.12																	
18	SWD	10.02	9.56	10.54	10.76	8.83	8.37	6.64	11.17	10.36	9.96	9.94	11.11	8.26	9.32	10.17	9.05	10.70	9.60	9.60	9.25	10.70	9.32	10.17	9.05	9.60	10.70	9.25	10.70	9.25	10.70	9.25	10.70	9.25	10.70																	
19	SDWT	20.91	19.38	22.06	17.97	24.26	13.25	14.19	14.42	19.43	20.15	20.98	16.91	20.14	16.93	21.20	16.81	19.61	20.98	20.98	18.90	19.61	20.15	20.98	16.81	20.98	19.61	18.90	19.61	20.98	19.61	20.98	19.61	20.98	19.61																	
20	DPI	8.92	7.24	11.10	8.54	7.31	6.68	7.89	7.49	7.14	7.11	7.76	7.65	7.12	6.76	6.70	7.93	7.81	9.28	9.28	10.07	7.81	6.76	6.70	7.93	9.28	7.81	10.07	7.81	9.28	7.81	9.28	7.81	9.28																		
21	PCF	19.46	16.59	19.50	19.08	12.78	9.47	12.15	10.70	18.28	17.30	18.45	20.86	7.15	6.85	7.40	6.71	19.33	12.25	12.25	10.18	19.33	6.85	7.40	6.71	12.25	19.33	10.18	19.33	10.18	19.33	10.18	19.33	10.18	19.33																	
22	DM	10.80	11.25	10.17	11.08	6.16	7.94	6.22	8.07	10.19	10.15	8.76	9.25	4.23	5.30	5.08	4.86	10.19	7.27	7.27	6.47	10.19	5.30	5.08	4.86	7.27	10.19	6.47	10.19	6.47	10.19	6.47	10.19	6.47	10.19																	
23	PYP	42.47	46.71	61.36	52.39	37.60	41.60	58.30	44.52	40.44	43.59	47.18	45.65	38.91	49.48	47.15	50.50	48.44	47.22	47.22	52.23	48.44	49.48	47.15	50.50	47.22	48.44	52.23	48.44	47.22	48.44	52.23	48.44	52.23																		
24	OIL	-	5.07	-	4.85	-	5.90	-	5.54	-	5.49	-	5.41	-	4.36	-	3.91	5.45	5.60	5.60	4.14	5.45	4.36	-	3.91	5.60	5.45	4.14	5.45	5.60	5.45	4.14	5.45																			

E1 - Raichur rainy; E2 - Raichur post rainy; E3 - Kawadimatti rainy; E4 - Kawadimatti post rainy
 EST - *Estimate*; HYPO - *Hypogaea*; VUI - *Vicia*
 PLPH - Plant height (cm); NPB - Number of primary branches; LPB - Length of the primary branches (cm); NNMS - Number of nodes on main stem; LCB - Length of the cotyledonary branches (cm)
 NNCB - Number of nodes on cotyledonary branches; TNP - Total number of pods; NMP - Number of mature pods; NPP - Number of pods per plant; PLN - Pod length (cm); PWD - Pod width; SH% - Shelling per cent; SLN - Seed length (cm); SWD - Seed width (cm); L.N - Leaf length (cm); L.WD - Leaf width (cm); DIF - days to initiation of flowering; DCF - Days to cessation of flowering; DM - Days to maturity; PYP - Pod yield per plant (g); OIL - Oil content (%).

4.2.1.5.4 Number of primary branches per plant (NPB)

At all four environments E1, E2, E3 and E4 wide range was observed having 1.0-7.4, 1.0-10.0, 0.2-8.2 and 1.0-10.8, respectively with CV of 50.10, 40.81, 57.67 and 41.87, accordingly. Highest range of 1.0-5.2 (E4), 1.2-10.8 (E4), 0.2-8.2 (E3) were observed for *fastigiata*, *hypogaea* and *vulgaris* respectively with highest CV of 60.88 (E1), 43.01 (E3) and 71.24 (E3) per cent, respectively. Similarly, among botanical varieties *hypogaea* had highest range (0.2-10.8) and *vulgaris* had highest CV (56.40%).

4.2.1.5.5 Length of the primary branches (LPB)

Range of 1.00-32.72 (E1), 1.7-22.0 (E2), 1.66-27.30 (E3) and 1.70-20.60 (E4) were observed with a CV of 60.46, 40.29, 49.24 and 49.25 per cent, respectively. For botanical variety at E3 (1.66-17.4), at E1 (3.0-32.7) and E3 (1.75-27.3) highest range was noticed in *fastigiata*, *hypogaea* and *vulgaris*, respectively, with CV of 72.90 (E3), 45.76 (E4) and 60.83 (E1) per cent, respectively. While among botanical varieties range of 1.7-32.7 was highest in *hypogaea* and CV of 55.08 per cent was highest in *vulgaris* (Table 12 and 13).

4.2.1.5.6 Number of secondary branches (NSB)

Range of 1-5, 2-7, 0-9 and 2-6 at E1, E2, E3 and E4 were observed with CV of 67.28, 41.96, 143.30 and 35.28 per cent, respectively. In botanical varieties *fastigiata* had no secondary branches, *hypogaea* and *vulgaris* had a range of 1-7 and 1-9, maximum CV of 106.90 (E3) and 101.9 (E3) per cent, respectively. Among botanical varieties *vulgaris* had wide range (1-9), and highest CV (90.85%) for number of secondary branches.

4.2.1.5.7 Length of the secondary branches (cm) (LSB)

59

Ranges were 2-12, 2-6, 2-10 and 2-8 at E1, E2, E3 and E4 with CV of 39.61, 21.32, 45.49 and 36.58 per cent, respectively. *Fastigiata* with no observations, *hypogaea* with highest range of 2-12 at E1, *vulgaris* with 2-9 at E3 and CV of 51.66 and 41.06 at E3 per cent, respectively. Among botanical varieties *hypogaea* had maximum range (2-12) and higher CV (38.57%) (Table 12 and 13).

4.2.1.5.8 Number of nodes on mainstem (NNMS)

Range variation noticed at four different environments were 8.33-25.80, 10.2-29.3, 7.5-26.0 and 10.2-26.8 at E1, E2, E3 and E4, respectively with CV of 12.46, 16.28, 17.38 and 12.15 per cent, accordingly. In botanical varieties for *fastigiata* highest range of 11.8-25.8 (E1), for *hypogaea* 10.4-39.3 (E2) and for *vulgaris* highest range of 10-28 (E2) were observed, which had maximum CV of 18.13 (E3), 17.59 (E3) and 15.80 (E2) per cent, respectively. Among botanical varieties *hypogaea* had wide range (7.5-39.3) and maximum CV was observed in *fastigiata* (15.66%).

4.2.1.5.9 Length of the cotyledonary branches (LCB)

For this trait values ranged from 18.5-58.8 (E1), 18.5-61.6 (E2), 15.3-54.0 (E3) and 18.5-60.2 (E4) with CV of 19.12, 19.58, 24.41 and 17.96 per cent, respectively. For *fastigiata* at E3 (21.8-54.0), for *hypogaea* at E2 (17.5-61.2) and for *vulgaris* at E2 (19.8-61.6) wide range was observed, while maximum CV were at E3 (27.67), E2 (18.04) and at E3 (21.50) per cent, respectively. Among botanical varieties *vulgaris* had highest range (15.3-61.6) and CV (22.81%) (Table 12 and 13).

4.2.5.10 Number of nodes on cotyledonary branches (NNCB)

The range of 13.5-47.4 (E1), 17.8-51.2 (E2), 8.5-43.2 (E3) and 17.8-50.2 (E4) were observed, with CV of 19.51, 16.55, 21.88 and 17.06 for E1, E2, E3 and E4 per cent, respectively. Highest range of 19.8-38.2 (E2), 17.0-51.2 (E2) and 8.5-34.4 (E2) were observed for *fastigiata*, *hypogaea* and *vulgaris*, respectively with maximum CV of 17.44 (E3), 17.87 (E1) and 20.49 (E3) per cent, respectively. Among botanical varieties *hypogaea* had wide range (13.5-51.2) while *vulgaris* had maximum CV (19.01%).

4.2.1.5.11 Total number of pods per plant (TNP)

At different environments for total number of pods per plant values ranged as follows, 4.6-50.6 (E1), 5.3-43.0 (E2), 4.0-35.2 (E3) and 5.3-40.8 (E4), with CV of 37.82, 30.73, 38.24 and 27.97 per cent, respectively. For *fastigiata* at E4 (5.3-23.5), for *hypogaea* at E1 (7.4-50.6) and for *vulgaris* at E2 (6.8-35.2) highest range were observed, with highest CV of 34.73 (E3), 36.06 (E3) and 31.11 (E1) per cent, respectively. Among botanical varieties *hypogaea* had highest range (5.33-50.6) and *fastigiata* had maximum CV (38.75%).

4.2.1.5.12 Total number of mature pods (NMP)

For the total number of mature pods at four different environments ranges observed were 2.2-45.0 (E1), 2.0-34.0 (E2), 2.0-30.2 (E3) and 2.0-30.6 (E4) with CV of 42.99, 34.25, 42.62 and 34.17 in E1, E2, E3 and E4 per cent, environments, respectively. Highest range of 2.0-18.0, 4.4-45.0 and 3.6-32.0 were observed for *fastigiata*, *hypogaea* and *vulgaris*, respectively. While the maximum CV at E4 (47.23), E3 (44.34) and at E1 (33.39). Among botanical varieties *hypogaea* had highest range (2.5-45.0) and *fastigiata* had maximum CV (46.21%) (Table 12 and 13).

4.2.1.5.13 Total number of pegs per plant (TNPP)

The range for total number of pegs per plant was 7.2-56.2 at E1, 9.4-53.2 at E2, 7.0-48.6 at E3 and 9.4-50.6 at E4 with CV of 34.20, 27.38, 36.83 and 26.04 per cent, respectively. In botanical varieties for *fastigiata* at E3 (7.0-25.6), for *hypogaea* at E1 (10.8-56.2) and for *vulgaris* at E2 (11.8-48.4) highest ranges were observed with maximum CV of 33.22 (E3) for *fastigiata*, 34.32 (E3) for *hypogaea* and 30.30 (E1) for *vulgaris* were observed. Among botanical variety *hypogaea* had highest range (7.0-56.2) and maximum CV was observed in *fastigiata* (37.85%).

4.2.1.5.14 Pod length (cm) (PL)

Wide range of 1.84-4.3, 1.8-3.7, 1.8-4.6 and 1.8-3.9 at E1, E2, E3 and E4 were noticed for pod length, with CV of 14.60, 13.28, 14.24 and 13.17 per cent, respectively. In botanical varieties *fastigiata*, *hypogaea* and *vulgaris* the pod length had highest range of 2.24-3.83 (E4), 1.8-4.6 (E3) and 1.54-3.35 (E2) with maximum CV of 14.69 (E2), 13.72 (E1) and 11.75 (E4) per cent, respectively. Among botanical varieties *hypogaea* had highest range (1.8-4.6). While, highest CV (13.80%) was noticed in *fastigiata* for this trait.

4.2.1.5.15 Pod width (cm) (PW)

The range of 0.9-1.78 (E1), 0.94-1.7 (E2), 0.82-1.64 (E3) and 0.94-1.80 (E4) were observed for pod width with CV of 10.93, 10.95, 9.98 and 9.54 per cent, respectively. At E2 for *fastigiata* (0.95-1.4) and *hypogaea* (0.84-1.7), at E4 and E1 for *vulgaris* (0.9-1.65) highest ranges were noticed, with maximum CV of 8.47 (E2), 11.04 (E2) and 9.10 (E4) per cent, respectively. Among botanical varieties *hypogaea* had highest range (0.84-1.80) and CV of 9.95 per cent (Table 12 and 13).

4.2.1.5.16 Shelling percentage (%) (SH)

This trait displayed wide range of variation at different environments, having 41.8-88.0 (E1), 50.2-87.0 (E2), 50.0-88.4 (E3) and 50.2-87.0 (E4) with CV of 14.55, 12.21, 13.87 and 12.57 per cent, respectively. Among botanical varieties, *fastigiata* at E3 (51.4-79.0), *hypogaea* at E1 (41.8-84.4) and *vulgaris* at E1 (50.0-88.0) had highest range, with maximum CV of 14.85 (E4), 13.72 (E1) and 15.32 (E1), respectively. Among botanical varieties *hypogaea* had highest range (41.8-88.4) and *vulgaris* had maximum CV (13.70%).

4.2.5.17 Seed length (cm) (SLN)

The range displayed by this trait at different environments, E1, E2, E3 and E4 were 0.89-2.00, 0.90-1.83, 0.88-2.05 and 0.98-1.98 per cent, respectively with CV of 17.02, 12.33, 15.67 and 13.30. In botanical varieties *fastigiata*, *hypogaea* and *vulgaris* exhibited highest range of 1.00-1.38 (E1), 0.9-2.0 (E1) and 0.88-1.66 (E3), respectively with maximum CV of 7.58, 12.77 and 11.37 at E1. Among botanical varieties range of 0.9-2.05 was highest and CV of 12.12 was maximum in *hypogaea* (Table 12 and 13).

4.2.1.5.18 Seed width (cm) (SWD)

The seed width ranges observed were 0.60-1.22, 0.56-1.20, 0.50-1.04 and 0.57-1.23 at E1, E2, E3 and E4, with CV of 10.02, 9.56, 10.54 and 10.76 at E1, E2, E3 and E4 per cent, respectively. In botanical varieties for *fastigiata* at E1, (0.64-0.94), for *hypogaea* at E4 (0.59-1.23) and for *vulgaris* at E3 (0.50-0.99) highest range was observed with maximum CV of 11.17 (E4), 11.11 (E4) and 10.17 (E3), respectively. Among botanical varieties *vulgaris* had highest range of 0.5-1.20 and maximum CV of 10.70 per cent in *hypogaea* was noticed.

For 100-seed weight ranges observed were 20.3-63.8 at E1, 18.8-63.6 at E2, 20.3-68.1 at E3 and 22.3-60.8 at E4 and CV of 20.91, 19.38, 22.06 and 17.97 per cent, respectively. In botanical varieties *fastigiata*, *hypogaea* and *vulgaris* had highest range of 20.6-63.2, 20.3-68.1 and 22.0-61.2 at E1, E3 and E3, respectively with highest CV of 24.26 (E1), 20.98 (E3) and 21.20 (E3) accordingly. Among botanical varieties highest range in *hypogaea* (18.6-68.1) and maximum CV (20.98%) in *fastigiata* was observed.

4.2.1.5.20 Days to initiation of flowering (DIF)

Days to first flowering ranged between 20-36 at E1, 27-39 at E2, 23-37 at E3 and 25-38 at E4 with CV of 8.92, 7.24, 11.10 and 8.54 per cent, respectively. In botanical varieties for *fastigiata* at E1 (22-32), for *hypogaea* at E1 (20-36) and *vulgaris* at E1 (22-35) highest ranges were recorded with maximum CV of 7.89 (E3), 7.76 (E3) and 7.93 (E4), respectively. Among botanical varieties *hypogaea* had highest range and *vulgaris* had highest CV (10.07%) (Table 12 and 13).

4.2.1.5.21 Days to cessation of flowering (DCF)

The range of variation for this trait varied between 60-123, 50-100, 60-125 and 45-112 at E1, E2, E3 and E4, with CV of 19.46, 16.59, 19.50 and 19.08 per cent, respectively. In botanical varieties *fastigiata*, *hypogaea* and *vulgaris* had highest range 70-117 (E3), 63-125 (E3) and 45-112 (E4) with maximum CV of 12.78 (E1), 20.86 (E4) and 7.4 (E3), respectively. Among botanical varieties *hypogaea* had wide range (45-120) and maximum CV (19.33%).

4.2.1.5.22 Days to maturity (DM)

Days to maturity at four environment varied as follows, from 102-152 at E1, 110-162 at E2, 103-158 at E3 and 110-166 at E4 with CV of 10.8, 11.25, 10.17 and 11.08 per cent, respectively. In botanical variety days to maturity for *fastigiata* at E4 (119-161), for *vulgaris* at E4 (110-166) and for *hypogaea* at E4 (108-158) highest range were recorded with maximum CV of 8.07 (E4), 10.19 (E1) and 5.3 (E2), respectively. Among botanical varieties *hypogaea* had highest range (10.2-16.6) and maximum CV (10.39%).

4.2.1.5.23 Pod yield per plant (g) (PYP)

Wide range was noticed for this trait, having 2.08-27.12, 2.09-22.75, 2.0-23.0 and 2.03-25.3 at E1, E2, E3 and E4, with CV of 42.47, 46.71, 61.36 and 52.39 per cent, respectively. In botanical varieties *fastigiata*, *hypogaea* and *vulgaris* had highest range of 2.2-18.6 (E3), 2.56-27.2 (E1) and 2.09-22.75 (E2), respectively with maximum CV of 58.30 (E3), 47.18 (E3) and 50.50 (E4). Among the botanical varieties *hypogaea* had highest range (2.04-27.12) and *vulgaris* had maximum CV (52.23%).

4.2.1.5.24 Oil content (%)

Oil content was estimated for only two post rainy environments (E2 and E4). The range of 34-50 and 35-49 with CV of 5.03 and 4.85 per cent was observed at E2 and E4, respectively. For *fastigiata* at E2 (38-50), for *hypogaea* at E4 (35-49) and for *vulgaris* at E2 (34-49) highest ranges were recorded with CV maximum at E2 (5.9), E2 (5.49) and at E2 (4.36), respectively. Among botanical varieties *hypogaea* had wide range (35-50) and *fastigiata* had maximum CV (5.69%) (Table 12 and 13).

4.2.2 Genetic parameters

Genetic parameters like heritability in broadsense and genetic advance were estimated for 24 traits at all the four environments and for the combined data of four environments which are presented in the Table 14.

4.2.2.1 Leaflet length (cm)

Leaflet length had an heritability estimates of 50.78, 29.91, 55.97 and 84.15 per cent at E1, E2, E3 and E4, respectively with GA of 0.52, 0.23 and 0.52 and 0.89 accordingly.

4.2.2.2 Leaflet width (cm)

Heritability of 19.83, 36.79, 50.30 and 48.61 at E1, E2, E3 and E4, respectively, GA of 0.07 (E1), 0.11 (E2), 0.20 (E3) and 0.2 (E4) were estimated (Table 14).

4.2.2.3 Plant height (cm)

The plant height had heritability of 58.78 at E1, 51.39 at E2, 42.68 at E3 and 38.42 per cent at E4, with GA of 5.00, 4.58, 3.41 and 2.74 at E1, E2, E3 and E4, respectively.

4.2.2.4 Number of primary branches per plant

Heritability of 25.30, 0.02, 66.48 and 13.82 per cent and GA of 0.37, 0.0003, 1.33 and 0.22 were estimated at E1, E2, E3 and E4, respectively.

4.2.2.5 Length of the primary branches (cm)

Heritability and GA of 0.019, 9.554, 21.18 and 0.24 per cent; 0.001, 0.41, 1.38 and 0.01 were estimated at E1, E2, E3 and E4 respectively (Table 14).

Table 14 : Heritability and genetic advance for different vegetative and reproductive traits at Raichur and Kawadimatti during 2000 rainy and 2000-01 post rainy seasons in Karnataka

Sl. No.	Traits	E1		E2		E3		E4	
		h ² (%)	GA (%)	h ² (%)	GA (%)	h ² (%)	GA (%)	h ² (%)	GA (%)
1.	LLN	50.78	0.52	29.91	0.23	55.97	0.52	84.15	0.89
2.	LWD	19.83	0.07	36.79	0.11	50.30	0.21	48.61	0.20
3.	PLHT	58.48	5.00	51.39	4.58	42.68	3.41	38.42	2.74
4.	NPB	25.30	0.37	0.019	0.0003	66.48	1.33	13.82	0.22
5.	LPB	0.019	0.001	9.554	0.41	21.18	1.38	0.24	0.01
6.	NNMS	12.28	0.35	27.00	1.07	2.82	0.08	26.29	0.83
7.	LCB	26.50	2.66	23.93	2.51	10.42	0.83	24.29	2.19
80.	NNCB	9.77	0.69	11.94	0.81	5.71	0.32	13.50	0.90
9.	TNP	32.40	3.22	26.46	2.63	87.29	8.86	25.33	2.12
10.	NMP	33.74	2.92	29.03	2.33	76.49	6.11	18.71	1.32
11.	NPP	41.52	4.74	29.65	3.45	89.64	10.64	23.26	2.26
12.	PLN	55.85	0.31	72.98	0.41	44.64	0.24	67.16	0.38
13.	PWD	4.77	0.007	47.94	0.08	73.05	0.13	53.42	0.09
14.	SH	17.18	2.53	22.63	2.82	49.57	7.16	27.22	3.48
15.	SLN	18.17	1.93	58.57	6.59	45.37	5.79	16.53	1.42
16.	SWD	26.08	0.06	25.80	0.05	48.11	0.12	31.84	0.06
17.	SDWT	48.93	0.06	69.85	0.09	34.50	0.04	40.12	0.05
18.	DIF	61.21	2.27	15.80	0.48	88.03	4.15	0.019	0.0006
19.	DCF	84.19	20.64	82.78	17.75	85.13	22.34	86.28	18.81
20.	DM	82.53	15.44	79.46	16.15	83.02	15.34	82.31	16.35
21.	PYP	26.32	1.75	93.6	0.48	25.67	1.39	20.07	1.03
22.	OIL	-	-	56.01	2.14	-	-	56.07	2.04

Note : h² = Heritability, GA = Genetic advance

E1 - Raichur rainy, E2 - Raichur post rainy, E3 - Kawadimatti rainy, E4 - Kawadimatti post rainy

EST - *Pastigata*, HYPO - *Hypogaea*, VUJ - *Vidua*

PLHT - Plant height (cm), NPB - Number of primary branches, LPB - Length of the primary branches (cm), NNMS - Number of nodes on main stem, LCB - Length of the cotyledonary branches (cm), NNCB - Number of nodes on cotyledonary branches, TNP - Total number of pods, NPP - Number of mature pods, NPB - Number of pegs per plant, PLN - Pod length (cm), PWD - Pod width, SH% - Shelling per cent, SLN - Seed length (cm), SWD - Seed width (cm), LLN - Leaf length (cm), LWD - Leaf width (cm), DIF - days to initiation of flowering, DCF - Days to cessation of flowering, DM - Days to maturity, PYP - Pod yield per plant (g), OIL - Oil content (%).

4.2.2.6 Number of secondary branches

Number of observations were very limited and therefore heritability and GA were not estimated.

4.2.2.7 Length of the secondary branches (cm)

Number of observations were very limited and therefore heritability and GA were not estimated.

4.2.2.8 Number of nodes on main stem

The estimates of heritability were 12.28, 27.00, 2.82 and 26.29 per cent, GA were 0.35, 1.07, 0.08 and 0.83 at E1, E2, E3 and E4, respectively for this trait (Table 14).

4.2.2.9 Length of the cotyledonary branches (cm)

For the length of the cotyledonary branches the heritability of 26.50, 23.93, 10.42 and 24.29 per cent, GA of 2.66, 2.51, 0.83 and 2.19 at E1, E2, E3 and E4, respectively were estimated.

4.2.2.10 Number of nodes on cotyledonary branches

At four different environments the heritability estimates were 9.77, 11.94, 5.71 and 13.50 per cent, with GA of 0.69, 0.81, 0.32 and 0.90 at E1, E2, E3 and E4, respectively.

4.2.2.11 Total number of pods per plant

For this trait the heritability of 32.40 (E1), 26.46 (E2), 87.29 (E3) and 25.33 (E4) per cent, GA of 3.22 (E1), 2.63 (E2), 8.86 (E3) and 2.12 (E4) were estimated (Table 14).

4.2.2.12 Number of mature pods per plant

Mature pods number per plant exhibited heritability of 33.77 (E1), 29.03 (E2), 76.49 (E3) and 18.71 per cent at (E4), with GA of 2.92 (E1), 2.33 (E2), 6.11 (E3) and 1.32 (E4).

4.2.2.13 Number of pegs per plant

The heritability and GA estimated for number of pegs per plant were 41.52, 29.65, 89.64 and 23.26 per cent; 4.74, 3.45, 10.64 and 2.26 at E1, E2, E3 and E4, respectively (Table 14).

4.2.2.14 Pod length (cm)

For pod length the heritability estimates were 55.85, 72.98, 44.64 and 67.16 per cent at E1, E2, E3 and E4, respectively, GA of 0.31 (E1), 0.41 (E2), 0.24 (E3) and 0.38 (E4) were estimated.

4.2.2.15 Pod width (cm)

The estimates of heritability were 4.77, 47.94, 73.05 and 53.42 per cent at E1, E2, E3 and E4, respectively, GA were 0.0007 (E1), 0.08 (E2), 0.13 (E3) and 0.09 (E4), for pod width.

4.2.2.16 Shelling percentage (%)

Heritability of 17.18, 22.63, 49.57 and 27.22 per cent, GA of 2.53, 2.82, 7.16 and 3.48 were observed at E1, E2, E3 and E4 for shelling percentage.

4.2.2.17 Hundred seed weight (g)

The heritability estimates were 18.17, 58.57, 45.37 and 16.53 per cent at E1, E2, E3 and E4, respectively, GA were 1.93 (E1), 6.59 (E2), 5.79 (E3) and 1.42 (E4) for 100-seed weight (Table 14).

4.2.2.18 Seed length (cm)

In seed length the heritability estimates were 26.08, 25.80, 48.11 and 31.84, while the GA values were 0.06, 0.05, 0.12 and 0.06 at E1, E2, E3 and E4, respectively.

4.2.2.19 Seed width (cm)

The seed width had heritability estimates of 48.93, 69.85, 34.50 and 40.12 per cent at E1, E2, E3 and E4, respectively, GA of 0.06 (E1), 0.09 (E2), 0.038 (E3) and 0.05 (E4).

4.2.2.20 Days to initiation of flowering

In this trait the heritability and GA estimates were different at four environments having values 61.21, 15.80, 88.03 and 0.019 per cent at E1, E2, E3 and E4, respectively, and 2.27 (E1), 0.48 (E2), 4.15 (E3) and 0.006 (E4), respectively (Table 14).

4.2.2.21 Days to cessation of flowering

This trait showed heritability of 84.19, 82.78, 85.13 and 86.28 per cent, while the values of GA were 20.64, 17.75, 22.34 and 18.81 at E1, E2, E3 and E4, respectively.

4.2.2.22 Days to maturity

The days to maturity had heritability of 82.53, 79.46, 83.02 and 82.31 per cent, GA of 15.44, 15.16, 15.34 and 16.35 at E1, E2, E3 and E4, respectively.

4.2.2.23 Pod yield per plant (g)

Pod yield per plant had heritability of 26.32, 93.60, 25.67 and 20.07 per cent, GA of 1.75, 0.48, 1.39 and 1.03 at E1, E2, E3 and E4, respectively.

4.2.2.24 Oil content (%)

Oil content was estimated through NMR in two post rainy environments (E2 and E4) in which heritability estimates of 56.01 (E2), 56.01 (E4) with GA of 2.14 (E2) and 2.04 (E4) were made (Table 14).

4.2.3 Correlation studies

Association of various vegetative and reproductive traits at four different environments were estimated. The results are presented in Table 15. The correlation coefficient with $r \geq \pm 0.4$ are presented below.

4.2.3.1 Leaflet length (cm)

A significant correlation of leaflet length with 18 traits at E1, 16 traits at E2, 20 traits at E3 and 19 traits at E4 were observed. A strong negative association with LPB (-0.412), SLN (-0.450) at E1, with NNCB (-0.423), SLN (-0.480), DIF (-0.590), PYP (-0.401) at E3 and with SLN (-0.401) at E4 was observed, while a positive association with LWD (0.629), DCF (0.44), DM (0.434) at E1, LWD, (0.755) at E2, LWD (0.814), DCF (0.496) and DM (0.461) at E3 and LWD (0.673) at E4 was noticed.

4.2.3.2 Leaflet width (cm)

At four different environments this trait was significantly correlated with 18, 16, 20 and 18 traits at E1, E2, E3 and E4, respectively. Strong positive association with LLN (0.629) at E1, LLN (0.755), DCF (0.450), DM (0.461) at E2, with LLN (0.814), DCF (0.536), DM (0.522) at E3 and with LLN (0.673), at E4 was observed. A strong negative association with SLN (-0.484) and DIF (-0.598) at E3 was observed (Table 15).

Table 15 : Correlation among various vegetative and reproductive traits in groundnut (*A. hypogaea* spp.) core collection at Raichur during 2000 rainy season (I-I)

R-R	PLHT	NPB	LPP	NNMS	LCB	NNCB	TNP	NMP	NPP	PLN	PWD	SH	SLN	SWD	SDWT	LLN	LWD	DIF	DCF	DM	PYP	OIL	
PLHT	1.000																						
NPB	0.161**	1.000																					
LPP	-0.04*	0.012**	1.000																				
NNMS	0.500**	0.030**	0.095**	1.000																			
LCB	0.456**	0.241**	0.862**	0.402**	1.000																		
NNCB	0.183**	0.431**	0.481**	0.251**	0.712**	1.000																	
TNP	-0.123**	0.292**	0.289**	-0.016	0.242**	0.312**	1.000																
NMP	-0.060*	0.208**	0.284**	-0.097	0.261**	0.331**	0.957	1.000															
NPP	-0.112**	0.400**	0.288**	-0.021	0.240**	0.321**	0.970	0.910**	1.000														
PLN	-0.061	0.208**	0.448**	0.028	0.275**	0.371**	0.933	0.940	0.933	1.000													
PWD	-0.020	0.427**	0.419**	0.018	0.306**	0.399**	0.911	0.910	0.945	0.615**	1.000												
SH	0.062*	-0.065	0.026	0.041	0.077	0.044	0.131**	0.140**	0.127**	-0.017	-0.054	1.000											
SLN	-0.180**	0.488**	0.181**	-0.047	0.402	0.420**	0.188**	0.175**	0.181**	0.552**	0.607**	-0.067*	1.000										
SWD	-0.065	0.115**	0.211**	-0.050	0.169	0.203**	0.080	0.091*	0.109*	0.255**	0.388**	0.041	0.415**	1.000									
SDWT	-0.04*	0.179**	0.189**	-0.046	0.163	0.229**	0.096*	0.100*	0.104*	0.396**	0.313**	0.135**	0.360**	0.336**	1.000								
LLN	0.295**	0.431**	-0.412**	0.138**	-0.110	-0.273**	-0.215**	-0.196**	-0.216*	-0.251**	-0.461**	0.053	-0.450**	-0.194**	-0.155**	1.000							
LWD	0.240**	-0.238**	-0.279**	0.158**	-0.072	-0.181**	-0.212**	-0.209**	-0.222**	-0.132**	-0.208**	0.019	-0.290**	-0.140**	-0.086*	0.629**	1.000						
DIF	-0.240**	0.412**	0.386**	-0.164**	0.183**	0.315**	0.218**	0.226**	0.248**	0.284**	0.316**	-0.004	0.454**	0.209**	0.180**	-0.437**	-0.326**	1.000					
DCF	0.048	-0.431**	-0.551**	-0.144**	-0.481**	-0.490**	-0.157**	-0.151**	-0.165**	-0.409**	-0.551**	0.073	-0.862**	-0.264**	-0.264**	0.410**	0.208**	-0.150**	1.000				
DM	-0.04*	-0.479**	-0.550**	-0.131**	-0.365**	-0.501**	-0.173**	-0.182**	-0.182**	-0.452**	-0.506**	0.043	-0.559**	-0.217**	-0.217**	0.431**	0.217**	-0.139**	0.957**	1.000			
PYP	-0.04*	0.216**	0.248**	0.048	0.174**	0.241**	0.290**	0.291**	0.289**	0.231**	0.220**	0.136**	0.261**	0.178**	0.167**	-0.217**	-0.164**	0.223**	-0.189**	-0.220**	1.000		

** Significant at 1% * Significant at 5% R-R = Raichur rainy.

PLHT – Plant height (cm), NPB – Number of primary branches, LPP – Length of the primary branches (cm), NNMS – Number of nodes on main stem, LCB – Length of the cotyledonary branches (cm), NNCB – Number of nodes on cotyledonary branches, TNP – Total number of pods, NMP – Number of mature pods, NPP – Number of pods per plant, PLN – Pod length (cm), PWD – Pod width, SH% – Shelling per cent, SLN – Seed length (cm), SWD – Seed width (cm), LLN – Leaf length (cm), LWD – Leaf width (cm), DIF – days to initiation of flowering, DCF – Days to cessation of flowering, DM – Days to maturity, PYP – Pod yield per plant (g), OIL – Oil content (%).

Raichur during 2000-2001 post rainy season (E2)

R-PR	PLH	NPB	LPB	NNMS	LCB	NNCB	TNP	NMP	NPP	PLN	PWD	SH	SLN	SWD	SDWT	LLN	LWD	DF	DCF	DM	PYP	Oil
	1.000																					
NPB	0.021	1.000																				
LPB	0.058	-0.066	1.000																			
NNMS	0.139**	-0.067	0.008	1.000																		
LCB	0.096**	0.171**	0.051	0.231**	1.000																	
NNCB	0.215**	0.129**	0.064	0.199**	0.660**	1.000																
TNP	-0.047	0.180**	0.003	0.090*	0.230**	0.281**	1.000															
NMP	-0.007	0.148**	0.001	0.126**	0.267**	0.117**	0.940**	1.000														
NPP	-0.041	0.255**	0.054	0.046	0.213**	0.256**	0.910**	0.893**	1.000													
PLN	-0.121**	0.090	-0.070	0.109**	0.109**	0.146**	0.019	0.057	0.021	1.000												
PWD	-0.003	0.121**	0.014	0.022	0.068	0.109**	0.091*	0.106*	0.089*	0.995**	1.000											
SH	0.029	0.052	0.081	-0.078	-0.011	-0.018	-0.066	-0.027	0.001	-0.085	-0.008	1.000										
SLN	-0.150**	0.116**	-0.041	-0.046	0.168**	0.175**	0.120**	0.146**	0.085	0.460**	0.419**	0.019	1.000									
SWD	0.008	0.019	0.025	0.023	0.014	0.018	0.062	-0.003	0.023	0.127**	0.191**	0.097*	0.418**	1.000								
SDWT	0.005	0.177**	0.047	-0.100*	0.148**	0.091*	0.097*	0.078	0.105*	0.251**	0.272**	0.083	0.299**	0.171**	1.000							
LLN	0.055**	-0.022	0.048	0.122**	-0.101**	-0.109**	0.192**	-0.201**	-0.161**	-0.419**	-0.218**	0.068	-0.467**	-0.002	-0.141**	1.000						
LWD	0.007**	-0.082	-0.068	0.119**	-0.102*	-0.191**	-0.186**	-0.171**	-0.159**	-0.346**	-0.264**	0.082	-0.181**	-0.047	-0.201**	0.755**	1.000					
DF	0.000	-0.048	-0.108*	0.031	0.075	0.074	0.085	0.121**	0.044	0.069	0.062	-0.043	0.207**	0.041	-0.06098	-0.212**	-0.125**	1.000				
DCF	0.111**	-0.081	-0.057	0.068	-0.117**	-0.172**	-0.096**	-0.100**	-0.087	-0.473**	-0.411**	0.028	-0.114**	-0.085	-0.171**	0.380**	0.450**	0.809	1.000			
DM	0.115**	-0.140**	-0.041	0.075	-0.183**	-0.191**	-0.123**	-0.108**	-0.114**	-0.462**	-0.431**	0.059	-0.631**	-0.022	-0.212**	0.191**	0.461**	0.648	0.965**	1.000		
PYP	0.078	-0.117**	0.044	0.047	0.099*	0.088	0.112**	0.119**	0.128**	0.021	0.041	-0.008	0.038	0.197**	0.068**	0.021	0.054	0.042	0.047	0.045	1.000	
Oil	-0.068	0.021	0.072	-0.014	-0.074	-0.045	0.040	0.021	0.068	-0.109**	-0.140**	0.081	-0.014	0.160**	0.089	0.112**	0.427**	0.024	0.209**	0.208**	0.162**	1.000

** Significant at 1%

* Significant at 5%

R-PR = Raichur post rainy

PLH - Plant height (cm), NPB - Number of primary branches, LPB - Length of the primary branches (cm), NNMS - Number of nodes on main stem, LCB - Length of the cotyledonary branches (cm), NNCB - Number of nodes on cotyledonary branches, TNP - Total number of pods, NMP - Number of mature pods, NPP - Number of pods per plant, PLN - Pod length (cm), PWD - Pod width, SH% - Shelling per cent, SLN - Seed length (cm), SWD - Seed width (cm), LLN - Leaf length (cm), LWD - Leaf width (cm), DF - days to initiation of flowering, DCF - Days to cessation of flowering, DM - Days to maturity, PYP - Pod yield per plant (g), Oil - Oil content (%)

Table 15. Contd...
Kawadimatti during 2000 rainy season (E3)

R-R	PLHT	NPP	LPB	NNMS	LCB	NNCB	TNP	NMP	NPP	PLN	PWD	SH	SLN	SWD	SDWT	LLN	LWD	DF	DCF	DM	PYP	OIL	
PLHT	1.000																						
LPB	0.049	1.000																					
LPB	0.051	0.212**	1.000																				
NNMS	0.555**	0.083	0.235**	1.000																			
LCB	0.507**	0.284**	0.217**	0.378**	1.000																		
NNCB	0.256**	0.149**	0.219**	0.212**	0.764**	1.000																	
TNP	0.062	0.140**	0.199**	0.062	0.444**	0.401**	1.000																
NMP	-0.024	0.269**	0.181**	0.137**	0.332**	0.857**	0.900**	1.000															
NPP	-0.065**	0.162**	0.182**	0.046	0.329**	0.939**	0.915**	0.871**	1.000														
PLN	0.222**	0.142**	0.195**	0.139**	0.389**	0.372**	0.013	-0.024	0.034	1.000													
PWD	0.201**	0.205**	0.138**	0.088*	0.341**	0.313**	0.003	-0.052	0.003	0.692	1.000												
SH	0.141**	0.127**	0.121**	0.100*	0.112**	0.150**	0.219**	0.222**	0.19**	0.178**	0.201**	1.000											
SLN	-0.029	0.265**	0.297**	-0.040	0.367**	0.447**	0.197**	0.129*	0.219**	0.645**	0.599**	0.219**	1.000										
SWD	0.185**	0.089	0.115**	0.160**	0.150**	0.109**	0.060	0.094**	0.082	0.171**	0.176**	0.119**	0.186**	1.000									
SDWT	0.194**	0.111**	0.205**	0.153**	0.352**	0.335**	0.121**	0.169**	0.123**	0.386**	0.381**	0.341**	0.345**	0.424**	1.000								
LLN	0.208**	-0.28**	-0.140**	0.222**	-0.290**	-0.423**	-0.314**	-0.220**	-0.167**	-0.257**	-0.186**	-0.217**	-0.489**	-0.165**	-0.165**	1.000							
LWD	0.151**	-0.303**	-0.204**	0.216**	-0.301**	-0.399**	-0.302**	-0.190**	-0.353**	-0.260**	-0.215**	-0.222**	-0.484**	-0.207**	-0.212**	0.814**	1.000						
DF	-0.189**	0.286**	0.252**	-0.188**	0.281**	0.386**	0.183**	0.290**	0.309**	0.230**	0.222**	0.188**	0.193**	0.227**	0.199**	0.598**	0.598**	1.000					
DF	-0.221**	-0.405**	-0.290**	-0.181**	-0.580**	-0.593**	-0.511**	-0.176**	-0.248**	-0.508**	-0.468**	-0.149**	-0.625**	-0.418**	-0.401**	0.196*	0.516**	0.479**	1.000				
DM	-0.220**	-0.328**	-0.262**	-0.164**	-0.544**	-0.511**	-0.218**	-0.169**	-0.251**	-0.466**	-0.461**	-0.355**	-0.587**	-0.419**	-0.402**	0.361**	0.522**	-0.446**	0.932**	1.000			
PYP	-0.064	0.284**	0.158**	-0.039	0.371**	0.411**	0.450**	0.417**	0.481**	0.266**	0.27**	0.300**	0.464**	0.559**	0.289**	-0.401**	-0.371**	0.447**	-0.437**	-0.404**	1.000		

** Significant at 1% * Significant at 5% K-R - Kawadimatti rainy.

PLHT - Plant height (cm), NPP - Number of primary branches, LPB - Length of the primary branches (cm), NNMS - Number of nodes on main stem, LCB - Length of the cotyledonary branches (cm), NNCB - Number of nodes on cotyledonary branches, TNP - Total number of pods, NMP - Number of mature pods, NPP - Number of pods per plant, PLN - Pod length (cm), PWD - Pod width, SH - Shelling per cent, SLN - Seed length (cm), SWD - Seed width (cm), LLN - Leaf length (cm), LWD - Leaf width (cm), DF - Days to initiation of flowering, DCF - Days to cessation of flowering, DM - Days to maturity, PYP - Pod yield per plant (g), OIL - Oil content (%).

Kawadimatti during 2000-2001 post rainy season (E4)

K-PR	PHF	NPB	LFB	NNMB	LCB	NMCB	TNP	NMP	NPP	PLN	PWD	SI	SLF	SWD	SWCT	LLS	LWD	DIF	DCT	DM	PYP	CHL
PLH1	1.000																					
NPB	-0.141**	1.000																				
LFB	-0.035	0.207**	1.000																			
NNMB	0.440**	0.093	-0.019	1.000																		
LCB	0.321**	0.204**	0.211**	0.269**	1.000																	
NMCB	0.142**	0.245**	0.32**	0.179**	0.366**	1.000																
TNP	-0.022	0.210**	0.152**	0.096*	0.190**	0.263**	1.000															
NMP	-0.047	0.260**	0.152**	0.124**	0.191**	0.264**	0.919**	1.000														
NPP	-0.040	0.217**	0.121**	0.111**	0.209**	0.269**	0.954**	0.902**	1.000													
PLN	-0.041	0.240**	0.150**	-0.019	0.146**	0.179**	-0.026	-0.019	-0.040	1.000												
PWD	-0.025	0.156**	0.162**	-0.006	0.102*	0.148**	0.006	-0.004	-0.021	0.477**	1.000											
SI	0.044	0.006	0.058	0.028	0.007	-0.012	0.016	0.029	0.028	0.017	-0.005	1.000										
SLF	-0.165**	0.286**	0.224**	-0.085*	0.186**	0.265**	0.119**	0.103*	0.112**	0.481**	0.427**	-0.052	1.000									
SWD	-0.062*	0.174**	0.172**	-0.063	0.114**	0.163**	0.091*	0.086	0.079	0.217**	0.141**	0.644	0.346**	1.000								
SWCT	-0.069	0.166**	0.055	-0.042	0.097*	0.142**	0.119**	0.111**	0.129**	0.190**	0.163**	0.107*	0.177**	0.264**	1.000							
LLS	0.400**	0.214**	-0.249**	0.146**	-0.048	-0.127**	-0.116**	-0.161**	-0.140**	-0.225**	-0.109**	0.012	-0.401**	-0.186**	-0.170**	1.000						
LWD	0.464**	-0.275**	-0.261**	0.205**	-0.076	-0.178**	-0.116**	-0.148**	-0.140**	-0.191**	-0.050	0.062	-0.462**	-0.204**	-0.159**	0.673**	1.000					
DIF	-0.099*	0.042	0.071	-0.041	0.064	0.098**	0.150**	0.151**	0.151**	-0.016	-0.006	0.008	0.215**	0.110**	0.163**	-0.304**	-0.209**	1.000				
DCT	0.156**	-0.421**	-0.497**	0.088**	-0.151**	-0.257**	-0.041	-0.026	0.010	-0.082**	-0.412**	0.043	-0.456**	-0.277**	-0.149**	0.574**	0.380**	-0.020	1.000			
DM	0.167**	-0.415**	-0.463**	0.063	0.151**	-0.248**	0.003	0.004	0.042	-0.140**	-0.441**	0.076	-0.491**	-0.254**	-0.155**	0.460**	0.484**	-0.022	0.927**	1.000		
PYP	-0.184**	0.143**	0.161**	-0.008	0.144**	0.149**	0.050	0.052**	-0.048	0.162**	0.122**	-0.044	0.284**	0.129**	0.165**	-0.247**	-0.273**	0.041	-0.435**	-0.176**	1.000	
CHL	0.045	-0.044	-0.111**	0.016	-0.066	-0.065	0.014	-0.013	0.040	-0.139**	-0.148**	0.068*	-0.066*	0.063	0.027	0.098*	0.169**	0.045	0.223**	0.216**	-0.180**	1.000

** Significant at 1%

* Significant at 5%

K-PR = Kawadimatti post rainy.

PHF – Plant height (cm), NPB – Number of primary branches, LFB – Length of the primary branches (cm), NNMB – Number of nodes on main stem, LCB – Length of the cotyledonary branches (cm), NMCB – Number of nodes on cotyledonary branches, TNP – Total number of pods, NMP – Number of mature pods, NPP – Number of pods per plant, PLN – Pod length (cm), PWD – Pod width, SH% – Shelling per cent, SLF – Shelling per cent, SWD – Seed width (cm), SWCT – Seed width (cm), LLS – Leaf length (cm), LWD – Leaf width (cm), DIF – Days to initiation of flowering, DCT – Days to cessation of flowering, DM – Days to maturity, PYP – Pod yield per plant (g), CHL – Oil content (%).

4.2.3.3 Plant height (cm)

Significant association with 13 traits at E1, nine at E2, 14 at E3 and 12 traits at E4 were observed for plant height. Plant height had a strong association with NNMS (0.560), LLB (0.456) at E1 with NNMS (0.479) at E2, with NNMS (0.555) and LCB (0.507) at E3, and with NNMS (0.440) at E4.

4.2.3.4 Number of primary branches

For this, 18 traits at E1, 10 traits at E2, 17 at E3 and 17 at E4 were found significantly associated. At E1, LPB (0.412), DIF (0.412), DCF (-0.433) and DM (-0.429) were found to be strongly associated with number of primary branches per plant (Table 15).

4.2.3.5 Length of the primary branches (cm)

This trait exhibited significant association with 18 traits at E1, one at E2, 19 at E3, and 16 traits at E4, respectively. The length of the primary branch was strongly associated with NNCB (0.481), PWD (0.419), SLN (0.483), LLN (-0.412), DCF (-0.551) and DM (-0.559) at E1.

4.2.3.6 Number of nodes on main stem

It was significantly associated with nine traits at E1, eight at E2, 15 at E3 and 10 traits at E4. At E1, plant height (0.560) and LCB (0.402), at E2 PLHT (0.479), at E3 and E4 PLHT (0.555 and 0.440) were found to be strongly associated with number of nodes on main stem.

4.2.3.7 Length of the cotyledonary branches

It was significantly correlated with 14, 15, 20 and 16 traits at E1, E2, E3 and E4, respectively. The PLHT (0.456), NNMS (0.402), NNCB (0.732) at E1; NNCB (0.69) at E2. At E3 PLHT (0.507), NNCB (0.764),

DCF (-0.580) and DM (-0.544) were strongly associated with length of the cotyledonary branches, while at E4 NNCB (0.736) had strong association with this trait (Table 15).

4.2.3.8 Number of nodes on cotyledonary branches

This trait had significant association with 19 traits at E1, 16 at E2, 20 at E3 and 19 at E4. The different traits viz., LPB (0.481), LCB (0.732), SLN (0.402), DCF (-0.499) and DM (-0.503) at E1, LCB at E2 (0.690), LCB (0.764), TNP (0.401), SLN (0.447), LLN (-0.423), DCF (-0.593), DM (-0.541) at E3 and PYP (0.411) at E4 LCB (0.736) were strongly associated with number of nodes on cotyledonary branches.

4.2.3.9 Total number of pods per plant

This trait exhibited a significant association with 16, 14, 15 and 13 traits at E1, E2, E3 and E4, respectively. At E1, NMP (0.957), NPP (0.970), at E2 NMP (0.94), NPP (0.93), at E3 NNCB (0.401), NMP (0.91), NPP (0.915), PYP (0.450) and at E4 NMP (0.919) and NPP (0.954) were strongly associated with total number of pods per plant.

4.2.3.10 Number of mature pods

Mature pods number was significantly correlated with 17 traits at E1, 14 traits at E2, 17 at E3 and 13 traits at E4, respectively. This trait had strong positive association with TNP (0.957), NPP (0.94) at E1, TNP (0.940) and NPP (0.893) at E2; TNP (0.90), NPP (0.871) and PYP (0.417) at E3 and TNP (0.919) and NPP (0.902) at E4.

4.2.3.11 Total number of pegs per plant

Total number of pegs per plant had significant association with 17 (E1), 11 (E2), 16 (E3) and 12 (E4) traits. At E1, TNP (0.97), NMP (0.94), at E2 TNP (0.93), NMP (0.893), at E3 TNP (0.915), NMP (0.831), DIF (0.406)

and PYP (0.481) and at E4 TNP (0.954) and NMP (0.902) were strongly associated (Table 15).

4.2.3.12 Pod length (cm)

The pod length had significant relationship with other traits, with 14 at E1, 12 at E2, 16 at E3 and 14 traits at E4. PWD (0.615), SLN (0.552), DCF (-0.499) and DM (-0.452) at E1, PWD (0.595) and SLN (0.460) at E2, PWD (0.692), SLN (0.635), DCF (-0.508) and DM (-0.466) at E3 and PWD (0.477), SLN (0.481) and DM (-0.410) at E4 was found to be strongly associated with pod length.

4.2.3.13 Pod width (cm)

Pod width was significantly correlated with 14 at E1, 14 traits each at E1 and E2, 16 at E3, and 13 traits at E4. At E1 LPB (0.419), PLN (0.615), SLN (0.602), DCF (-0.531), DM (-0.506), at E2 PLN (0.595), SLN (0.419), DCF (-0.413) and DM (-0.431), at E3 PLN (0.692), SLN (0.599), SWD (0.476), DCF (-0.468) and DM (-0.461) and at E4 PLN (0.477) found to have strong association with pod width.

4.2.3.14 Shelling percentage (%)

Significant association with six, one, 20 and two traits at E1, E2, E3 and E4, respectively was observed. But only at E3 few traits showed strong association.

4.2.3.15 Seed length (cm)

Seventeen traits at E1, fifteen at E2, 18 at E3 and 20 at E4 were significantly correlated with seed length. Among those LPB (0.487), NNCB (0.420), PLN (0.552), PWD (0.602), DIF (0.454), SWD (0.415), LLN (-

0.450), DCF (-0.582) and DM (-0.559) at E1; PLN (0.460), PWD (0.419), SWD (0.418) at E2, NNCB (0.447), PLN (0.635), PWD (0.599), SWD (0.486), LLN (-0.480), LWD (-0.484), DIF (0.493), DCF (-0.625), DM (-0.587) and PYP (0.464) at E3 and PLN (0.481), SWD (0.436), LLN (-0.401), DCF (-0.456) and DM (-0.494) at E4 were found to have strong association with seed length (Table 15).

4.2.3.16 Seed width (cm)

This trait was significantly correlated with 15 traits at E1, seven at E2, 17 at E3 and 16 traits at E4. However among these SLN (0.415), E1, SLN (0.418) at E2, PWD (0.476), SLN (0.486), SDWT (0.424), DCF (-0.448) and DM (-0.419) at E3 and SLN (0.436) at E4 had significant correlation with seed width.

4.2.3.17 Hundred seed weight (g)

Among different traits 17 at E1, 15 at E2, 20 at E3 and 17 at E4 were significantly associated while few traits DM (-0.424) at E2, SWD (0.424), DCF (-0.401), DM (-0.402) at E3 were strongly associated with 100-seed weight.

4.2.3.18 Days to initiation of flowering

Nineteen traits at E1, five at E2, 20 at E3 and 10 traits at E4 were found to have significant correlation with days to initiation of flowering. At E1 NPB (0.412), SLN (0.454), LLN (0.437), at E3 NPP (0.406), SLN (0.493), PYP (0.447), LLN (-0.590), LWD (-0.598), DCF (-0.479) and DM (-0.446) had strong correlation with this trait (Table 15).

4.2.3.19 Days to cessation of flowering

At four different environments, 18 at E1, 13 at E2, 20 at E3 and 16 at E4 had significant correlation with days to cessation of flowering. At

E1 LLN (0.440), NPB (-0.433), LPB (-0.551), NNCB (-0.499), PLN (-0.499), PWD (-0.531), SLN (-0.582) and DM (0.957), at E2 LWD (0.450), DM (0.905) and PWD (-0.413), at E3 LLN (0.496), LWD (0.536), LCB (-0.580), NNCB (0.593), PLN (-0.508), PWD (-0.468), SLN (-0.625), SWD (-0.448), DM (0.932), SDWT (-0.401), DIF (-0.479) and PYP (-0.437) were found to be strongly correlated with days to cessation of flowering while at E4 DM (0.927) and SLN (-0.456) were strongly associated.

4.2.3.20 Days to maturity

This trait had significant association was found with 18, 15, 20 and 15 traits at E1, E2, E3 and E4, respectively. At E1 LLN (0.434), DCF (0.957), NPB (-0.429), NNCB (-0.503), LPB (-0.559), PLN (-0.452), PWD (-0.506) and SLN (-0.559), at E2 LWD (0.461), DCF (0.905), PWD (-0.431) and SDWT (0.424) were the traits which showed strong correlations. Similarly, at E3 LLN (0.461), LWD (0.522), LCB (-0.544), NNCB (-0.541), PLN (-0.466), PWD (-0.461), SLN (-0.587), SWD (-0.419), SDWT (-0.402), DIF (-0.446), DCF (0.932) and PYP (-0.404) and at E4 DCF (0.927), PLN (-0.410) and SLN (-0.494) had strong correlation with days to maturity (Table 15).

4.2.3.21 Pod yield per plant (g)

There were 19, nine, 18 and 16 traits at E1, E2, E3 and E4, respectively, which were significantly associated with pod yield per plant. At E3 TNP (0.450), NNCB (0.411), NMP (0.417), NPP (0.481), SLN (0.464), DIF (0.447), LLN (-0.401) and DM (-0.404) had strong association for pod yield per plant.

4.2.3.22 Oil content (%)

Eight and ten traits at E2 and E4 exhibited significant correlation, however none of these traits showed strong correlation with oil content.

4.3 Diversity estimation

Diversity was estimated by Shano-Weaver diversity indices (H') which was estimated for each of the botanical varieties at all four environments (Table 16). The diversity was also estimated following Johns *et al.* (1997) and the mean, minimum and maximum diversity were estimated in each environment and the accession displaying minimum and maximum diversity were found (Table 17).

The levels of mean diversity over four environments were 0.511 ± 0.25 , 0.581 ± 0.012 and 0.587 ± 0.013 for *fastigiata*, *hypogaea* and *vulgaris*, respectively. There was not much difference in the diversity of three botanical varieties.

The mean diversity of different traits for different botanical varieties revealed that almost all the traits showed nonsignificant differences except days to cessation of flowering and days to maturity. While, the levels of diversity were 0.188, 0.391 and 0.452 for days to maturity in *fastigiata*, *hypogaea* and *vulgaris*, respectively. Days to cessation of flowering had low level of mean diversity (0.277) in *fastigiata* when compared to other two botanical varieties (0.507 in *hypogaea* and 0.450 in *vulgaris*).

The diversity for different traits in the same botanical variety at four different environments revealed that, in *fastigiata*, for traits LWD (0.498), LCB (0.488), NMP (0.413), NPP (0.481) and PLN (0.490) at E3, for DIF at E2 (0.481) and E3 (0.430) moderate level of diversity was observed. While, low diversity of 0.237, 0.237, 0.443 and 0.194 at E1, E2, E3 and E4 were recorded for DCF. Similarly, for DM a low H' of 0.194 (E1), 0.173 (E2), 0.194 (E3) and 0.194 (E4) for DM were noticed. The PYP

Table 16 Shannon-Weaver diversity indices for different vegetative and reproductive traits at Raichur and Kawadimatti during 2000 rainy and 2000-01 post rainy seasons in Karnataka

Sl No.	Traits		EST				HYPO				VUI				Grand mean	S.E.±			
			E1	E2	E3	E4	Mean	E1	E2	E3	E4	Mean	E1	E2			E3	E4	Mean
1	L:LN	0.551	0.595	0.581	0.573	0.575	0.607	0.611	0.619	0.616	0.613	0.624	0.623	0.608	0.621	0.619	0.605	0.005	
2	L:WD	0.535	0.568	0.498	0.522	0.530	0.569	0.621	0.526	0.576	0.573	0.614	0.628	0.617	0.625	0.621	0.568	0.015	
3	P:LIH	0.519	0.585	0.519	0.577	0.550	0.581	0.611	0.623	0.622	0.609	0.605	0.594	0.616	0.618	0.608	0.593	0.011	
4	NNMIS	-	0.546	0.601	0.556	0.567	0.612	0.525	0.615	0.606	0.589	0.610	0.597	0.604	0.629	0.610	0.591	0.009	
5	L:CB	0.510	0.514	0.488	0.564	0.519	0.620	0.610	0.615	0.552	0.599	0.613	0.591	0.582	0.542	0.582	0.562	0.013	
6	NNCB	0.628	0.552	0.576	0.519	0.568	0.596	0.613	0.612	0.586	0.601	0.613	0.630	0.619	0.602	0.616	0.593	0.009	
7	TNIP	0.569	0.580	0.515	0.593	0.564	0.579	0.629	0.599	0.551	0.589	0.624	0.608	0.617	0.607	0.614	0.586	0.011	
8	NMP	0.578	0.577	0.413	0.552	0.530	0.574	0.616	0.611	0.618	0.604	0.615	0.628	0.610	0.621	0.618	0.573	0.022	
9	NPP	0.519	0.577	0.481	0.593	0.542	0.577	0.620	0.607	0.588	0.598	0.605	0.617	0.628	0.623	0.618	0.587	0.015	
10	PLN	0.518	0.563	0.490	0.585	0.539	0.623	0.620	0.605	0.612	0.615	0.625	0.638	0.613	0.609	0.621	0.587	0.014	
11	PWD	0.533	0.606	0.545	0.522	0.551	0.591	0.569	0.598	0.606	0.591	0.582	0.604	0.585	0.623	0.598	0.582	0.009	
12	SH	0.568	0.553	0.526	0.446	0.523	0.600	0.514	0.616	0.573	0.590	-	0.588	0.547	0.587	0.574	0.558	0.013	
13	SLN	0.614	0.611	0.546	0.535	0.576	0.622	0.613	0.635	0.603	0.618	0.610	0.614	0.617	0.619	0.615	0.599	0.010	
14	SWD	0.532	0.556	0.576	0.506	0.542	0.567	0.642	0.614	0.551	0.593	0.616	0.557	0.588	0.626	0.596	0.583	0.011	
15	SDWT	0.518	0.590	0.573	0.556	0.559	0.606	0.614	0.588	0.584	0.598	0.600	0.622	0.591	0.620	0.608	0.605	0.005	
16	DIF	0.579	0.481	0.430	0.572	0.515	0.569	0.607	0.608	0.595	0.594	0.583	0.609	0.536	0.569	0.574	0.548	0.020	
17	DCF	0.237	0.237	0.443	0.194	0.277	0.521	0.511	0.507	0.492	0.507	0.418	0.487	0.364	0.531	0.450	0.423	0.032	
18	DM	0.194	0.173	0.194	0.194	0.188	0.383	0.364	0.398	0.419	0.391	0.482	0.348	0.478	0.502	0.452	0.345	0.036	
19	PYP	0.594	0.540	0.396	0.488	0.504	0.621	0.567	0.573	0.565	0.581	0.615	0.558	0.509	0.523	0.551	0.516	0.018	
20	OIL	-	0.589	-	0.501	0.545	-	0.599	-	0.521	0.560	-	0.587	-	0.604	0.595	0.567	0.018	
21	Mean	0.516	0.530	0.494	0.507	0.511	0.58	0.587	0.588	0.572	0.581	0.592	0.586	0.575	0.595	0.587	0.558	0.011	
22	S.E.±	0.027	0.026	0.022	0.025	0.025	0.012	0.014	0.013	0.010	0.012	0.013	0.015	0.015	0.009	0.013	0.016	0.002	

E1 Raichur rainy, E2 Raichur post rainy, E3 Kawadimatti rainy, E4 Kawadimatti post rainy
 EST - *Festuca*
 HYPO - *Hypogaea*
 VUI - *Vigna*
 PLHT - Plant height (cm), NPB - Number of primary branches, LPB - Length of the primary branches (cm), NNMIS - Number of nodes on main stem, LCB - Length of the cotyledonary branches (cm),
 NNCB - Number of nodes on cotyledonary branches, TNP - Total number of pods, NMP - Number of mature pods, NPP - Number of pegs per plant, PLN - Pod length (cm), PWD - Pod width, SH% - Shelling per cent, SLN - Seed length (cm), SWD - Seed width (cm), LI:LN - Leaf:let length (cm), LWD - Leaf:let width (cm), DJF - days to initiation of flowering, DCF - Days to cessation of flowering, DM - Days to maturity, PYP - Pod yield per plant (g), OIL - Oil content (%).

Table 17 : Mean minimum and maximum diversity between different environments during 2000 rainy and 2000-2001 post rainy seasons

	FST				HYPO				VUI			
	1	2	3	4	1	2	3	4	1	2	3	4
Mean	0.31459	0.2858	0.3192	0.3035	0.1994	0.1937	0.1862	0.1911	0.1798	0.1963	0.1918	0.1916
Min	0.14326	0.1326	0.1476	0.1376	0.0507	0.0638	0.0439	0.0583	0.0568	0.0550	0.0553	0.0599
Max	0.59920	0.4188	0.5443	0.4868	0.4628	0.4100	0.4291	0.4638	0.4231	0.4356	0.4340	0.3923
Min between accessions	ICG-29	ICG-7223	ICG-13902	ICG-29	ICG-5351	ICG-11428	ICG-12209	ICG-12873	ICG-12869	ICG-14807	ICG-5833	ICG-8351
Max between accessions	ICG-6205	ICG-8360	ICG-9144	ICG-57	ICG-5880	ICG-11456	ICG-12358	ICG-13130	ICG-7037	ICG-8682	ICG-7836	ICG-8657
	ICG-380	ICG-9114	ICG-3148	ICG-13648	ICG-10171	ICG-3145	ICG-10171	ICG-15126	ICG-13570	ICG-15112	ICG-13570	ICG-121
	ICG-9503	ICG-9503	ICG-9503	ICG-5238	ICG-521	ICG-4798	ICG-10113	ICG-4906	ICG-7713	ICG-7327	ICG-9973	ICG-14161

FST- *Fragaria* HYPO - *Hypogaea* VUI - *Fragaria*

exhibited moderate level of H' at E4 (0.484) and at E3 (0.396). All other traits showed higher level of H' in the botanical variety *fastigiata*.

In *hypogaea* DCF (0.492) and DM (0.419) exhibited moderate level of diversity at E4, DM at E1 (0.383), E2 (0.364) and at E3 (0.398) showed comparatively less diversity. All other traits had high H' in the botanical variety *hypogaea*.

In *vulgaris* DCF at E1 (0.418) and E2 (0.487), DM at E1 (0.482) and at E3 (0.478) showed moderate level of H' . Comparatively low H' of 0.364 (E3) and 0.348 (E2) were observed for DCF and DM, respectively all other traits exhibited high level of diversity.

Mean, minimum and maximum diversities were also estimated using Johns *et al.* (1997) botanical varieties-wise (Table 17), for *fastigiata* at E1 the mean diversity of 0.315 was observed. The minimum diversity of 0.143 between accessions ICG 29 and ICG 6205 and maximum diversity of 0.599 between ICG 380 and ICG 9503 was observed. At E2 the estimates of mean, minimum and maximum diversity were 0.2858, 0.1326 and 0.4488, respectively. While, minimum diversity was between ICG 7223 and ICG 8360, the maximum diversity was between ICG 9114 and ICG 9503. At E3 0.3192 (Mean), 0.1476 (min) and 0.5443 (Max) diversity were observed. The accessions involved were ICG 13902 and ICG 9144 for minimum and ICG 3148 and ICG 9503 and for maximum diversity. The diversity values at E4 0.3035 (mean), 0.1376 (min) and 0.4868 (max) and the accessions involved were ICG 29 and ICG 57 for minimum, ICG 13648 and ICG 5238 for maximum.

In *hypogaea* mean diversity of 0.1994, 0.1937, 0.1862 and 0.1911 were recorded at E1, E2, E3 and E4 respectively. The minimum diversity

between ICG 5351 and ICG 5880 (0.0507) at E1, between ICG 11428 and ICG 11436 at E2 (0.0638), between ICG 12209 and ICG 12350 at E3 (0.0439), between ICG 12873 and ICG 13130 (0.0583) at E4 were recorded while the maximum diversity was 0.0507 between ICG 10171 and ICG 521 at E1, 0.41 (ICG-3145 and ICG-4798) at E2, 0.4291 (ICG-10171 and ICG-10413) at E3, and 0.4638 (ICG-15126 and ICG-4906) at E4.

In *vulgaris* mean diversity estimates were 0.1798, 0.1963, 0.1918 and 0.1916 at E1, E2, E3 and E4 respectively, minimum diversity 0.0568 (ICG 12869 and ICG 7037) at E1 and 0.055 (ICG 14807 and ICG 8682) at E2, 0.0553 (ICG 5833 and ICG 7836) at E3 and 0.0599 (ICG 8351 and ICG 8657) at E4 were observed.

While maximum diversities were observed between ICG 13570 and ICG 7713 at E1 (0.4231), between ICG15112 and ICG 7327 at E2 (0.4356), between ICG 13570 and ICG-9973 at E3 (0.4340) and between the accessions ICG 121 and ICG 14161 (0.3923) at E4.

Discussion

V. DISCUSSION

The main aim of plant breeding programme is to improve the plant traits for agronomic and economic value. However, these important quantitative traits are under polygenic control and display a great variety of genotype x environment interaction. The knowledge about nature and extent of variability present in the germplasm accessions is important in planning a sound breeding strategy. In addition to this, information on various genetic parameters, association between traits will provided strong insight into control of those traits. The collection of germplasm from diverse eco-geographic regions and its evaluation under local conditions is pre-requisite to identify the superior sources for various traits and for its efficient and effective utilization.

Therefore, in the present study an attempt has been made to characterize the Asian core collection of groundnut comprising of 504 accessions. The results of the experiment are discussed in this chapter under different headings as follows.

5.1 Frequency distribution

5.2 Variability and related components

5.3 Genetic parameters

5.4 Correlation coefficients and

5.5 Diversity estimation.

5.1 Frequency distribution

The results of the frequency of different morphological descriptors are presented in Table 5b.

Growth habits and branching patterns forms the basis for the classification of groundnut. Gibbons *et al.* (1972) classified the groundnuts on this basis, subsp. *hypogaea* had alternate branching pattern with erect or prostrate growth habit. While, subsp. *fastigiata* is erect in habit with sequential branching pattern, Jacquot (1962) and Maeda (1964) after investigating association of floral traits with varietal differences concluded that vegetative and fruit characters appear to be more useful characters than floral characters in the classification of groundnut. Bunting (1955) and Gregory (1951) accepted branching pattern as the basis of classification. The different growth habits and branching patterns were reported by different scientists like irregular type of branching in the subsp. *pintoii* (Brigitte *et al.*, 1993). Decumbent type of growth habit, sequential and alternate branching pattern were noticed in the accessions of subsp. *fastigiata* and *hypogaea*, respectively (Esquivel *et al.*, 1993). In the present investigation six type of growth habits were observed. All *fastigiata* and 55.57 per cent of *vulgaris* accessions had erect type of growth habit, decumbent-1 (60.8%) and decumbent-2 (25.69%) were observed in the *hypogaea* accessions and other growth habits were decumbent-2, procumbent-1 and decumbent-3. Almost all the above mentioned growth habits were also noticed by Chandran and Pandya (2000) and by Upadhyaya *et al.* (2001). With respect to branching pattern alternate and sequential types were observed in the core collection. Sequential type in all *fastigiata* and in 97.5 per cent of *vulgaris* accessions, alternate type in 100.0 per cent of *hypogaea* accessions indicating predominance of alternate and sequential type branching pattern in the collection. The above result is in confirmation with report made by Esquivel *et al.* (1993).

The presence of stem colour and hairs are important characteristics as descriptors for groundnut varieties. But both of these traits are highly variable. Colour of the stem varies with the presence or absence and intensity of pigments in the stem tissue, which is highly influenced by the environment particularly exposure to the sunlight. So recording of the typical colours becomes almost impossible, as a result stem colour is recorded as present or absent. In the current investigation stem colour was absent in the maximum number of accessions (229 *hypogaea* and 239 *vulgaris*) while, presence of colour in all *fastigiata* accessions (29) indicating absence of stem colour as a major option in this core collection. Similar results were obtained by Upadhyaya *et al.* (2001) and also similar results with respect to presence of stem pigmentation in *fastigiata*, absence of pigmentation in *vulgaris* and a contrary result on absence of stem colour in *hypogaea* were obtained by Bhagat *et al.* (1985).

Number and length of the stem hairs and number of rows are also highly variable and even its distribution also varies, which is cultivar dependent, least influenced by the environment. In the present study subglabrous type with one or two rows of hairs were observed to the maximum extent in all the three botanical varieties, 75.8 per cent in *fastigiata*, 94.98 per cent in *hypogaea* and 94.42 per cent in *vulgaris* followed by moderately hairy with three or four rows of hairs. Similar result of subglabrous to moderately hairy were obtained by Brigett *et al.* (1993).

Leaf characters are important in the sub specific classification of groundnut. These leaf characters are however, highly variable. Variation in shape, size and hairiness between leaflets of the different plants of

same variety and even of the same plant is as great as any variation which may appear between the plants of different varieties (Bunting, 1972). In our study light green and green colour was noticed almost in equal proportions. All *fastigiata* and 232 accessions of *vulgaris* showed light green and 226 accessions of *hypogaea* exhibited green colour. In our results light green colour noticed in subsp. *fastigiata* is in confirmation with Gibbons *et al.* (1972) and Mital and Mehta (1951) and contrary to the leaf colour of green in subsp. *hypogaea*.

Almost glabrous type of leaf surface and elliptic leaf shape in all the three botanical varieties and in one accession of *hypogaea* lanceolate type was noticed. Similar results with respect to leaf surface were reported by Chandran and Pandya (2000). Varisai Muhammad *et al.* (1973) observed various types of leaflet shapes like oblong elliptic to obovate. As the leaf characters are highly variable different results were reported by the different scientists even in the same material.

Flower colour is one of the distinct feature of the different species of the groundnut. In the present study to an extent of 100 per cent flower colour was orange in all the accessions. Whereas, a number of flower colours were observed by Upadhyaya *et al.* (2001) in the world collection of groundnut. Like garnet, lemon yellow, light orange, orange, dark orange and yellow :

Peg colour is highly influenced by the environment and it is cultivar dependent, various grades of colour and differential expression occur on the same plant depending on the exposure to light. So peg colour was recorded as just presence or absence of colour. A large number of accessions in the Asian core collection showed presence of

colour (29FST, 228 HYPO and 245 VUL). Only 2 accessions of *hypogaea* showed absence of peg colour. Similar results were observed in the study of Bhagat *et al.* (1985).

The pods and seeds are important traits used in the classification of groundnuts (Gibbons *et al.*, 1972 and Bunting and Smartt, 1972). Morphology of pods and seeds have agronomic importance since moderate or prominent pod characters like constriction and reticulation may lead to higher pod loss during harvest due to adherence of soil particles. This will also affect the marketability of the pods. Among the seed colours, lighter colours are preferred in the confectionery markets.

In groundnut the tip of the indehiscent fruit may end in an appearance called beak. The prominence of beak varies in the different varieties. In the Asian core collection studied moderate (11 FST, 113HYPO and 100 VUL) and slight (18FST, 95 HYPO and 123 VUL) beak were observed. While pod constriction is an interesting characteristic as it affects the developing seed. Non constricted pods generally have seeds with flattened ends and are in contact with other ends in the pod, which may result in the damage to the embryo (Coffelt and Hammons, 1974). Such seeds tend to split during shelling, on the other hand pod with deep constrictions may also break due to adherence of more soil particles. Most of the commercial cultivars have slight to moderate constriction between the seeds. In the present investigation slight constriction in 29, 204 and 50 accessions of *fastigiata*, *hypogaea* and *vulgaris* was observed, followed by moderate constriction in 22 accessions of *hypogaea* and 190 accessions of *vulgaris*.

Reticulation on the pods is a prominent characteristic. In general most of the groundnut cultivars exhibit reticulation to different degrees.

Reticulation also contributes to the cleanness of pods at the time of harvest and have a impact on quality and marketability. In our investigation moderate reticulation was observed in nine *fastigiata*, 210 *hypogaea* and 210 accessions of *vulgaris* and slight reticulation in 18 *fastigiata* accessions.

Similar results were noticed by Bhagat *et al.* (1985) for all the above mentioned pod characters. While, slight type for all the three pod characters to the maximum extent was reported by Rajgopal *et al.* (1997).

Number of seeds may vary from one to five, single seeded pods may occur in almost all cultivars but single seededness is not cultivar specific (Bunting, 1955). While, Seshadri (1982) argued that the number of seeds is basically a cultivar dependent. Though it is influenced by season and other factors. Varisai Muhammad *et al.* (1973a) reported three or four seeded pods common in var *fastigiata* than in var *vulgaris* and var *hypogaea*. Similarly, in the present study 3-2-1/3-1-2 seeded pods were observed only in *fastigiata*, 2-3-1/2-1-3 seeded pods in 113 accessions of *hypogaea* followed by two or one seeded pods to the maximum extent in 242 accessions of *vulgaris* and 112 accessions of *hypogaea*. Similar result of two seeded pods followed by three or four seeded pods have reported by Esquivel *et al.* (1993).

In the present core collection study tan colour predominated being present in four *fastigiata*, 200 *hypogaea* and 224 *vulgaris* accessions followed by red and dark red. Predominant rose colour followed by red and dark purple was reported by Bhagat *et al.* (1985), Darkpurple and various other colours were reported by Upadhyaya *et al.* (2001).

5.2 Variability and related components

Estimated variance component gives an idea about the variability available for a trait. In the present study DM, DCF, DIF and DM at E1,

PLN, DCF, DM and LPB at E2, DM and DCF at E3, PLN, SWD, SDWT, DCF and DM at E4 showed highly significant variance component indicating availability of genetic variability in the core collection for these traits. Variance for both DM and DCF was highly significant in all four environments indicating that it can be effectively used to develop varieties with different days of maturity at different locations.

In the combined analysis entries (genotypes) significant for more traits except NSB and LSB. Interaction of entry with season was significant for 13 traits, and with location for 15 traits. Similarly in three factor interactions also entry was involved in more number of traits indicating it as an important source of variability and also its role in interactions.

In the botanical varieties wise analysis entry, except SEA X LOC and SEA X BOT all other two factors interactions and all three and four factors interactions found significant for maximum number of traits. From this it can be concluded that botanical variety alone is not a source of variation. But its interaction with entry and other factor is the main source of variation.

Comparison of means, variance and median for different traits indicated that, instances of significance were observed in more number of traits, at four different environments, botanical varieties wise and across the botanical varieties. This revealed differential performance of the core collection entries at different environments which strengthened the view that core collection should be subjected to multi location evaluation to identify the accessions with desirable traits.

Wide range for all the traits among the germplasm accessions both within and between varieties was observed indicating availability of wide variability (Table). This wide variability enables the breeder in the picking up of the genotypes for desirable traits for their inclusion in the breeding programme. Among different environments 10 traits at E1, four traits at E2, five traits at E3 and four traits at E4 showed highest range. Botanical varieties wise, in *fastigiata*, seven traits at E1, three traits at E2, six traits at E3 and E4 exhibited wider range, for *hypogaea* 10 traits at E1, six traits E2, two traits at E3 and five traits E4 showed highest range and four traits at E1, nine traits at E2, 12 traits at E2, 12 traits at E3 showed highest range and no traits at E4 in the botanical variety *vulgaris*. While, across the botanical varieties 23 traits in *hypogaea* and two traits in *vulgaris* exhibited highest range indicating availability of variation both within as well as between varieties. The differential performance of the accessions at different environments is expected as all these characters are quantitative in nature means controlled by polygenes and are affected by the environment to a greater extent.

In the present investigation rainy season and Raichur location (E1) favoured almost all the traits. Botanical varieties-wise *fastigiata* performed well at E1 and E4, *hypogaea* performed well at three environments (except at E3) and *vulgaris* performed poorly at E4 than in other environments. Among the botanical varieties *hypogaea* performed well indicating that this group has genes which perform well even under poor environmental conditions.

In earlier studies also wider ranges have been reported for 14 traits by Bhagat *et al.* (1984), for eight traits by Vaddoria and Patel (1990), for 10 traits by Swamy Rao *et al.* (1988), for seven traits by Pathirana (1993),

for 100 seed weight and shelling percentage by Natarajan *et al.* (1978) and for seven traits in both rainy and post rainy seasons by Harch *et al.* (1997).

The coefficient of variation gives an idea about amount of variability available for a trait in relation to its mean. In the present study highest CV was recorded for traits like LPB (60.46%), NSB (67.28%), NMP (42.99%) at E1, for traits NPB (57.67%), LSB (45.49%), PYP (61.30%) at E3 highest CV were recorded. The desirable genotypes can be selected for these traits. Moderate CV for SDWT (22.06%), NPP (36.88%), TNP (38.24%), NNCB (21.88%), LCB (24.41%) and PLHT (25.78%) at E3. For other traits low CV was observed.

Botanical varieties wise two traits PYP (58.30%) and LPB (72.90%) at E3, NMP (47.23%) and NPB (60.88%) at E1 and E4 exhibited high CV. Moderate CV of 27.72, 27.67 and 34.73 per cent at E3 were recorded for PLHT, LCB and TNP, respectively. SDWT (24.26%) at E1 showed moderate CV and all other traits were low in CV at different environments for the botanical variety *fastigiata*.

In *hypogaea* three traits NPB (43.07), NMP 944.34) and PYP (47.18) at E3 and LPB (45.76%) at E4 exhibited high CV while PLHT (21.77%), TNP (36.06%), SDWT (20.98%) at E3 displayed moderate CV. Low CV were recorded for other traits.

The highest CV values were noticed for LPB (60.88), NPB (71.24) and PYP (50.50%) at E1, E3 and E4, moderate CV for PLHT (22.19%), LCB (21.50%), NNCB (20.49%), SDWT (21.20%) at E3, respectively in the botanical variety *vulgaris*. In the botanical variety comparison for NMP (46.2) in *hypogaea*. For NPB (56.40%), LPB (55.08%) and NSB (90.80%)

highest CV were observed in *vulgaris*. PLHT (24.11%), NNMS (22.59%), TNP (38.75%), NPP (37.55%) and SDWT (20.98%) showed moderate CV in *fastigiata*. The results indicated that for NPB, LPB, NSB, NMP and PYP highest CV were observed at all the environments and even in individual botanical varieties at different environments as well. So selection can be practiced to improve these traits at different environments. The comparison of results of the present investigation with earlier works, it was found that high CV were reported by Swamy Rao *et al.* (1988) for NMP, NPP and NPB which is similar to the present investigation and moderate for PLHT, NNCB, LWD, high CV for LCB, PLN, PWD and moderate CV for LLN, LWD, PLHT, NNCB were reported by Chandran and Pandya (2000). A similar result of moderate to low CV for SDWT and low CV for SH was noticed by Natarajan *et al.* (1978). For most of the characters moderate to low CV were reported by Esquivel *et al.* (1993). While, wider variation even in relatively smaller collection has been reported for yield and yield related components (Chauhan and Shukla, 1985, Velu and Gopalkrishnan, 1985, Deshmukh *et al.*, 1986).

5.3 Genetic parameters

Eventhough coefficient variation gives an idea about amount of variability, it does not give true picture about the extent of inheritance of the character. Heritability estimates by separating out the environmental influence from the total variability, indicates accuracy with which a genotype can be assessed by its phenotypic performance. Thus permitting greater effectiveness of phenotypic selection however, its use would be limited as it is influenced to a great extent by environment and genotypes included. The estimation of heritability has a greater role to play in determining the effectiveness of selection of a character provided it is considered in conjunction with the predicted genetic advance as suggested by Johnson *et al.* (1955).

In the present investigation highest heritability was recorded for the traits NPB (66.48%), TNP (81.29%), NPP (89.64%), PWD (73.05%), DIF (88.03%) at E3, for PLN (72.98%), PWD (69.85%), PYP (88.07) at E2. But for DCF and DM at all four environments highest heritability was noticed indicating least influence of the environment on the inheritance of the above traits. Moderate heritability for PLN, SH, SDWT, SLN at E3, LLN at E1 and E2, except at E3 for LWD, at E4 for SWD and at two post rainy season environment for oil content were noticed. For other traits heritability estimates were low at different environments. The genetic advance except for DM and DCF at all four environments and NPP at E3 all other traits showed low genetic advance. A similar result of high heritability for NPB by Swamy Rao *et al.* (1988), for PYP by Dixit *et al.* (1971), for NMP, NPP, PYP by Vaddoria and Patel (1990) were observed. A low genetic advance observed in the present study is similar to the report made by Lakshmaiah (1978) for most of the traits. High genetic advance for DM, NPP were noticed by Vaddoria and Patel (1990), for NPP and OIL high GA, for PLHT, NPB, SH and SDWT moderate GA were noticed by Swamy Rao *et al.* (1988).

A reliable value of heritability along with high CV and GA offers the most effective condition for selection. Results of the present study indicated that selection for DCF, NMP and NPP at E3 and for PYP and SDWT at E2 could be effective in improving the yield.

5.4 Correlation studies

The yield in a plant is the sum of effects of several yield related component characters and environment. For a rational approach towards the improvement of yield, selection has to be made for the components of

yield. Thus, this assumes a special importance as the basis for selecting desired genotypes. Correlation co-efficient helps the breeder in determining relative importance of yield components for indirect selection for yield.

In the present study the significant associations were observed at all the four environments among different traits. But at E3 maximum number of traits exhibited significant correlation with other traits followed by E4, E1 and E2 respectively. LCB, LLN, LWD, NPB, NNCB, TNP, NMP, NPP, PLN, PWD, SLN, SDWT, DCF and DM were significantly correlated with more number of traits at all four environments followed by PLHT, LPB, SWD, DIF, PYP and NNMS and SH at E3 OIL at E1 and E3 exhibited significant association with maximum number of traits. Among yield related components NMP, TNP and NPP at all four environments are highly correlated with each other.

The proportion of variance in one trait that can be attributed to its linear relationship with a second trait is indicated by the square of the correlation co-efficient (Snedecor and Cochran, 1980). Considering the above criterion, the correlation co-efficients with an absolute value greater than 0.701 have been suggested to be as meaningful (Skinner *et al.*, 1999). So more than 50 per cent of the variation in one trait is predicted by the other. In our study, we found several such *meaningful* relationship in the core collection studied (Table 18). Number of mature pods and total number of pods (0.957, 0.940, 0.900 and 0.919), number of pegs per plant and total number of pods (0.970, 0.930, 0.915 and 0.954), number of pegs per plant and number of mature pods (0.940, 0.893, 0.871 and 0.902), days to maturity and *days to cessation of* flowering (0.957, 0.905, 0.932 and 0.927) at all four environments,

Table 18 : Correlation co-efficients with values more than 0.701 between traits in the core collection

Traits	Correlation co-efficient
NNCB and LCB (E1)	0.732
NNCB and LCB (E3)	0.764
NNCB and LCB (E4)	0.736
NMP and TNP (E1)	0.957
NMP and TNP (E2)	0.940
NMP and TNP (E3)	0.900
NMP and TNP (E4)	0.919
NPP and TNP (E1)	0.970
NPP and TNP (E2)	0.930
NPP and TNP (E3)	0.915
NPP and TNP (E4)	0.954
NPP and NMP (E1)	0.940
NPP and NMP (E2)	0.893
NPP and NMP (E3)	0.871
NPP and NMP (E4)	0.902
DM and DCF (E1)	0.957
DM and DCF (E2)	0.905
DM and DCF (E3)	0.932
DM and DCF (E4)	0.927
LWD and LLN (E2)	0.775
LWD and LLN (E3)	0.932

E1 – Raichur rainy.

E2 – Raichur post rainy.

E3 – Kawadimatti rainy.

E4 – Kawadimatti post rainy

number of nodes on cotyledonary branches and length of the cotyledonary branches (0.732, 0.764 and 0.736) at E1, E2 and E4 and leaflet length and leaflet width (0.775 and 0.814) at E2 and E3 exhibited such meaningful relationship. So from this it can be concluded that to improve yield it is better to go for selection of plant with more number of pegs, more number of pods and mature pods. Since days to maturity and days to cessation of flowering, number of nodes on cotyledonary branches and length of the cotyledonary branches are strongly associated. They can also be improved through selection based on the requirements. Some of the earlier works have also reported *similar* results. Positive association between pod yield and shelling percentage (Kumar and Yadav, 1978), pod yield with number of matured pods (Kataria *et al.*, 1984), leaflet length with yield (Swamy Rao *et al.*, 1988), height of the mainstem with length of the primary and secondary branches (Rao, 1979; Vindhiyavarman and Raveendran, 1989 and Balaiah *et al.*, 1980), 100-seed weight and pod width (Coffelt and Hammons, 1974). A positive association with $r > 0.701$ between leaflet length and leaflet width by Upadhyaya *et al.* (2000), pod yield with plant height, yield by Lin *et al.* (1969) with number of mature pods by Bhargava *et al.* (1970), 100-seed weight with length of the lateral branches by Sangha and Sandhu (1970) have also been reported. Badwal and Singh (1973) found a negative correlation of number of mature pods with 100-seed weight while, Lakshmaiah (1978) found this trait to be negatively related with plant height.

5.5 Diversity estimation

Wider diversity in any crop provides a first step to breeder for its improvement. Crosses between groups with the maximum genetic

divergence would be more responsive to improvement since they are likely to produce desirable recombinations in their progenies estimates of diversity would also help to chose parents for hybridization in order to exploit heterosis in the cross pollinated crops and to select desirable segregants in the self pollinated crops.

In the present study diversity was estimated by Shannon-Weaver diversity index. A low diversity index indicates an extremely unbalanced frequency and a lack of genetic diversity. A wider diversity was observed for almost all the traits in the core collection as indicated by their mean diversities but DM and DCF had low to moderate diversity. DCF had low level of mean diversity in *fastigiata* when compared to *hypogaea* and *vulgaris*. Except this all the traits had moderate to high diversity. The mean diversities of different traits at four different environments were similar in three botanical varieties (0.511 ± 0.025 in *fastigiata* 0.581 ± 0.012 in *hypogaea* and 0.887 ± 0.013 in *vulgaris*) indicating no difference in the diversities of different traits among botanical varieties. However, within the botanical varieties wider diversity was observed and can be exploited in the crop improvement programs.

Wider diversity for number of mature pods, plant height, 100-seed weight by Vinodkumar Reddy *et al.* (1984), for pod yield by Nadaf *et al.* (1986), for days to flowering by Sigamani (1981), for pod yield, length of the primary branch and number of pods by Sandhu and Sangha (1974), for 100-seed weight and pod number by Sangha (1971) were reported all the above are similar to the present investigation.

The best accessions were identified for the yield attributes like pod yield, 100 seed weight, shelling percentage and oil content are presented in Table 19.

Table 19 : Superior germplasm accessions identified for yield attributes at different environments during 2000-2001

Environments	Pod yield (g) ($\geq 20g$)	Shelling percentage (%) ($>80\%$)	Hundred seed weight (g) ($>60g$)	Days to maturity (<105)
E1	ICG-900 (27.20) ICG-15034 (24.80) ICG-9656 (22.75) ICG-2986 (21.75) ICG-4006 (21.75) ICG-4219 (21.36) ICG-7326 (21.30) ICG-3809 (20.05)	ICG-15015 (81.6) ICG-121 (81.5) ICG-7557 (81.5) ICG-407 (81.3) ICG-2452 (81.2) ICG-10576 (81.2) ICG-8887 (81.0) ICG-9135 (81.0) ICG-4933 (80.9) ICG-6377 (80.9) ICG-8472 (80.6) ICG-14393 (80.5) ICG-2024 (80.5) ICG-4758 (80.3) ICG-4729 (80.2)	ICG-15017 (60.9) ICG-9585 (63.2)	ICG-2990 (102) ICG-2986 (102) ICG-3024 (102) ICG-13324 (103) ICG-13907 (103) ICG-13890 (103) ICG-13895 (103) ICG-13337 (103) ICG-2252 (103) ICG-1505 (103) ICG-2781 (103) ICG-2745 (103)
E2	ICG-9585 (22.75) ICG-15094 (20.20)	ICG-10707 (80.3) ICG-13934 (80.1)	ICG-6996 (63.9) ICG-2918 (63.9) ICG-521 (63.0) ICG-15017 (63.8)	-
E3	ICG-7086 (23.00), ICG-2725 (22.87), ICG-7152 (21.90), ICG-75 (21.80), ICG-12358 (21.60), ICG-7325 (21.36), ICG-15111 (21.20), ICG-7092 (21.10), ICG-15021 (20.10)	ICG-11197 (80.6) ICG-3050 (80.3) ICG-13942 (80.2) ICG-3081 (8.2) ICG-9402 (80.2) ICG-6377 (80.2) ICG-3954 (80.1) ICG-4453 (80.1) ICG-7867 (80.1) ICG-11318 (80.2)	ICG-521 (63.6) ICG-6996 (60.6) ICG-2918 (60.0) ICG-130 (60.7) ICG-3486 (60.7) ICG-15034 (60.5) ICG-1425 (60.3) ICG-15034 (60.5) ICG-1425 (60.3)	ICG-2745 (103) ICG-2781 (103)
E4	ICG-14362 (25.30) ICG-3841 (22.93) ICG-12621 (20.38) ICG-3809 (20.05) ICG-5024 (20.05)	ICG-10207 (81.0) ICG-13934 (80.8)	ICG-15017 (60.8)	-

E1 – Raichur rainy, E2 – Raichur post rainy, E3 – Kawadimatti rainy, E4 – Kawadimatti post rainy

Superior accessions like, ICG 3148, ICG 116, ICG 3048, ICG 15126, for oil content, ICG 13942, ICG 6377, ICG 15015, ICG 10707, ICG 3954, ICG 11197, ICG 13934, ICG 4453, ICG 7867, ICG 121, ICG 11328 shelling percentage, ICG 521, ICG 6996, ICG 15017, ICG 521, ICG 2918, ICG 9581, for seed weight, ICG 2990, ICG 2986, ICG 3048, ICG 13324 for early maturity were identified.

These accessions can be evaluated extensively to select parents for hybridization. Some of the accessions with acceptable agronomic characteristics can be released as cultivar.

Summary

VI. SUMMARY

For any crop improvement program it is pre-requisite to maintain the genetic variability to identify the desirable genotypes. The germplasm collection are vast resources and evaluation of the entire set of collection is costly and nearly impossible. Considering this, Frankel (1984) proposed the strategy of core collection. Upadhyaya *et al.* (2001) developed an Asia region core collection of groundnut consisting of 504 accessions. Since yield and yield related attributes display wide range of interaction this core collection was evaluated at different environments in Karnataka to identify desirable accessions.

In the present study core collection was evaluated during 2000 rainy and 2001 post rainy at Raichur and Kawadimatti with the objectives like characterization of core collection, identify the superior accessions, study the genetic parameters, study the association and assess the diversity in the core collection.

Characterization of groundnut core collection revealed that erect type followed by procumbent-1 and decumbent-2 growth habit, alternate and sequential type of branching pattern, absence of stem pigmentation, subglabrous with one or two rows of hairs on the stem, light green followed by green leaf colour, almost glabrous type of leaf surface, elliptic leaf shape, orange flower colour, presence of peg colour, 2-1 seeded pods followed by 2-3-1/2-1-3, slight to moderate beak and constriction, moderate reticulation, tan followed by red seed colour dominated the core collection.

In the analysis of variance entry and its interaction was found significant over more number of traits indicating entry as a source of variation, mean, median and Leven's tests were found significant indicating differential performance of the accessions and availability of wider variation and almost all the traits exhibited wider ranges. Coefficient of variations were high for NPB, NPP, NMP at all environments and even botanical varieties wise, across the botanical variety *hypogaea* exhibited high CV for most of the traits.

Heritability estimates were high for NPB, TNP, NPP, PWD, DIF, PLN, SWD, PYP at different environments. While, for DM and DCF at all environments. Genetic advances were low for almost all the traits except DM and DCF and NPP at E3.

Association of different traits revealed that between most of the traits significant correlation was observed. But between the traits NMP and TNP, NPP and TNP, NPP and NMP, DM and DCF, NCB, and NNMS at three environments (E1, E2 and E4) and between LLN and LWD at E1 and E2 meaningful associations were observed having $r > 0.701$.

Diversity estimation indicated that almost all the traits showed moderate to high level of diversity except DCF and DM. DCF exhibited low level of diversity in *fastigiata* when compared to *hypogaea* and *vulgaris*. Comparison of mean diversities exhibited no difference between the botanical varieties.

Superior accessions like, ICG 3148, ICG 116, ICG 3048, ICG 15126, for oil content, ICG 13942, ICG 6377, ICG 15015, ICG 10707,

ICG 3954, ICG 11197, ICG 13934, ICG 4453, ICG 7867, ICG 121, ICG 11328 for shelling percentage ICG 521, ICG 6996, ICG 15017, ICG 521, ICG 2918, ICG 9581 for seed weight, ICG 2990, ICG 2986, ICG 3048, ICG 13324 for early maturity were identified.

From the current investigation on variability, heritability and genetic advance, association and diversity, it could be inferred that no germplasm accession had all the desirable characters. However, different germplasm accessions have been identified as promising for different traits. A gene pool comprising of best accessions could be created to utilise as a base population for breeding programmes to evolve superior lines, varieties.

References

Released on — ~~1946~~

14 NOV 2003

U. A. S.
University Library
DHARWAD.

Acc. No. Th-7128

VII. REFERENCES

- ALI, N., 1984, New promising varieties of groundnut. *Progressive Farming*, **4** : 26-29.
- ANONYMOUS, 1992, Descriptors for groundnut. International Board for plant genetic resources, Rome, Italy, International crops Research Institute for the semi-arid tropics. Patancheru, India.
- ANONYMOUS, 1993, *Genstat 5, Reference Manual*, Oxford University Press, Inc, New York.
- ANONYMOUS, 1997, *Statsoft*. Statistics for windows Statsoft, USA.
- ANONYMOUS, 1999, *Food and Agriculture Organization*, **53** : 113-114.
- ANONYMOUS, 2000, *Oilseeds Situation*. A statistical compendium. Indian Culture of Agricultural Research, Hyderabad, pp. 12-13.
- BADWAL, S.S. AND SINGH, H., 1973, Effects of growth habit on correlations and path co-efficients in groundnut. *Indian Journal of Genetics and Plant Breeding*, **33** : 101-111.
- BALAJIAH, C., REDDY, P.S. AND REDDY, M.V., 1980, Correlation studies of some yield components in the F₂ segregating populations of the groundnut cross, 'J11' X 'Gujarat narrow leaf mutant'. *Indian Journal of Agricultural Sciences*, **50** : 213-215.
- BHAGAT, N.R., LALWANI, H.B., TASLIM AHMAD, DHAPWAL, G.S. AND NAGARAJ, G., 1984, Evaluation of groundnut collections from Zambia. *Indian Journal of Genetics and Plant Breeding*, **44**:406-410.
- BHAGAT, N.R., TASLIM AHMAD, H.B., LALWANI AND HARENDER SINGH, 1985, Status of National resources of cultivated groundnuts. *Indian Journal of Genetics and Plant Breeding*, **45** : 171-177.
- BHARGAVA, P.D., DIXIT, P.K., SAXENA, D.K. AND BHATIA, L.K., 1970, Correlation studies on yield and its components in erect varieties of groundnut (*Arachis hypogaea* L.). *Rajasthan Journal of Agricultural Sciences*, **1** : 64-67.

- BRIGETTE, L.M., TORRES, A.M. AND OCAMPO, C.H., 1993, Morphological and isozyme characterisation of *Arachis pintoii* Krap. et Gren. nom. nud. germplasm. *Euphytica*, **70** : 43-52.
- BROWN, A.H.D., 1989a, Core collections : a practical approach to genetic resources management. *Genome*, **31** : 818-824.
- BUNTING, A.H., 1955, A classification of cultivated groundnut. *Empire Journal of Experimental Agriculture*, **23** : 158-170.
- CHANDOLA, R.P., DIXIT, P.K. AND SAXENA, D.K., 1973, Note on the path co-efficient analysis of yield components in groundnut. *Indian Journal of Agricultural Sciences*, **43** : 897-898.
- CHANDRAN, K. AND PANDYA, S.M., 2000, Morphological characterization of *Arachis* species of section *Arachis*. *Plant Genetic Resource Newsletter*, **121** : 38-41.
- CHAUHAN, R.M. AND SHUKLA, P.T., 1985, Variability heritability and genetic advance in bunch and spreading groundnut. *Indian Journal of Agricultural Sciences*, **56** : 816-821.
- COFFELT, T.A. AND HAMMONS, R.O., 1974, Inheritance of pod constriction in peanuts. *Journal of Heredity*, **65** : 94-96.
- CORLEY HOLBROOK, C., WILLIAM, F.A. AND ROY, N.P., 1993, Selection of a core collection from the U.S. germplasm collection of peanut. *Crop Science*, **33** : 859-861.
- DESHMUK, S.N., BASU, M.S. AND REDDY, P.S., 1986, Genetic variability, character association and path co-efficient of quantitative traits in virginia bunch varieties of groundnut. *Indian Journal of Agricultural Sciences*, **56** : 816-821.

- DIVEKAR, C.B., 1961, Flowering in groundnut varieties. *Indian Oilseeds Journal*, **5** : 264-273.
- DIXIT, P.K., BHARGAVA, P.D., SAXENA, D.K. AND BHATIA, L.H., 1970, Estimates of genotypic variability of some quantitative characters in groundnut (*Arachis hypogaea* L.). *Indian Journal of Agricultural Sciences*, **40** : 197-202.
- DIXIT, P.K., BHARGAVA, P.D., SAXENA, D.K., BHATIA, L.H. AND SHARMA, K.N., 1971, Variability in groundnut (*Arachis hypogaea* L.). *Indian Journal of Agricultural Sciences*, **41** : 685-691.
- ESQUIVEL, M., BARRIOS, M., WALON, L. AND HAMMER, K., 1993, Peanut (*Arachis hypogaea* L.) genetic resources in Cuba I. collecting and characterization. *IBPGR Plant Genetic Resource Newsletter*, **91/92** : 9-15.
- ESQUIVEL, M., FUNDORA, Z. AND HAMMER, K., 1993, Peanut (*Arachis hypogaea* L.) genetic resources in Cuba. II. preliminary evaluation. *IBPGR Plant Genetic Resource Newsletter*, **91/92** : 17-20.
- FRANKEL, O.H., 1984, Genetic perspective of germplasm conservation. In Genetic manipulations, impact on man and society. : Arber, W., Limensec K., Peacock, W.J. and Starlinger, P. (eds.), Cambridge University Press, Cambridge, pp. 161-170.
- FRANKEL, O.H. AND BROWN, A.H.D., 1984, Current plant genetic resources - Critical appraisal. In : *Genetics : New Frontiers* Eds. Chopra V.L., Joshi, B.C., Sharma, R.P. and Bansal, H.C. , Oxford and IBH Publishing Co. New Delhi, **4** : 1-13.
- GIBBONS, R.W., BUNTING, A.H. AND SMARTT, J., 1972, The classification of varieties of groundnut (*Arachis hypogaea* L.). *Euphytica*, **21** : 78-85.

- GOSH, J.K. AND DASGUPTA, D.K., 1975, Effects of dates of sowing on growth and yield of groundnut (*Arachis hypogaea* L.) in laterite upland. *Plant Science*, **7** : 56-60.
- GREGORY, W.C. AND GREGORY, M.P., 1976, Groundnut, *Arachis hypogaea*. *Evolution of Crop Plants*, pp. 151-154.
- GREGORY, W.C., SMITH, B.W. AND YARBROUGH, J.A., 1951, *The Peanut, The Unpredictable Legume*. Washington D.C., National Fertilizer Association, pp. 28-85.
- GUOK, H.P., WYNNE, J.C. AND STALKER, H.T., 1986, Recurrent selection within a population from an interspecific peanut cross. *Crop Science*, **26** : 249-253.
- HALWARD, T.M. AND WYNNE, J.C., 1991, Generation mean analysis for productivity in two diverse peanut crosses. *Theoretical and Applied Genetics*, **82** : 784-792.
- HALWARD, T.M., WYNNE, J.C. AND STALKER, H.T., 1991, Recurrent selection progress in a population derived from an interspecific peanut cross. *Euphytica*, **52** : 79-84.
- HARCH, B.D., BASFORD, K.E., DeLACY, I.H. AND LAWRENCE, P.K., 1997, The analysis of large scale data taken from the world groundnut (*Arachis hypogaea* L.) germplasm collection I. Two-way-quantitative data. *Euphytica*, **95** : 27-38.
- HARCH, B.D., LAWRENCE, P.K., CRUICKSHANK, A., TONKS, J., BASFORD, K.E., DeLACY, I.H. AND McLEOD, C.M., 1995, Diversity in the Australian groundnut germplasm collection. *International Arachis Newsletter*, **15** : 15.

- JACQUOT, M., 1962, Observations de quelques caractères morphologiques floraux sur *Arachis hypogaea* L. Liaisons naturelles de ces caractères. Remarque sur la classification des arachides cultivées. *Agron. Trop*, Nogent. **10** : 817-827.
- JIAO, C.H., 1991, Expedition for and collection of oil crop germplasm resources from shennonjia and sanxia regions with their preliminary evaluation. *Crop Genetic Resources*, **1** : 4-6.
- JOHN, C.M., VENKATANARAYANA, G. AND SESHADRI, C.R., 1954, Varieties and forms of groundnut (*Arachis hypogaea* L.), their classification and economic characters. *Indian Journal of Agricultural Sciences*, **24** : 159-193.
- JOHNSON, H.W., ROBINSON, H.F. AND COMSTOCK, R.E., 1955, Estimates of genetics and environmental variability in soybean. *Agronomy Journal*, **47** : 477-483.
- JOHNS, M.A., SKROCH, P.W., NIENHUIS, J., HINRICHSSEN, P., BASCUR, G. AND SCHICK, C.M., 1997, Gene pool classification of common bean land races from Chile based on RAPD and morphological data. *Crop Science*, **37** : 605-613.
- KATARIA, V.P., RAO, S.K. AND KUSHWAHA, J.S., 1984, Yield components in bunch type of groundnut. *Mysore Journal of Agricultural Sciences*, **18** : 13-16.
- KATULE, B.K., THOMBARE, M.V., DUMBARE, A.D. AND PAWAR, B.B., 1992, Genetic diversity in groundnut. *Journal of Maharashtra Agricultural Universities*, **17** : 302-303.

- KEULS, M., 1952, The use of the "studentized range" in connection with an analysis of variance. *Euphytica*, **1** : 112-122.
- KHANGURU, B.S.C. AND SANDHU, R.S., 1972, Path analysis in groundnut. *Indian Journal of Agricultural Sciences*, **42** : 792-795.
- KOTZAMANIDIS, S. AND STAVROPOULOS, N., 1998, Characterization and preliminary evaluation of greek groundnut (*Arachis hypogaea* L.) germplasm for their earliness, high pod concentration and synchronized maturity. *Agriculture Mediterranea*, **128** : 21-27.
- KRPOVICKAS, A. AND GREGORY, W.C., 1994, Taxonomia del genero *Arachis* (Leguminosae). *Bonplandia*, **8** : 1-187.
- KULKARNI, G.N. AND ALBUQUERQUE, S.D.S., 1967, Study of variation in some quantitative characters of nine strains of groundnut evolved at Raichur. *Mysore Journal of Agricultural Sciences*, **1** : 53-59.
- KUMAR, P. AND YADAV, T.P., 1979, Estimates of variation and heritability in groundnut. *Journal of Research*, Haryana Agricultural University, **9** : 231-234.
- LABANA, K.S. AND MOHINDER SINGH, 1979, The scope of raising off season groundnut for advancing generations. *Crop Improvement*, **6** : 166-167.
- LAKSHMAIAH, B., 1978, Studies on relationship between yield and its components in groundnut (*Arachis hypogaea* L.). *M.Sc. (Agri.) Thesis*, Andhra Pradesh Agricultural University, Bapatla, Andhra Pradesh.

- LAKSHMAIAH, B., REDDY, P.S. AND REDDY, B.M., 1983, Selection criteria for improving yield in groundnut (*Arachis hypogaea* L.). *Oleagineux*, **38** : 607-613.
- LEE, J.I., PARK, H.W., PARK, Y.H., HAN, E.D., HAM, Y.S. AND KANG, K.H., 1983, A new erect type high oil content and high oil yielding groundnut variety Shinpeng. *Crop*, **25** : 190-194.
- LEVENE, H., 1960, Robust tests for equality of variances. In Olsein I (ed) contributions to probability and statistics : essays in honour of Harold Hotelling. Standard University Press, Standford, pp. 278-292.
- LIN, H., CHEN, C.C. AND LIN, C.Y., 1969, Studies on the yield components of peanut II. The path co-efficient of yield components in different crops of peanut. *Journal of Agricultural Association of China*, **65** : 22-31.
- LIQO-XM, ZHANG-LH, LI-LR AND ZHENG-GE, 1989, Correlation and partial correlation analysis of the characters of Spanish groundnut varieties. *Oil Crops of China*, **2** : 29-31.
- LUAN, W.Q. AND HAN, S.P., 1990, Preliminary analysis of the nutritive value of the groundnut germplasm resources in Shangdong province. *Crop Genetic Resources*, **2** : 22-25.
- LUSH, J.L., 1949, Heritability of quantitative characters in farm animals, *Proceedings of 8th Congress of Genetics and Heridities*. **35** : 356-375.
- LYNCH, R.E., 1990, Resistance in peanut to major orthropod pests. *Florida Entomologist*, **73** : 422-445.

- MAEDA, K., 1964, On variation in number of sterile stamens in the groundnut and its significance in varietal classification. *Proceedings of Crop Science Society, Japan*, **33** : 94-104.
- MAJUMDAR, P.K., RAMPRAKASH AND MD. FAZUL HAQUE, 1969, Genotypic and phenotypic variability in quantitative characters in groundnut. *Indian Journal of Genetics and Plant Breeding*, **29** : 291-296.
- MISRA, J.B., CHAUHAN, S. AND MATHUR, S., 1992, Variation in oil and protein contents in groundnut germplasm. *Groundnut News*, **4** : 2-3.
- MITAL, S.P. AND MEHTA T.R., 1954, Some studies on groundnuts (*Arachis hypogaea* L.). *Indian Journal of Genetics and Plant Breeding*, **14** : 13-21.
- NADAF, H.L., HABIB, A.F. AND GOUD, J.V., 1986, Analysis of genetic diversity in bunch groundnut. *Journal of Oilseeds Research*, **3** : 37-45.
- NATARAJAN, S.T., SATHIAMOORTHY, M.R. AND RAMACHANDRAN, T.K., 1978, A note on the variability in kernal weight and shelling outturn in groundnut. *Journal of Maharashtra Agricultural Universities*, **3** : 67-68.
- NEWMAN, D., 1939, The distribution of range in samples from a normal population expressed, interms of an independent estimate of standard deviation. *Biometrika*, **31** : 20-30.

- OMRAN, A.O., DEMIAN, K.R. AND ABDEL-AL-I.M., 1980, Flowering and fruiting pattern in prostrate and semi-prostrate type. *Agricultural Review*, **58** : 107-116.
- ONO, Y., 1979, Flowering and fruiting of peanut plants. *Japan Agriculture Research Quarterly*, **3** : 226-229.
- PANSE, V.G. AND SUKHATME, P.V., 1967, *Statistical Methods for Agricultural Workers*. Indian Council of Agricultural Research New Delhi.
- PATHIRANA, R., 1993, Yield components of bunch groundnut (*Arachis hypogaea* L. subsp. *fastigiata*) germplasm in Sri Lanka. *Tropical Agriculture*, **70** : 256-259.
- PHANDIS, B.A., EKBOTE, A.P. AND MARKER, A.R., 1973, Correlation studies in some metrical characters in groundnut (*Arachis hypogaea* L.). *Jawaharlal Nehru Krishi Viswa Vidyalyaya, Research Journal*, **7** : 68-72.
- RAJGOPAL, K., CHANDRAN, K., BHAGAT, N.R. AND BHALODIA, P.K., 1997, Morphological characterization of valencia and virginia bunch peanut (*Arachis hypogaea* L.) germplasm. *Plant Genetic Resources Newsletter*, **109** : 27-29.
- RAJGOPAL, K., GHETIA, N.R., BHALODIA, P.K. AND BHAGAT, N.R., 1991, Variation in leaf characters in four forms of groundnut germplasm. *Groundnut News*, **3** : 1-2.
- RAMAN, V.S. AND SREE RANGASWAMY, S.R., 1970, Genetic variability of quantitative attributes in the progenies of the hybrid *Arachis hypogaea* L. x *Arachis monticola*. *Madras Agricultural Journal*, **57** : 571-577.

- RAMANATHAN, T. AND RAMAN, V.S., 1968, Studies on the relation of certain genetic characters in hybrid populations of groundnut (*Arachis hypogaea* L.). *Journal of Botanical Society*, **47** : 113-120.
- RAO, V.R. AND MWENDA, F.F., 1987, Collecting groundnut germplasm in Tanzania IBPGR *Plant Genetic Resource Newsletter*, **70** : 35-37.
- REDDY, K.H.P. AND REDDY, K.R., 1993, Genetic divergence in groundnut (*Arachis hypogaea* L.). *Annals of Agricultural Research*, **14** : 9-14.
- RETAMAL, N., LOPEZ, VENCES, M. AND DUAN, J.M., 1990, Seed morphology of 75 genotypes of peanut (*Arachis hypogaea* L.) grown in Spain. IBPGR *Plant Genetic Resource Newsletter*, **80** : 1-4.
- ROBINSON, D.L., 1987, Estimation and use of variance components. *The Statistician*, **36** : 3-14.
- SANDHU, R.S. AND SANGHA, A.S., 1974, Analysis of diversity in groundnut (*Arachis hypogaea* L.) I. Bunch group. *Oilseeds Journal*, **14** : 1-8.
- SANGHA, A.S., 1971, Analysis of Groundnut (*Arachis hypogaea* L.) II. Spreading Group. *Madras Agricultural Journal*, **58** : 875-881.
- SANGHA, A.S. AND SANDHU, R.S., 1970, Genetic variability and correlation studies in groundnut (*Arachis hypogaea* L.). *Journal of Research*, Punjab Agricultural University, **7** : 143-150.
- SANGHA, A.S. AND SANDHU, R.S., 1974, Genetic variability and correlation studies in bunch groundnut. *Oilseeds Journal*, **4** : 22-30.

- SESHADRI, C.R., 1962, *Groundnut*. The Indian Central Oilseed committee, Hyderabad, Andhra Pradesh. p. 274.
- SHANNON C.E. AND WEAVER, W., 1949, *The Mathematical Theory of Communication*. University of Illinois Press, Urbana.
- SHIBUYA, T., 1935, Morphological and physiological studies on the fructification of peanut. *Taihoku Imperial Univ.Fac. Sc. and Agr. Memoirs*, **17** : 120.
- SIGAMANI, T.S.N., 1981, Genetic divergence studies in groundnut (*Arachis hypogaea* L.). *M.Sc. (Agri.) Thesis*, University of Agricultural Sciences, Bangalore.
- SINGH, A.K., RAMANATHA RAO V. AND MENGESHA, M.H., 1992, Groundnut genetic resources : progress and prospects. In : *Groundnut - a global perspective*. Proceedings of an International Workshop, Nov. 1991, ICRISAT Center, India. pp. 297-309.
- SINGH, A.K., SUBRAMANYA, P. AND SANTOS-GURTU AND GURTU, S., 1996, Variation in wild groundnut species (*Arachis duranensis*). *Genetic Resource and Crop Evaluation*, **43** : 135-142.
- SKINNER, D.Z., BAUCHAN, G.R., AURICHT, G. AND HUGGHES, S., 1999, A method for the efficient management and utilization of large germplasm collections. *Crop Science*, **39** : 1237-1242.
- SMITH, B.W., 1950, *Arachis hypogaea*, Aerial flower and subterranean fruit. *American Journal of Botany*, **37** : 802-815.

- SMITH, B.W., 1954, *Arachis hypogaea* : Reproductive efficiency. *American Journal of Botany*, **4** : 607-616.
- SNEDECOR, G.W. AND COCHRAN, W.G., 1980, *Statistical Methods*, 7th Edn. Iowa state University Press, Ames.
- STALKER, H.T., 1992, Utilizing *Arachis* germplasm resources. In : *Groundnut a global Perspective*, pp. 281-295.
- STALKER, H.T., 1992, A new species in section *Arachis* of peanuts with AD genome. *American Journal of Botany*, **78** : 630-637.
- SWAMYRAO, T., 1979, Genetic variability in groundnut. *Crop Improvement*, **6** : 66-67.
- SWAMYRAO, T., ANGADI, S.P. AND DOSHI, S.P., 1988, Variability and interrelationship among yield and yield components in groundnut (*Arachis hypogaea* L.). *Journal of Oilseeds Research*, **5** : 16-21.
- TRIPATHI, A.K., BISEN, M.S., MUKHERJEE, S.C. AND SHAW, S.S., 1974, Performance of groundnut genotypes under rainfed conditions in northern hills of Chattishgarh. *International Arachis Newsletter*, **17** : 67-68.
- UPADHYAYA, H.D., ORITZ, R., BRAMEL, P.J. AND SUBE SINGH , 2000, Development of a core collection using taxonomical, geographical and morphological descriptors. *Genetic Resources and Crop Evolution* (press).
- UPADHYAYA, H.D., ORITZ, R., BRAMEL, P.J. AND SUBE SINGH, 2001, Development of groundnut core collection from Asia region. pp. 43-44. In 100 years of post-mendelian genetics and plant breeding – Retrospect and Prospects. Diamond Jubilee Symposium, 6-9 November 2001. *Indian Society of Genetics and Plant Breeding*, New Delhi, India. :

- VADDORIA, M.A. AND PATEL, V.J., 1990, Genetic variability in virginia runner groundnut (*Arachis hypogaea* L.). *Journal of Oilseeds Research*, **7** : 130-132.
- VARISAI MUHAMMED, S., RAMANATHAN, T. AND RAMACHANDRAN, M., 1973a, Variation in morphological characters of *Arachis hypogaea* L. *Madras Agricultural Journal*, **60** : 1373-1379.
- VARISAI MUHAMMAD, S., RAMANATHAN, T. AND RAMACHANDRAN, M., 1973b, Classification of *Arachis hypogaea* L. var. *fastigiata*. *Madras Agricultural Journal*, **60** : 1399-1402.
- VARISAI MUHAMMAD, S. AND STEPHENDORAIRAJ, 1969, Flowering pattern and reproductive efficiency in bunch varieties of *Arachis hypogaea* L. *Madras Agricultural Journal*, **56** : 239-243.
- VELU, G. AND GOPALKRISHNAN, S., 1985, Habitual and varietal variation in yield, harvest index and quality characteristics of groundnut. *Madras Agricultural Journal*, **72** : 518-521.
- VINDHIYAVARMAN, P. AND RAVEENDRAN, T.S., 1989, Association and path analysis in groundnut (*Arachis hypogaea* L.). *Journal of Oilseeds Research*, **6** : 369-372.
- VINODKUMAR REDDY, P., KRISHNAMURTHY, B., SUBRAMANYAM, D. AND SRIRAMREDDY, N., 1984, Genetic diversity for some quantitative traits in groundnut (*Arachis hypogaea* L.) virginia Gresp. *Andhra Agricultural Journal*, **31** : 272-276.
- WARD, J., 1963, Hierarchical grouping to optimize an objective function. *Journal of American Statistical Association*, **38** : 236-244.
- WILCOXON, F., 1945, Individual comparisons by ranking methods. *Biometrics Bulletin*, 1. pp. 80-83.

Appendices

Appendix

Details of the accessions in the Asian core collection of groundnut

Sl.No.	ICG	BOTVAR	Identity
1	972	HYR	S 230
2	4	FST	RS 6
3	29	FST	RS 90
4	57	FST	B 6/B
5	380	FST	PI 169294; NCAC 1002
6	1132	FST	Small japan
7	1267	FST	AH 7229
8	2007	FST	AH 63
9	2243	FST	AK 8-11
10	3148	FST	Almel No.1
11	2738	FST	Gangapuri
12	3443	FST	Rajkot valencia
13	4725	FST	Virginia bunch
14	5238	FST	EC 36890
15	5490	FST	AH 7179; CPI 14577
16	5584	FST	AH 7835
17	6205	FST	PI 268559; NCAC 10121
18	7223	FST	EC 123064
19	15119	FST	SDR 25
20	8360	FST	NCAC 18121
21	13941	VUL	ICGS 44
22	8371	FST	NCAC 18138
23	8711	FST	MJH 39
24	8831	FST	A 1132
25	9144	FST	58-589: Latta qieh jableh beladi
26	9376	FST	59-483: Kopergaon
27	9581	FST	VRR 472
28	10704	FST	Tai san; Jewel Nut
29	12333	FST	ICGM 286
30	12684	FST	RV 25
31	13942	HYB	ICGS 76
32	12883	FST	RT 19
33	12978	FST	US 10
34	13570	FST	CES 101
35	13627	FST	SSI 54
36	13902	FST	SS 34
37	14161	FST	Ly tay ninh
38	14819	FST	SKN 34
39	15016	FST	ICGV-SM 88726
40	15021	HYB	ICGV-SM 89786
41	972	HYR	S 230
42	17	HYB	RS 31
43	212	HYB	511/28
44	512	HYB	AH 699
45	521	HYB	AH 6609
46	615	HYB	TG 1
47	745	HYB	Cochin red
48	765	HYB	KAR 3-24-11-11

	ICG	BOTVAR	Identity
49	1505	HYB	#1025
50	2252	HYB	PI 269710; NCAC 38
51	2738	FST	Gangapuri
52	2425	HYB	VRR 18
53	15034	HYB	ICGV-SM 92748
54	2745	HYB	HG
55	2781	HYB	Local Caude
56	2891	HYB	#5-8
57	2906	HYB	#57-3
58	2986	HYB	AH 6795
59	2990	HYB	AH 7207
60	3048	HYB	ND 8-2
61	13941	VUL	ICGS 44
62	3050	HYB	Nimbargh area
63	3053	HYB	#275
64	3809	HYB	AH 699
65	3820	HYB	Virginia bunch; EC 4086
66	3841	HYB	Small japan
67	3880	HYB	AH 8395; EC 81607: Osmaniya
68	4032	HYB	HR 174
69	4036	HYB	TMV 10/3
70	4116	HYB	AH 8395; EC 81067: Osmaniya
71	13942	HYB	ICGS 76
72	4180	HYB	AH 7036
73	4186	HYB	AH 7049
74	4217	HYB	AH 7334
75	4219	HYB	AH 7366
76	4598	HYB	Hyderabad
77	4778	HYB	KU No. 145; Chiba 43
78	4798	HYB	C No. 942
79	4827	HYB	AH 7850
80	4906	HYB	AH erecta
81	972	HYR	S 230
82	4942	HYB	AH 7019
83	5232	HYB	EC 27485
84	5342	HYB	TG 16
85	5616	HYB	AH 45
86	5719	HYB	NC 2 Line 7; PI 371856; NCAC 17162
87	5804	HYB	VRR 60
88	6996	HYB	KU 126
89	7325	HYB	334 A; EC 123072
90	7596	HYB	VRR 409
91	2738	FST	Gangapuri
92	7867	HYB	OG 43-4-1
93	7973	HYB	K 489; IN 59-42; PI 269061; NCAC 9978
94	8352	HYB	NCAC 18109
95	8894	HYB	AY 110
96	9402	HYB	61-30; No. 93

	ICG	BOTVAR	Identity
97	9656	HYB	VRR 645
98	9702	HYB	VRR 716
99	10302	HYB	AH 7780-1
100	10413	HYB	PI 268914; NCAC 16575
101	13941	VUL	ICGS 44
102	10707	HYB	TCG 1525
103	11197	HYB	B 30
104	11673	HYB	NS 078
105	11802	HYB	Chungju 1; 300317
106	11807	HYB	Pungyeong; 300331
107	11820	HYB	Woelseong; 300390
108	11828	HYB	Cheongyang 1; 300402
109	11863	HYB	Hwaseongibudo 1; 300529-1
110	12144	HYB	Yeongweol 1; 300411
111	13942	HYB	ICGS 76
112	12353	HYB	Suweon 20; 300494
113	12368	HYB	AKG 276
114	13324	HYB	EC 21886
115	13337	HYB	EC 102587
116	13884	HYB	SS 17
117	13890	HYB	SS 23
118	13895	HYB	SS 29
119	13907	HYB	SS 38
120	13922	HYB	2245
121	972	HYR	S 230
122	13934	HYB	CS 13 x CS 9-33
123	13942	HYB	ICGS 76
124	15105	HYB	SDR 10
125	14362	HYB	SNW 1
126	14376	HYB	SNW 25
127	14378	HYB	SNW 27
128	14834	HYB	Banki
129	15017	HYB	ICGV-SM 88762
130	15111	HYR	SDR 16
131	2738	FST	Gangapuri
132	15112	HYR	SDR 17
133	15126	HYR	AKS 7
134	9	HYR	RS 14
135	67	HYR	S 68
136	69	HYR	Costalroy
137	75	HYR	P 8
138	76	HYR	T 27
139	91	HYR	TG 649
140	116	HYR	T 23
141	13941	VUL	ICGS 44
142	184	HYR	Ginak
143	199	HYR	HG 10
144	202	HYR	TMV 8

	ICG	BOTVAR	Identity
145	736	HYR	B. Ceylon
146	739	HYR	Culture 830
147	740	HYR	Culture 964
148	772	HYR	Dhodjas
149	776	HYR	Bellary
150	812	HYR	A 24-11
151	13942	HYB	ICGS 76
152	825	HYR	C 30
153	839	HYR	C 75
154	864	HYR	C 123
155	880	HYR	C 145-12-P-6
156	900	HYR	C 160
157	1028	HYR	AH 6990
158	1048	HYR	47-16
159	1084	HYR	AH 7373; 47-16
160	1094	HYR	Changja
161	972	HYR	S 230
162	1596	HYR	AH 7115; Chikodi
163	2281	HYR	PI 138870; NCAC 737
164	2366	HYR	PI 138869; NCAC 2890
165	2452	HYR	AH 25; PI 159663
166	2512	HYR	C 22
167	2548	HYR	C 113
168	2561	HYR	C 133
169	2575	HYR	C 149
170	2599	HYR	C 179
171	2738	FST	Gangapuri
172	2725	HYR	Virginia bunch
173	2748	HYR	JH 28
174	2825	HYR	RS 4
175	2812	HYR	Palitana 226-21
176	2907	HYR	#59-9
177	2918	HYR	B 3
178	2941	HYR	638 of Hyderabad
179	3007	HYR	Durgapura 3
180	3145	HYR	AK 8-11
181	13941	VUL	ICGS 44
182	3818	HYR	AH 7194; K 138; CPI 17175
183	3857	HYR	Haryanawadi
184	3881	HYR	C 62
185	3882	HYR	C 830
186	3884	HYR	Hyderabad 477
187	3915	HYR	AH 3849
188	3976	HYR	578-6
189	3954	HYR	C 179
190	4006	HYR	RS 1
191	13942	HYB	ICGS 76
192	4131	HYR	AH 6933

	ICG	BOTVAR	Identity
193	4138	HYR	AH 6944
194	4152	HYR	AH 6993
195	4161	HYR	AH 7111
196	4207	HYR	AH 7295
197	4208	HYR	AH 7298
198	4270	HYR	C 89
199	4310	HYR	G 1021
200	4324	HYR	IC 22966
201	972	HYR	S 230
202	4389	HYR	IC 22951
203	4873	HYR	AH 7112
204	4877	HYR	AH 7010
205	4933	HYR	AH 7541
206	4965	HYR	AH 7007
207	4969	HYR	AH 7666
208	5024	HYR	FAN D 1 #17; NCAC 1248
209	5240	HYR	EC 36892
210	4155	HYR	AH 7000
211	2738	FST	Gangapuri
212	5351	HYR	Apau-C 4
213	5626	HYR	AH 3262
214	5628	HYR	AH 3849
215	5857	HYR	VRR 91
216	5880	HYR	VRR 114
217	6361	HYR	TMV 3; PI 240567; NCAC 3012
218	6377	HYR	WJR 322
219	6686	HYR	K 482; IN 59-36; PI 269056; NCAC 9973
220	7014	HYR	VRR 157
221	13941	VUL	ICGS 44
222	7019	HYR	VRR 162
223	7021	HYR	VRR 164
224	7034	HYR	VRR 177
225	7086	HYR	VRR 230
226	7092	HYR	VRR 236
227	7140	HYR	VRR 284
228	7152	HYR	VRR 298
229	7189	HYR	PI 138870; NCAC 2791
230	7326	HYR	EC 123073; K 36
231	13942	HYB	ICGS 76
232	7563	HYR	VRR 375
233	8355	HYR	Lampang local; NCAC 18114
234	8496	HYR	RG 186; 50-50 Mani
235	9301	HYR	58-452
236	9647	HYR	VRR 623
237	9682	HYR	VRR 684
238	9703	HYR	VRR 720
239	9721	HYR	VRR 757
240	9725	HYR	VRR 766

	ICG	BOTVAR	Identity
241	972	HYR	S 230
242	9732	HYR	VRR 781
243	10084	HYR	G 143
244	11199	HYR	EC99961-1
245	10608	HYR	PI 337317
246	10717	HYR	TCG 1543
247	11041	HYR	AMR 121
248	11471	HYR	PI 158856
249	11640	HYR	CHA 62-3
250	11655	HYR	AKG 142
251	2738	FST	Gangapuri
252	11789	HYR	RV 116
253	11814	HYR	Jungweon; 300348
254	11818	HYR	Kangreung; 300359
255	11825	HYR	Yeoju 1; 300394-1
256	12209	HYR	NS 41 VR
257	12358	HYR	AKG 86
258	12370	HYR	AKG 280
259	12394	HYR	CHA 29-1
260	12619	HYR	RAP 100
261	13941	VUL	ICGS 44
262	12621	HYR	RAP 107 S1
263	12623	HYR	RAP 190
264	12873	HYR	RT 9
265	12874	HYR	RT 10
266	12886	HYR	RT 21-1
267	12890	HYR	RT 24
268	13130	HYR	RJ 14 A
269	13132	HYR	RP 1 A
270	13136	HYR	RP 3 A
271	13942	HYB	ICGS 76
272	13137	HYR	RP 3 B
273	13139	HYR	RR 5 A
274	13147	HYR	RY 8 B S1
275	13148	HYR	RY 9 A
276	13318	HYR	K 3605
277	13319	HYR	K 3606
278	13322	HYR	S 59
279	14169	HYR	Gasan
280	14835	HYR	No. 334
281	972	HYR	S 230
282	15094	HYR	AKS 2
283	15095	HYR	AKS 3
284	15101	HYR	SDR 6
285	15108	HYR	SDR 13
286	15120	VUL	SDR 26
287	15133	VUL	9
288	15227	VUL	Taishan zhengeh

	ICG	BOTVAR	Identity
289	7	VUL	RS 11
290	8	VUL	RS 12
291	2738	FST	Gangapuri
292	21	VUL	RS 63
293	24	VUL	RS 70
294	25	VUL	RS 75
295	27	VUL	RS 82
296	32	VUL	RS 113
297	33	VUL	RS 114
298	121	VUL	13/47
299	130	VUL	T 25
300	149	VUL	Philippine pink
301	13941	VUL	ICGS 44
302	190	VUL	DH 3-30
303	237	VUL	IARI 687
304	407	VUL	Java PL: NCAC 2682
305	1088	VUL	Bhagalkot
306	1092	VUL	Chandodi
307	1137	VUL	Sulebhani Bijapur
308	1207	VUL	AH 2615-1
309	1211	VUL	AH 2800
310	1216	VUL	AH 3275
311	13942	HYB	ICGS 76
312	1249	VUL	AH 7044
313	1255	VUL	AH 7144; Small Spanish
314	1319	VUL	GO 553
315	1344	VUL	RB 1
316	1425	VUL	U 4-4-7; EC 21058; Spanish 5
317	1445	VUL	U 4-7-1; EC 21084; Imp Spanish
318	1494	VUL	#70
319	1529	VUL	7-1
320	1605	VUL	Pei kang pe you: NCAC 37
321	972	HYR	S 230
322	1734	VUL	D 103-10
323	1868	VUL	654-2
324	1901	VUL	Spanish improved
325	1927	VUL	NG 243
326	1965	VUL	AH local
327	1977	VUL	Nandi kesari
328	2024	VUL	AH 3272
329	2075	VUL	#924
330	2078	VUL	#1630
331	2738	FST	Gangapuri
332	2082	VUL	#1852
333	2124	VUL	Talax 68-4
334	2132	VUL	KG 61-240
335	2184	VUL	AH 3524
336	2201	VUL	#417

	ICG	BOTVAR	Identity
337	2209	VUL	#3273
338	2232	VUL	Lin yuch tao
339	2233	VUL	Philippine pink
340	2234	VUL	Halahrvi local
341	13941	VUL	ICGS 44
342	2410	VUL	VRR 3
343	2414	VUL	VRR 7
344	2542	VUL	C 103
345	2965	VUL	OG 69-6-1
346	2979	VUL	AH 70
347	3078	VUL	EC 109275
348	3081	VUL	AH 34; Small Japan
349	3086	VUL	AH 63
350	3098	VUL	AH 814-20
351	13942	HYB	ICGS 76
352	3122	VUL	AH 7232
353	3127	VUL	AH 7292
354	3144	VUL	AK 3
355	3149	VUL	Apaxue
356	3162	VUL	Chandra berry
357	3180	VUL	DH 3-20
358	3194	VUL	Erect peanut; EC 2215
359	3334	VUL	Exotic 5-3
360	3380	VUL	JH 357
361	972	HYR	S 230
362	3393	VUL	Lampang 1
363	3395	VUL	Limdi 4
364	3421	VUL	NG 268
365	3458	VUL	RS 181
366	3465	VUL	Sakaria
367	3473	VUL	Spanish
368	3481	VUL	Sukatai
369	3486	VUL	Tainan Sel 9; EC 94943
370	3540	VUL	You Ka Ich
371	2738	FST	Gangapuri
372	3550	VUL	14-4
373	3560	VUL	26-5-1
374	3570	VUL	29-1-2
375	3572	VUL	31-8-2
376	3581	VUL	45-24
377	3612	VUL	Virginia bunch
378	3628	VUL	Isreal 1-2-3
379	3711	VUL	AH 7228
380	3715	VUL	AH 7289
381	13941	VUL	ICGS 44
382	3718	VUL	AH 7592; Chinese bunch
383	3721	VUL	AH 39; Spanish 10
384	3723	VUL	AH 7311

	ICG	BOTVAR	Identity
385	3725	VUL	AH 36
386	3727	VUL	AH 3527
387	3750	VUL	R 4-A
388	3752	VUL	Russian International 2
389	3772	VUL	#276
390	4024	VUL	X 1107-2-A-4
391	13942	HYB	ICGS 76
392	4044	VUL	AH 6677; Erect
393	4057	VUL	AH 7145
394	4069	VUL	AH 7406
395	4084	VUL	AH 7575; R 4
396	4091	VUL	AH 7762
397	4453	VUL	VAR 154; EC 16660
398	4561	VUL	AH 8068
399	4566	VUL	C 817
400	4729	VUL	Worte Sutuei
401	972	HYR	S 230
402	4758	VUL	KU No. 154
403	4981	VUL	AH 15(S)
404	5096	VUL	IN 59-2; PI 268823; NCAC 16495
405	5256	VUL	EC 61908
406	5276	VUL	EC 97132
407	5345	VUL	TG 20
408	5410	VUL	AH 7326
409	5430	VUL	G. local
410	5440	VUL	No. 2257
411	2738	FST	Gangapuri
412	5469	VUL	AH 6648
413	5494	VUL	AH 7234
414	5526	VUL	AH 7796
415	5564	VUL	AH 7866
416	5779	VUL	VRR 35
417	5794	VUL	VRR 50
418	5832	VUL	VRR 66
419	5833	VUL	VRR 67
420	6069	VUL	Harbour Local
421	13941	VUL	ICGS 44
422	6680	VUL	PI 268689; NCAC 9605
423	6779	VUL	PI 268813; NCAC 16485
424	6957	VUL	Tainan 1; PI 269713; NCAC 2640
425	6997	VUL	KU 134
426	7037	VUL	VRR 180
427	7050	VUL	VRR 194
428	7088	VUL	VRR 232
429	7121	VUL	VRR 266
430	7131	VUL	VRR 276
431	13942	HYB	ICGS 76
432	7160	VUL	VRR 306

	ICG	BOTVAR	Identity
433	7262	VUL	No. 354; KU 200
434	7327	VUL	Kanto #41; EC 123075
435	7530	VUL	VRR 340
436	7531	VUL	VRR 341
437	7557	VUL	VRR 369
438	7568	VUL	VRR 380
439	7713	VUL	PI 268743; NCAC 16415
440	7827	VUL	JL 24
441	972	HYR	S 230
442	7836	VUL	AH 8451
443	7858	VUL	OSN 1
444	7876	VUL	JL 19
445	7968	VUL	PI 268648; NCAC 9564
446	8274	VUL	NCAC 18019
447	8351	VUL	CHANTABURI; NCAC 18108
448	8364	VUL	NCAC 18127
449	8368	VUL	NCAC 18134
450	8370	VUL	NCAC 18136
451	2738	FST	Gangapuri
452	8472	VUL	RG 89
453	8631	VUL	ACC 434
454	8638	VUL	ACC 454
455	8657	VUL	ACC 722
456	8682	VUL	MJH 1
457	8683	VUL	MJH 2
458	8696	VUL	MJH 18
459	8703	VUL	MJH 28
460	8704	VUL	MJH 29
461	13941	VUL	ICGS 44
462	8707	VUL	MJH 33
463	8718	VUL	Medan
464	8882	VUL	Samutsakorn 5; NCAC 18128
465	8887	VUL	Red manyema 389; PI 268601
466	9135	VUL	58-560; Shantung Tsinau
467	9235	VUL	58-498
468	9499	VUL	PR 5287
469	9501	VUL	PR 5290
470	9502	VUL	PR 5291
471	13942	HYB	ICGS 76
472	9503	VUL	PR 5291-A
473	9506	VUL	PR 5331
474	9585	VUL	VRR 480
475	9586	VUL	VRR 481
476	9591	VUL	VRR 498
477	9612	VUL	VRR 544
478	9637	VUL	VRR 600
479	9642	VUL	VRR 613
480	9648	VUL	VRR 624

	ICG	BOTVAR	Identity
481	972	HYR	S 230
482	9973	VUL	NCAC 10002.1
483	10171	VUL	47-55
484	10305	VUL	AMR 22
485	10306	VUL	AMR 28
486	10308	VUL	AMR 43
487	10320	VUL	Dernut
488	10558	VUL	0310; PI 313139
489	10561	VUL	0318; PI 313146
490	10562	VUL	0932; PI 313181
491	2738	FST	Gangapuri
492	10576	VUL	No.331-34; PI 319749
493	10701	VUL	Shantung
494	10988	VUL	V 79
495	15135	VUL	11
496	11188	VUL	V 75
497	11200	VUL	Early runner 1; PI 337317.1
498	11302	VUL	CS 3
499	11326	VUL	CS 31
500	11328	VUL	CS 33
501	13941	VUL	ICGS 44
502	11357	VUL	CS 807
503	11402	VUL	CS 2245
504	11407	VUL	CS 2298
505	11414	VUL	CS 2374
506	11428	VUL	CS 2419
507	11436	VUL	CS 2482
508	11444	VUL	180/21
509	11510	VUL	Meixianhongyi
510	11511	VUL	Maihuadidou
511	13942	HYB	ICGS 76
512	11513	VUL	Suixigoubi
513	11579	VUL	Kuchcha local
514	11686	VUL	RAP 66
515	11701	VUL	RV 12
516	11725	VUL	RV 44
517	11732	VUL	RV 51
518	11752	VUL	RV 75
519	11833	VUL	Ganghwa 1; 300428
520	11858	VUL	Suweon 48; 300524
521	972	HYR	S 230
522	11859	VUL	Suweon 49; 300525
523	12341	VUL	Bayeo; 300328
524	12343	VUL	Jangseong; 300345
525	12464	VUL	B 4
526	12615	VUL	RAP 12
527	12683	VUL	RV 23 S1
528	12694	VUL	RV 54 S2

	ICG	BOTVAR	Identity
529	12695	VUL	RV 54-2 Red
530	12869	VUL	RT 4
531	2738	FST	Gangapuri
532	12872	VUL	RT 8
533	12877	VUL	RT 13
534	12976	VUL	US 8
535	12983	VUL	US 15
536	12990	VUL	US 24
537	12994	VUL	US 28
538	13030	VUL	US 76
539	13588	VUL	SSI 7
540	13594	VUL	SSI 14
541	13941	VUL	ICGS 44
542	13606	VUL	SSI 33
543	13628	VUL	SSI 55
544	13630	VUL	SSI 57
545	13634	VUL	SSI 61
546	13644	VUL	SSI 70
547	13941	VUL	ICGS 44
548	14031	VUL	SSI 34
549	13648	VUL	SSI 68
550	14366	VUL	SNW 5
551	13942	HYB	ICGS 76
552	14393	VUL	SNW 70
553	14397	VUL	SNW 74
554	14807	VUL	SKN 23
555	14823	VUL	SKN 38
556	14827	VUL	SKN 42
557	14829	VUL	SKN 44
558	14830	VUL	SKN 46
559	14831	VUL	SKN 47
560	15015	VUL	ICGV-SM 87079