GENETIC VARIABILITY, CHARACTER ASSOCIATION AND STABILITY ANALYSIS IN VIRGINIA BUNCH GROUNDNUT (*Arachis hypogaea* L.)

By

BARAD SACHIN HARIBHAI

(Registration No - 1010118001)

M. Sc. (Agri.)

DEPARTMENT OF GENETICS AND PLANT BREEDING

COLLEGE OF AGRICULTURE

JUNAGADH AGRICULTURAL UNIVERSITY

JUNAGADH - 362 001

SEPTEMBER - 2021

BARAD S. H. GENETICS & PL. BREEDING SEP. - 2021

GENETIC VARIABILITY, CHARACTER ASSOCIATION AND STABILITY ANALYSIS IN VIRGINIA BUNCH GROUNDNUT (*Arachis hypogaea* L.)

A THESIS SUBMITTED TO
JUNAGADH AGRICULTURAL UNIVERSITY
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN

GENETICS AND PLANT BREEDING

BY

BARAD SACHIN HARIBHAI
(Registration No- 1010118001)
M. Sc. (Agri.)

DEPARTMENT OF GENETICS AND PLANT BREEDING
COLLEGE OF AGRICULTURE
JUNAGADH AGRICULTURAL UNIVERSITY
JUNAGADH - 362 001

SEPTEMBER - 2021

DEPARTMENT OF GENETICS AND PLANT BREEDING
COLLEGE OF AGRICULTURE
JUNAGADH AGRICULTURAL UNIVERSITY
JUNAGADH

Name of Student	Major Guide
Barad Sachin Haribhai	**Dr. L. L. Jivani**

GENETIC VARIABILITY, CHARACTER ASSOCIATION AND STABILITY ANALYSIS IN VIRGINIA BUNCH GROUNDNUT (*Arachis hypogaea* L.)

ABSTRACT

Key words: Variability, correlation, path analysis, stability, groundnut

An experiment was conducted with a set of fifty genotypes of Virginia bunch groundnut to estimate genetic variability, correlation coefficient, path analysis, G x E interaction and stability in Randomized Block Design with three replications during *kharif* 2019 and *kharif* 2020 at two locations; Main Oilseeds Research Station, JAU, Junagadh and Oilseeds Research Station, JAU, Manavadar. The characters studied were the days to 50 % flowering, days to maturity, number of primary branches per plant, number of secondary branches per plant, plant height, number of matured pods per plant, number of immature pods per plant, sound mature kernel, 100-kernel weight, shelling out-turn, pod yield per plant, kernel yield per plant, biological yield per plant, harvest index and oil content.

The analysis of variance revealed that mean square due to genotypes was highly significant for all fifteen characters studied under all environments. A wide range of variation in all environments were observed for number of matured pods per plant, number of immature pods per plant, 100-kernel weight, pod yield per plant, kernel yield per plant, biological yield per plant and harvest index. The values of phenotypic coefficient of variation in all environments were slightly higher than that of genotypic coefficient of variation for all the traits studied. High genotypic coefficient of variations, high heritability coupled with high genetic advance as percent of mean was observed for number of matured pods per plant, number of immature pods per plant, pod yield per plant and kernel yield per plant under all environments.

For all environments pod yield per plant had significant and positive correlation with number of secondary branches per plant, number of matured pods per plant, kernel

yield per plant, biological yield per plant and harvest index. High and positive direct effects was observed of kernel yield per plant on pod yield per plant, while biological yield per plant and harvest index have moderate to low direct effect on pod yield per plant under all four environments.

The pooled analysis of variance revealed non-linear component of interaction (pooled deviation) was significant for all characters except days to maturity. The variance due to genotypes were highly significant indicating the presence of considerable variation amongst genotypes for most of the characters. Genotype x environment interactions was highly significant for all the characters. This suggested importance of testing the material over different environments. G x E (linear) component was significant for all the traits except shelling out-turn, while the mean squares due to environments (linear) were significant for all the characters. For pod yield per plant, genotypes JVB-2516 and JVB-2529 were average stable as having high pod yield per plant, near unit regression coefficient and non-significant deviation from regression indicated that these genotype were highly stable across all the environments. While genotypes JVB-2508, JVB-2528, JVB-2532, GG-20 and GJG-22 were exhibited high mean value, less than unit regression coefficients and non-significant deviation from regression, indicates these genotypes were good for poor environment and considered as above average stable.

COLLEGE OF AGRICULTURE

JUNAGADH AGRICULTURAL UNIVERSITY

JUNAGADH

CERTIFICATE – I

This is to certify that the thesis entitled **"GENETIC VARIABILITY, CHARACTER ASSOCIATION AND STABILITY ANALYSIS IN VIRGINIA BUNCH GROUNDNUT (*Arachis hypogaea* L.)''** submitted by **Mr. BARAD SACHIN HARIBHAI (Reg. No. 1010118001)** in partial fulfilment of the requirements for the award of the degree of **DOCTOR OF PHILOSOPHY (AGRICULTURE)** in the subject of **GENETICS AND PLANT BREEDING** to the Junagadh Agricultural University is a record of bonafide research work carried out by him under my guidance and supervision and the thesis has not previously formed the basis for the award of any degree, diploma or other similar title. The candidate has fulfilled all the prescribe requirements. The assistance and help received during the course of investigation have been fully acknowledged. He has successfully completed the comprehensive / preliminary examination held on **November 26th, 2020** as required under the regulation for post-graduate studies. He has submitted *kachcha* bound thesis on **July 26th, 2021.**

Place: Junagadh

Date: 26/07/2021

(L. L. Jivani)
Major Guide and
Senior Scientist and Head
Krishi Vigyan Kendra
Junagadh Agricultural University
Gor Khijadia (Morbi)

COLLEGE OF AGRICULTURE
JUNAGADH AGRICULTURAL UNIVERSITY
JUNAGADH

CERTIFICATE-II

Date: 13/09/2021

This is to certify that the thesis entitled **"GENETIC VARIABILITY, CHARACTER ASSOCIATION AND STABILITY ANALYSIS IN VIRGINIA BUNCH GROUNDNUT (*Arachis hypogaea* L.)''** submitted by **Mr. BARAD SACHIN HARIBHAI (Reg. No. 1010118001)** to Junagadh Agricultural University, Junagadh in partial fulfilment of the requirements for award of the degree of **DOCTOR OF PHILOSOPHY (AGRICULTURE)** in the subject of **GENETICS AND PLANT BREEDING** after recommendation by the external examiners were defended by the candidate before the following members of the examination committee. The performance of the candidate in the oral examination was satisfactory. We, therefore, forward with recommendation.

(R. B. Madariya)
Minor Guide and
Associate Research Scientist
Main Oilseeds Research Station
J.A.U., Junagadh

(L. L. Jivani)
Major Guide and
Senior Scientist and Head
Krishi Vigyan Kendra
J.A.U., Gor Khijadia (Morbi)

(L. D. Parmar)
External Member and
Associate Professor
Dept. of Genetics and Plant Breeding
C.P.C.A., S.D.A.U., S.K.Nagar

(R. K. Patel)
External Examiner and
Professor and Head
Dept. of Genetics and Plant Breeding
N.M.C.A., N.A.U., Navsari

(D. R. Mehta)
Professor and Head
Dept. of Genetics and Plant Breeding
College of Agriculture
J.A.U., Junagadh

(S. G. Savalia)
Principal and Dean
College of Agriculture
J.A.U., Junagadh

Approved by

(P. M. Chauhan)
Director of Research and Dean, P. G. Studies
Junagadh Agricultural University
Junagadh

COLLEGE OF AGRICULTURE
JUNAGADH AGRICULTURAL UNIVERSITY
JUNAGADH

CERTIFICATE-II

Date: 13/09/2021

This is to certify that the thesis entitled **"GENETIC VARIABILITY, CHARACTER ASSOCIATION AND STABILITY ANALYSIS IN VIRGINIA BUNCH GROUNDNUT (*Arachis hypogaea* L.)''** submitted by **Mr. BARAD SACHIN HARIBHAI (Reg. No. 1010118001)** to Junagadh Agricultural University, Junagadh in partial fulfilment of the requirements for award of the degree of **DOCTOR OF PHILOSOPHY (AGRICULTURE)** in the subject of **GENETICS AND PLANT BREEDING** after recommendation by the external examiners were defended by the candidate before the following members of the examination committee. The performance of the candidate in the oral examination was satisfactory. We, therefore, forward with recommendation.

(R. B. Madariya)
Minor Guide and
Associate Research Scientist
Main Oilseeds Research Station
J.A.U., Junagadh

(L. L. Jivani)
Major Guide and
Senior Scientist and Head
Krishi Vigyan Kendra
J.A.U., Gor Khijadia (Morbi)

(D. R. Mehta)
Professor and Head
Dept. of Genetics and Plant Breeding
College of Agriculture
J.A.U., Junagadh

(S. G. Savalia)
Principal and Dean
College of Agriculture
J.A.U., Junagadh

Approved by

(P. M. Chauhan)
Director of Research and Dean, P. G. Studies
Junagadh Agricultural University
Junagadh

ACKNOWLEDGEMENT

Acknowledgement is written at last, placed at first and read the least, but still it is the only opportunity to thank one and all who are responsible in completion of this entire work.

Journey is easier when you travel together. Interdependence is certainly more valuable than independence. This thesis is the result of three years of work whereby I have been accompanied and supported by many peoples. It is pleasant aspect that I have now the opportunity to express my gratitude for all of them.

I consider myself lucky to have worked under the excellent guidance of **Dr. L. L. Jivani,** Senior Scientist and Head, Krishi Vigyan Kendra, Junagadh Agricultural University, Gor Khijadia (Morbi) for his keen interest, scientific guidance, constructive criticism and inspiration during the course of investigation and preparation of this dissertation.

I express my sense of respect and sincere thanks to **Dr. R. B. Madariya,** Associate Research Scientist, Main Oilseeds Research Station, JAU, Junagadh, **Dr. J. B. Patel**, Associate professor, Department of Seed Science & Technology, College of Agriculture, JAU, Junagadh, **Dr. A. G. Pansuriya,** Associate Research Scientist, Wheat Research Station, JAU, Junagadh, **Dr. M. G. Valu,** Associate Research Scientist, Cotton Research Station, JAU, Junagadh, **Dr. V. H. Kachhadia,** Associate Research Scientist, Vegetable Research Station, JAU, Junagadh, my advisory committee members, for suggesting need based research, thought provoking ideas, invaluable inspiring guidance and sustained interest.

I am sincerely thankful to **Dr. V. P. Chovatia**, Hon'ble Vice Chancellor and Director of Research and Dean, P. G. Studies, JAU, Junagadh, **Dr. K. A. Khunt,** Principal, College of Agriculture, JAU, Junagadh and **Dr. D. R. Mehta**, Professor and Head, Department of Genetics and Plant Breeding, JAU, Junagadh and all the professors and staff members of Department of Genetics and Plant Breeding for their continues support, guidance and help during the entire course. I gratefully acknowledge the most willing help rendered by **Dr. L. J. Raval** for statistical analysis.

I would like to express special thanks to **Dr. Rajiv Kumar,** Dr. S. B. Chaudhari, Dr. G. U. Kulkarni, Dr. M. H. Sapovadiya, Miss Advani Janki, Mr.

Jeevabhai, Makwanabhai and other staff members of Department of Genetics and Plant Breeding for their continues and ultimate support, guidance and help during the entire course of research work.

I am thankful to **Mr. C. J. Rajani,** Mr. U. J. Shekhda and other staff member of Main Oilseeds Research Station, Junagadh Agricultural University, Junagadh for their immense help and best co-operation during the study and experimentation.

The importance of library and role of its staff can never be underestimated, but it is mostly forgotten during acknowledgements. I specially appreciate librarian **Miss P. I. Dave** and staff members for their ever willing help during this study. I am also thankful for all the staff members of **C-branch** of College of Agriculture, Junagadh Agricultural University, Junagadh.

To me research is not one man’s endeavour. At each stage of this work a big group of my friends including **Mahesh, Dana, Indrajay, Harsh, Dinesh, Juned, Aniruddh, Tejas, Mayur, Uday, Ravi, Yash, Jaydip, Satyajit, Surpal, Rakesh, Bharat, Alpesh, Parimal, Vijay, Kirit, Hiten, Mayank, Bharat, Biswajit and Jignesh** all shared my labour. All the friends are so intimate that it seems awkward to say “Thank you”. Rather I shall always be willing to help them whenever opportunity arises and I also wish to thanks to my seniors **Harpal** and **Chanabhai** for their guidance.

There are number of well wishers to whom I cannot forget and I thank to one and all associated with me directly and indirectly. The fulfilment of this research is due to the cooperation of many people. Therefore, I can only hope that I mention you all and those who I forget at this moment please forgive me and despite this lapse I really do appreciate you all.

At last but foremost, I express my deep sense of gratitude to my family for their patience, lasting love, personal sacrifice, continued encouragement and inspiration throughout the period of study, without which it would have remained a dream for me to receive this higher education.

Last but not least, my million thanks to god. Almightily who made me to do this task made every job a success for me.

Place: Junagadh

Date: 26/07/2021 **(Barad Sachin H.)**

LIST OF TABLES

Table No.	Title	Page No.
3.1	List of fifty pure genotypes used in present study with their parentage	38
3.2	Analysis of variance	43
3.3	Analysis of covariance between two characters	47
3.4	Analysis of variance for G x E interaction as per Eberhart and Russel (1966) model	51
4.1	Analysis of variance showing mean squares for various characters in 50 genotypes of groundnut at Junagadh during *Kharif*-2019 (E_1)	55
4.2	Analysis of variance showing mean squares for various characters in 50 genotypes of groundnut at Junagadh during *Kharif*-2020 (E_2)	56
4.3	Analysis of variance showing mean squares for various characters in 50 genotypes of groundnut at Manavadar during *Kharif*-2019 (E_3)	57
4.4	Analysis of variance showing mean squares for various characters in 50 genotypes of groundnut at Manavadar during *Kharif*-2020 (E_4)	58
4.5	Phenotypic range, coefficient of range, mean ± S.Em, phenotypic and genotypic coefficients of variation, heritability (broad sense), genetic advance and genetic advance expressed as percentage of mean for various characters in 50 genotypes of groundnut at Junagadh during *Kharif*-2019 (E_1)	62
4.6	Phenotypic range, coefficient of range, mean ± S.Em, phenotypic and genotypic coefficients of variation, heritability (broad sense), genetic advance and genetic advance expressed as percentage of mean for various characters in 50 genotypes of groundnut at Junagadh during *Kharif*-2020 (E_2)	63
4.7	Phenotypic range, coefficient of range, mean ± S.Em, phenotypic and genotypic coefficients of variation, heritability (broad sense), genetic advance and genetic advance expressed as percentage of mean for various characters in 50 genotypes of groundnut at Manavadar during *Kharif*-2019 (E_3)	64
4.8	Phenotypic range, coefficient of range, mean ± S.Em, phenotypic and genotypic coefficients of variation, heritability (broad sense), genetic advance and genetic advance expressed as percentage of	65

Table No.	Title	Page No.
	mean for various characters in 50 genotypes of groundnut at Manavadar during *Kharif*-2020 (E_4)	
4.9	Genotypic (r_g) and phenotypic (r_p) correlation coefficients among 15 characters in 50 genotypes of groundnut at Junagadh during *Kharif*-2019 (E_1)	84
4.10	Genotypic (r_g) and phenotypic (r_p) correlation coefficients among 15 characters in 50 genotypes of groundnut at Junagadh during *Kharif*-2020 (E_2)	85
4.11	Genotypic (r_g) and phenotypic (r_p) correlation coefficients among 15 characters in 50 genotypes of groundnut at Manavadar during *Kharif*-2019 (E_3)	86
4.12	Genotypic (r_g) and phenotypic (r_p) correlation coefficients among 15 characters in 50 genotypes of groundnut at Manavadar during *Kharif*-2020 (E_4)	87
4.13	Phenotypic path coefficient analysis showing direct (diagonal and bold) and indirect effects of different characters on pod yield per plant in 50 genotypes of groundnut at Junagadh during *Kharif*-2019 (E_1)	94
4.14	Phenotypic path coefficient analysis showing direct (diagonal and bold) and indirect effects of different characters on pod yield per plant in 50 genotypes of groundnut at Junagadh during *Kharif*-2020 (E_2)	95
4.15	Phenotypic path coefficient analysis showing direct (diagonal and bold) and indirect effects of different characters on pod yield per plant in 50 genotypes of groundnut at Manavadar during *Kharif*-2019 (E_3)	96
4.16	Phenotypic path coefficient analysis showing direct (diagonal and bold) and indirect effects of different characters on pod yield per plant in 50 genotypes of groundnut at Manavadar during *Kharif*-2020 (E_4)	97
4.17	Analysis of variance for stability over four environments in groundnut as per Eberhart and Russel (1966) model	99
4.18	Estimates of environmental index for various characters under different environments in groundnut	102
4.19	Mean over the environment ($\overline{X}$), regression coefficient (b_i), and deviation from regression (S^2di) for days to 50 % flowering	103

Table No.	Title	Page No.
4.20	Mean over the environment ($\bar{X}$), regression coefficient (b_i), and deviation from regression (S^2di) for days to maturity	105
4.21	Mean over the environment ($\bar{X}$), regression coefficient (b_i), and deviation from regression (S^2di) for number of primary branches per plant	107
4.22	Mean over the environment ($\bar{X}$), regression coefficient (b_i), and deviation from regression (S^2di) for number of secondary branches per plant	109
4.23	Mean over the environment ($\bar{X}$), regression coefficient (b_i), and deviation from regression (S^2di) for plant height (cm)	111
4.24	Mean over the environment ($\bar{X}$), regression coefficient (b_i), and deviation from regression (S^2di) for number of matured pods per plant	113
4.25	Mean over the environment ($\bar{X}$), regression coefficient (b_i), and deviation from regression (S^2di) for number of immature pods per plant	115
4.26	Mean over the environment ($\bar{X}$), regression coefficient (b_i), and deviation from regression (S^2di) for sound mature kernel (SMK) %	117
4.27	Mean over the environment ($\bar{X}$), regression coefficient (b_i), and deviation from regression (S^2di) for 100-kernel weight (g)	119
4.28	Mean over the environment ($\bar{X}$), regression coefficient (b_i), and deviation from regression (S^2di) for shelling out-turn (%)	121
4.29	Mean over the environment ($\bar{X}$), regression coefficient (b_i), and deviation from regression (S^2di) for pod yield per plant (g)	123
4.30	Mean over the environment ($\bar{X}$), regression coefficient (b_i), and deviation from regression (S^2di) for kernel yield per plant (g)	125
4.31	Mean over the environment ($\bar{X}$), regression coefficient (b_i), and deviation from regression (S^2di) for biological yield per plant (g)	127
4.32	Mean over the environment ($\bar{X}$), regression coefficient (b_i), and deviation from regression (S^2di) for harvest index (%)	129
4.33	Mean over the environment ($\bar{X}$), regression coefficient (b_i), and deviation from regression (S^2di) for oil content (%)	131
5.1	List of genotypes found stable for various characters in groundnut	145

CONTENTS

CHAPTER	TITLE	PAGE NO.
I	**INTRODUCTION**	**1-4**
II	**REVIEW OF LITERATURE**	**5-37**
	2.1 Genetic variability	5
	2.2 Correlation coefficient	14
	2.3 Path coefficient analysis	22
	2.4 Genotype x Environment interaction and stability	28
III	**MATERIALS AND METHODS**	**38-53**
	3.1 Experimental material	38
	3.2 Experimental details	40
	3.3 Observations recorded	40
	3.4 Statistical analysis	42
IV	**EXPERIMENTAL RESULTS**	**54-132**
	4.1 Analysis of variance	54
	4.2 Genetic variability parameters	54
	4.3 Correlation coefficients	82
	4.4 Path coefficients analysis	91
	4.5 G X E interaction and stability parameters	98
V	**DISCUSSION**	**133-147**
	5.1 Analysis of variance	134
	5.2 Genetic variability	134
	5.3 Correlation coefficients	138
	5.4 Path coefficient analysis	141
	5.5 G x E interaction and stability	142
VI	**SUMMARY AND CONCLUSIONS**	**148-150**
	BIBLIOGRAPHY	**I-XIV**
	APPENDICES	**I-XX**

LIST OF FIGURES

Figure No.	Title	After Page No.
4.1	Diagrammatic representation of phenotypic path analysis in groundnut at Junagadh during *Kharif*-2019 (E_1)	97
4.2	Diagrammatic representation of phenotypic path analysis in groundnut at Junagadh during *Kharif*-2020 (E_2)	97
4.3	Diagrammatic representation of phenotypic path analysis in groundnut at Manavadar during *Kharif*-2019 (E_3)	97
4.4	Diagrammatic representation of phenotypic path analysis in groundnut at Manavadar during *Kharif*-2020 (E_4)	97

LIST OF PLATES

Plate No.	Title	After Page No.
3.1	Field view of the experiment	43

CHAPTER – I

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is one of the most important annual unpredictable legumes, both in subsistence and commercial agriculture in arid and semi-arid regions of the world. It is one of the principal economic crops of the world. The botanical name of groundnut (*Arachis hypogaea* L.) is derived from two Greek words, *Arachis* means a legume and *hypogaea* means below ground, referring to the formation of pods in the soil. It is a member of the order *Fabales* and family *Fabaceae* also known as *Leguminosae*. It is widely grown annual crop with self-pollinated and dicotyledonous behavior. It is an allotetraploid having chromosome number 2n=4x=40.

Species of the genus *Arachis* are native of South America. Krapovickas (1969) postulated that the cultivated groundnut, (*Arachis hypogaea* L.) is believed to have originated in Northern Argentina and South Bolivia. Bolivia has the second largest number of species followed by Paraguay, Argentina and Uruguay. The gene pool of groundnut has been divided into two subspecies and each subspecies is divided into two botanical varieties. The sub specific classification of *Arachis hypogaea* L. is described elsewhere (Krapovickas, 1973, Gregory *et al.*, 1980 and Weiss, 2000) and have been given in short as under:

- *Arachis hypogaea* L. subspecies *hypogaea* : Semi-spreading or spreading in habit, which have alternative branching pattern, inflorescence simple and absent on main axis, smaller and pointed leaflet with dark green foliage. Generally seed dormancy is present in this type and pod is medium to bold with large and heavier seed size. It includes two varieties, i) var. *hypogaea* : Virginia bunch and Virginia runner and ii) var. *hirsute* : Peruvian runner
- *Arachis hypogaea* L. subspecies *fastigiata* : Erect and bunch in habit, which have sequential branching pattern, inflorescence usually present on the main axis and first branching on the cotyledonary laterals are reproductive, large and oblong leaflet with light green foliage. Generally seed dormancy is absent in this type and pod is small to medium with smaller seed size. It includes two varieties, i) var. *fastigiata* : Velencia and ii) var. *vulgaris* : Spanish

Groundnut is cultivated in tropical, sub-tropical and warm temperate regions between 40ºN and 40ºS latitudes. The production is largely confined to Asian and African countries. Asia accounts for about 50 % of area and 60 % of world production of groundnut with largest share of India (>20 %) in the groundnut coverage followed by China (>18 %). However, China accounts for the highest share (37 %) in the total production of groundnut in the world. The major groundnut producing countries in the world are India, China, Nigeria, Senegal, Sudan, Burma and the United States of America. In India, six states *viz.,* Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Rajasthan and Tamil Nadu account for about 90 % of the total groundnut area of the country. Andhra Pradesh and Gujarat contribute >55 % of the total area and production of groundnut. The total groundnut production in India during the year 2019-20 is about 6.72 million tons from 4.73 million ha area and with 1422 kg/ha productivity (Anon., 2020a). Groundnut is the major oilseed crop of Gujarat with 1.67 million ha area and 3.04 million tons of production with 1871 kg/ha productivity during the year 2019-20 (Anon., 2020b).

Groundnut has a distinct position among the oilseeds as it can be consumed and utilized in diverse ways. It is a rich source of edible oil (44-55 %), high quality protein (22-32 %) and carbohydrates (8-14 %) and hence, it is valued both for edible oil and confectionery purposes. Groundnut kernels are consumed as raw, boiled, roasted or fried products and also used in a variety of culinary preparations like peanut candies, peanut butter, peanut milk and chocolates (Desai *et al.*, 1999). Cake left after extraction of the oil is an excellent feed for livestock. Vegetative parts of groundnut like leaves and stems are good source of nutritionally high quality fodder for farm animals. Dry roasted, salted peanuts are also marketed in significant quantities. Boiled peanuts are a preparation of raw, unshelled green peanuts boiled in brine and typically eaten as a snack. Groundnut is also used in cosmetics, nitroglycerin, plastics, dyes and paints.

The reason for low yield of groundnut in the country was observed that lack of assured rainfall was one of the major reasons. Majority of the groundnut crop (75 %) is being grown in a low to moderate rainfall zone with a short period of distribution (Ramanamurthy, 1985). The erratic distribution of rainfall coupled with prolonged dry spells results in lower productivity in rainfed area. Further, lack of groundnut varieties possessing wider genetic base with stable performance over wide range of environments particularly under moisture stress situations was another reason for the lower productivity.

Among the various measure's to increase groundnut production and productivity, development of high yielding varieties having wider genetic base with stable performance over wider range of environmental conditions including moisture stress situations is keenly felt. It is widely believed that the cross derivatives with wider genetic base are more consistent in their performance over different environmental conditions than purelines. Accordingly the groundnut breeders are resorting to multiple crosses and to isolate superior genotypes not only with high yielding potential but also with wider genetic base complex with stability of performance. Evaluating the breeding lines in advanced generations for their stability is an integral part of a breeding programme.

Variability studies are the basic studies to assess the genotypes for their variation in quantitative and qualitative characters. The extent of the genetic and nongenetic components of variation formulates proper breeding programme to reach the goal. Information concerning genetic variability present in a population and estimation of variability parameters including heritability is pre-requisite for planning an effective breeding programme for improvement of any crop. The genetic variability is determined with the help of certain genetic parameters *viz*., genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (h^2) and genetic advance (GA). The attempts about improvement in yield and its economic attributes in groundnut are generally directed towards the manipulation of genetic variability.

Correlation studies provide better understanding of yield components which helps the plant breeder during selection. A positive correlation between desirable characters is favourable to the plant breeder because, it helps in simultaneous improvement of both the characters. Yield being a complex character. It is a result of action and interaction of many yield contributing characters and it is highly influenced by environment. Hence, it becomes necessary to partition the observed variability into heritable and non-heritable components.

Path analysis splits the correlation coefficient into direct and indirect effects. Path analysis, showing direct and indirect effects, is effective to get high selection response simultaneously for several characters from the diverse populations and analysis could provide a more realistic picture of the interrelationship.

The phenotypic performance of a genotype is influenced by its genetic constituents, environments and their interactions. The detection of significant G × E interaction indicates that all phenotypic responses to change in the environment are not the same for all genotypes. This may means that the best genotype in one environment is not the best in another environment. Stability analysis helps in understanding the adaptability of advance lines over a wide range of environmental conditions and in the identification of adaptable genotypes.

Therefore, the present study was planned to evaluate genetic variability, character association, path coefficient analysis and stability under two locations and two seasons in advanced breeding lines of groundnut with the following objectives;

1. To assess the extent of variability parameters in respect to pod yield and its component characters
2. To elucidate the extent of correlation coefficients between pod yield and its component characters
3. To study the path coefficient for relative contribution of yield components on pod yield, through their direct and indirect effects
4. To find out the nature and magnitude of G × E interaction and workout stability parameters for yield and important yield component characters

CHAPTER – II

REVIEW OF LITERATURE

A brief review pertaining to genetic variability, correlation coefficient, path coefficient analysis and stability analysis in groundnut is presented under the following heads;

2.1 Genetic variability

2.2 Correlation coefficient

2.3 Path coefficient analysis

2.4 Genotype x Environment interaction and stability

2.1 Genetic variability

The variability of a biological population is an outcome of genetic constitution of the individuals making up of that population in relation to the prevailing environments. A survey of genetic variability with the help of suitable parameters such as genotypic coefficient of variation, heritability estimates and genetic advance is absolutely necessary to start an efficient breeding programme. All the attempts about improvement in yield and its economic return in groundnut are now directed towards the manipulation of genetic variability. The literatures related to genetic variability in groundnut have been reviewed as under;

Venkataramana (2001) assessed genetic variability, heritability and genetic advance in 30 groundnut genotypes and stated that oil content, pod yield, 100-kernel weight and kernel yield had high genotypic coefficient of variation. Heritability estimates were high for sound mature kernel percentage, oil content and 100-kernel weight. High heritability coupled with high genetic advance was detected for 100-kernel weight.

Nath and Alam (2002) conducted the experiment to evaluate 15 exotic groundnut genotypes to study yield and yield contributing characters for genetic variability analysis. High PCV and heritability were observed for plant height, pods per plant, harvest index and pod yield per plant. High heritability was also recorded for shelling percentage and 100-pod weight. High genetic advance as percentage of mean was observed for pod yield per plant, plant height, pods per plant and harvest index.

Prasad *et al.* (2002) assessed genetic variability, heritability and genetic advance in groundnut and reported high PCV and GCV for harvest index, while the values were moderate for pod yield per plant, number of primary branches, height of main axis, number of pods per plant and 100-kernel weight. High heritability combined with high genetic advance was observed for harvest index, pod yield per plant and number of pods per plant.

Singh and Chaubey (2003) studied genetic variability, heritability and genetic advance in 40 genotypes of groundnut. High heritability along with high magnitude of genetic advance as percentage of mean was observed for plant height, number of primary branches per plant, number of pods per plant and 100-kernel weight. Days to 50 % flowering, days to maturity and shelling percentage exhibited high heritability and low genetic advance.

Kumar and Rajamani (2004) assessed genetic variation in 12 genotypes of groundnut. High PCV and GCV values were observed for plant height, yield per plant, 100-kernel weight and percentage of sound matured kernels. Moderate PCV and GCV values were observed for shelling percentage and these values were low for days to 50 % flowering. The estimates of PCV were higher than GCV indicating the presence of environmental influence in the expression of the characters studied.

Mothilal *et al.* (2004) studied components of variation, heritability and genetic advance by using 65 confectionery groundnut genotypes and reported that values of GCV and PCV were high for matured pods per plant and pod yield per plant and those were moderate too low for plant height, 100-pod weight and 100-kernel weight. However, genetic advance as percentage of mean was high for pods per plant and pod yield per plant and it was moderate for plant height and 100-kernel weight.

Parameshwarappa *et al*. (2004) studied 48 groundnut genotypes to assess variability, heritability and genetic advance for yield and yield contributing characters. Number of primary branches, pod yield per plant, kernel yield and plant height showed high genetic variability. Number of pods, 100-kemel weight and seed size had moderate genetic variability, while low genetic variability was recorded for oil content and sound mature kernels. High heritability coupled with high genetic advance was recorded for kernel yield, sound mature kernels and 100-kenel weight.

Wani *et al.* (2004) assessed the variability in advance generation lines of groundnut. High GCV values were observed for number of matured pods per plant, number of pegs per plant and harvest index. High heritability was observed for days to maturity, 100-kernel weight and shelling out-turn. High heritability coupled with high genetic advance was recorded for days to maturity and 100-kernel weight.

Mahalakshmi *et al.* (2005) evaluated 57 groundnut genotypes for variability parameters. High heritability estimates combined with high genetic advance were observed for number of unproductive pegs per plant, number of un-matured pods per plant, number of matured pods per plant, shelling percentage and 100-kernel weight.

Kadam *et al.* (2007) computed variability, heritability and genetic advance using 40 groundnut genotypes of different botanical groups. The high GCV values were recorded for kernel yield, pod yield, number of pods per plant, number of branches per plant, plant height and harvest index. High heritability coupled with high genetic advance was observed for pod yield per plant and kernel yield per plant.

Khote *et al.* (2009) evaluated 30 exotic groundnut genotypes for various genetic parameters for yield and yield contributing characters. Higher PCV and GCV values were observed for pods per plant, fodder weight per plant, harvest index and pod yield per plant. Characters like days to flowering, pod length, kernel length, 100-pod weight and dry matter per plant showed high heritability. The maximum genetic advance as percentage of mean was noted for kernel yield per plant, fodder weight per plant, harvest index and pod yield per plant.

Korat *et al.* (2009) studied components of variation, heritability and genetic advance by using 65 groundnut genotypes and reported that values of GCV and PCV were high for number of secondary branches per plant and number of aerial pegs per plant. High heritability along with high genetic advance as per cent of mean was observed for number of secondary branches per plant and number of aerial pegs per plant, while moderate genetic advance as per cent of mean was observed for biological yield per plant and harvest index.

Vekariya *et al.* (2011) evaluated 50 diverse genotypes of groundnut for genetic parameters *viz.*, variability, heritability and genetic advance. The estimates of PCV and GCV were high for number of matured pods per plant, kernel yield per plant, harvest index, biological yield per plant and 100-kernel weight and low for days to first flower, days to 50 % flowering and days to maturity. High heritability coupled with high genetic advance was observed for number of matured pods per plants, kernel yield per plant and pod yield per plant.

Zaman *et al.* (2011) assessed genetic variability, heritability and genetic advance in 34 groundnut genotypes and stated that high values of GCV, PCV, heritability and genetic advance were observed for number of branches per plant, number of immature and matured nuts per plant, 100 kernel weight and plant height, whereas these values were low for days to 50 % flowering, oil content and days to maturity.

Babariya (2012) evaluated 100 genotypes of groundnut to estimate variability for pod yield and its component characters and reported that high values of GCV and PCV were observed for number of pods per plant, number of matured pods per plant, number of immature pods per plant, biological yield per plant and number of pegs per plant, while moderate values were observed for plant height, shelling out turn and 100- kernel weight, whereas these values were low for days to 50 % flowering, days to maturity and oil content. High heritability along with high genetic advance was observed for biological yield per plant, kernel yield per plant, number of secondary branches per plant, number of pods per plant, pod yield per plant, sound mature kernels, number of matured pods per plant and harvest index.

John *et al.* (2012) studied morphological, physiological and yield attributes related to moisture stress tolerance in groundnut and the results showed that high heritability combined with high genetic advance as percent of mean was observed for shelling percentage, sound mature kernels weight and pod yield per plant. Oil content showed high heritability with low genetic advance. They also reported wide variability and moderate heritability values for chlorophyll content and seed weight per plant. High GCV, PCV, heritability and genetic advance were noticed for harvest index and its component traits *viz*., pod yield per plant, number of branches per plant and sound mature kernel percentage.

John *et al.* (2013) assessed genetic variability, heritability and genetic advance in 37 genotypes of groundnut and reported high heritability and high genetic advance as percentage of mean was recorded for plant height, haulm yield per plant, pod yield per plant and kernel yield per plant. Moderate heritability and high genetic advance as per cent of mean was observed for number of primary branches per plant, number of secondary branches per plant, number of matured pods per plant and 100-pod weight indicating the importance of both additive and non-additive gene actions in the inheritance of these characters.

Kumar *et al.* (2014) evaluated 15 groundnut genotypes (including check) for qualitative parameters. The components of variance revealed that the PCV were higher than GCV for all the parameters. Moderate estimates of GCV were exhibited by kernel yield and days to 50 % flowering and moderate estimates of PCV were exhibited by kernel yield, seed yield per plant, pod yield, number of primary branches per plant, days to 50 % flowering and pod yield per plant. High values for heritability were estimated by pant height, days to 50 % flowering, shelling percentage and pod yield per plant.

Patil *et al.* (2014) evaluated 58 Spanish bunch groundnut genotypes for variability studies for 16 characters. The maximum heritability was recorded for days to 50 % flowering, plant height and 100-kernel weight. The maximum genetic advance was observed for 100-kernel weight and plant height. Moderate to high heritability coupled with moderate to high genetic advance was recorded for days to 50 % flowering, plant height, 100-pod weight, 100-kernel weight, shelling percentage and harvest index.

Dewangan *et al*. (2015) evaluated 50 genotypes of groundnut for genetic variability. The estimates of PCV, GCV and heritability were high for pod yield per plant and plant height. High value of genetic advance was observed for plant height, while moderate value of genetic advance was observed for shelling percentage.

Gupta *et al.* (2015a) evaluated 60 diverse genotypes of Virginia groundnut. The PCV and GCV values were high for plant height, number of matured pods per plant and kernel yield per plant, while these values were moderate for harvest index, 100-kenel weight and biological yield per plant, whereas low values were observed for days to 50 % flowering, days to maturity, shelling out turn, sound mature kernel percentage and oil content. High heritability coupled with high genetic advance was observed for 100-kernel weight, biological yield per plant and kernel yield per plant.

Moderate to low genetic advance was observed for shelling out turn, oil content, number of matured pods per plant, harvest index, plant height, days to 50 % flowering and days to maturity.

Sanjeevakumar *et al.* **(**2015) assessed 49 genotypes of groundnut to studied genetic variability for yield and its related traits. The highest GCV were observed for secondary branches per plant, immature pods, matured pods and pod yield, while this value were low for days to 50 % flowering, days to maturity, shelling out turn and oil content. The highest heritability was observed for number of matured pods per plant, days to 50 % flowering, 100-kernel weight, number of immature pods per plant, plant height and oil content. Moderate to low genetic advance was observed for shelling out turn, days to 50 % flowering, days to maturity, number of primary branches per plant, number of immature pods per plant and oil content. Low genetic advance as percentage of mean was observed for days to maturity.

Namrata *et al.* (2016) evaluated 30 genotypes of groundnut to study the variability for different component characters. Higher estimates of GCV were observed for number of matured pods per plant and dry pod yield per plant, while moderate GCV were observed for biological yield per plant and low variability were observed for plant height, number of branches per plant, shelling out turn, sound mature kernels and oil content. The maximum heritability was found for 100 kernel weight, oil content and sound matured kernels. While, maximum genetic gain was observed for dry pod yield per plant, 100-kernel weight and number of matured pods per plant. Thus, the traits *viz.,* number of matured pods per plant, dry pod yield per plant and 100-kernel weight indicated the presence of additive gene effects as they showed high GCV, heritability and genetic gain.

Ashutosh *et al*. (2017) evaluated 29 breeding lines of groundnut to estimate genetic variability, heritability and genetic advance for various characters. The PCV and GCV values were high for pod yield per plant, number of pods per plant and hundred kernel weight.

Chavadhari *et al.* (2017) evaluated 70 groundnut genotypes for quantitative and yield parameters. High estimates of the GCV were observed for kernel yield per plant, number of branches per plant, harvest index and biological yield per plant. The estimates of heritability were observed to be high for harvest index followed by biological yield per plant, kernel yield per plant, 100-kernel weight, plant height, 100-

pod weight and number of branches per plant, which indicated that these characters were less influenced by the environmental fluctuations. High heritability along with high genetic advance was observed for 100-pod weight. High heritability along with moderate genetic advance was observed for biological yield per plant, 100-kernel weight and harvest index.

Gouranga *et al.* (2017) evaluated 19 genotypes of groundnut to study the genetic variability for different component characters. High GCV and high heritability coupled with high genetic advance as percentage of mean were observed in case of kernel yield per plant, numbers of pods plant per and 100 kernel weight, while moderate values of GCV and PCV were recorded for pod yield per plant and harvest index, whereas low heritability estimates were observed for shelling out turn, sound mature kernel, plant height and oil content. Moderate to low genetic advance was observed for plant height, haulm yield and oil content.

Mukesh and Lal (2017) assessed variability for yield and its contributing traits in 40 genotypes of groundnut. The higher PCV and GCV values were observed for plant height, pod yield per plant and hundred kernel weight. High genetic advance was observed for 100-kerenel weight and sound mature kernels, moderate for shelling out turn, while low value was observed for days to 50 % flowering, days to maturity, number of branches per plant and pod yield per plant. High genetic advance as percentage of mean was recorded for 100-kerenel weight and pod yield per plant, moderate for shelling out turn and sound mature kernels and low value was recorded for days to maturity and days to 50 % flowering.

Om and Nadaf (2017) evaluated advanced breeding lines of groundnut to study the variability, heritability and genetic advance for different characters. The estimates of the PCV were higher than the GCV signifying the influence of environmental factors, while in certain cases the low magnitude of difference observed indicated that these characters were less influenced by the environments. Pod yield revealed moderate to high PCV and GCV. Low to medium variability was observed for 100-kernel weight, shelling per cent and oil content. Genetic advance and genetic advance as percentage of mean was low for shelling per cent, 100-kernel weight and oil content.

Singh *et al.* (2017) conducted an experiment on 15 genotypes of groundnut to study genetic characterization for yield and its related traits. Dry pod yield per plant had the maximum GCV followed by kernel yield per plant suggesting substantial amount of genetic variability present. Low variability was observed for days to 50 % flowering, sound mature kernels, shelling out turn and oil content. Dry pod yield per plant, kernel yield per plant, 100-kernel weight and days to maturity exhibited high heritability and high genetic advance.

Sushree *et al.* (2017) evaluated 32 F_6 progenies along with four released varieties as parents to assess variability, heritability and genetic advance for various characters. The PCV and GCV estimates were high for haulm yield per plant and low for harvest index and shelling percent. The moderate values for PCV and GCV were reported for plant height, number of branches per plant, number of pods per plant, 100-kernel weight and pod yield per plant. Moderate heritability and genetic advance as percentage of mean was recorded for plant height, pod number per plant, kernel number per plant, kernel yield and pod yield.

Ukiey *et al*. (2017) assessed genetic variability, heritability and genetic advance in 30 groundnut genotypes and stated that high estimates of GCV and PCV were observed for number of matured pods per plant, number of immature pods per plant and dry pod yield per plant. High heritability coupled with high genetic advance was detected for number of matured pods per plant, number of immature pods per plant, dry pod yield per plant, 100-kernel weight, shelling percentage and oil content.

Mahesh *et al.* (2018) evaluated 144 genotypes of groundnut for 13 characters to assess the variability, heritability and genetic advance. Plant height, number of primary branches per plant, number of matured and immature pods per plant, kernel yield per plant, 100-kernel weight, haulm yield per plant and dry pod yield per plant had high GCV, PCV, heritability and genetic advance as percentage of mean. Low variability was observed for days to 50 % flowering, shelling out turn, sound mature kernel percentage and oil content.

Omima *et al.* (2018) studied genetic variability, heritability and genetic advance for yield and yield contributing characters in eight groundnut genotypes. High GCV and PCV were observed for number of branches per plant, number of pods per plant and pod yield per plant. High heritability estimates coupled with high genetic advance were obtained with number of pods per plant, pod yield per plant and 100-seed weight.

Wadikar *et al.* (2018) evaluated 40 diverse genotypes of groundnut to measure genetic variability. High PCV, GCV and heritability coupled with high genetic advance as percentage of mean values were observed for kernel yield per plant, pod yield per plant and number of pods per plant, while low variability was recorded for days to 50 % flowering, days to maturity, shelling percentage and oil content. High genetic advance was recorded for shelling out turn, sound mature kernel and 100-kernel weight while moderate to low genetic advance were observed for harvest index, days to 50 % flowering, days to maturity, number of branches per plant, pod yield per plant and oil content.

Solanki *et al.* (2019) study genetic variability in 60 genotypes of groundnut. The observations were recorded on 14 characters. The highest genotypic coefficient of variation was observed for plant height. Heritability was observed high for days to 50 % flowering followed by biological yield per plant, number of matured pods per plant, shelling out-turn, plant height, pod yield per plant, number of pods per plant, number of immature pods per plant, 100-kernel weight, sound mature kernel, harvest index, days to maturity and number of branches per plant. Genetic advance expressed as percentage of mean was found high for plant height followed by number of matured pods per plant, pod yield per plant, number of immature pods per plant, biological yield per plant, number of pods per plant, harvest index, days to 50 % flowering, shelling out-turn and 100-kernel weight.

Kumari and Sasidharan (2020) evaluate fifty *Arachis* genotypes belonging to different botanical types *viz*., spanish bunch, virginia bunch, valencia, *peruviana* and *aequatoriana* for 28 quantitative characters to study the genetic variability parameters. Analysis of variance indicated highly significant differences among genotypes for all the traits. High magnitude of genetic coefficient of variation (GCV), phenotypic coefficient of variation (PCV) and broad sense heritability was observed for number of matured pods per plant, number of immature pods per plant, pod yield per plant, kernel yield per plant, hundred pod mass, hundred seed weight, plant height, number of secondary branches, shelling out turn and SMK %.

Mitra *et al.* (2021) carried out an experiment to assess genetic variability in 31 groundnut genotype. Number of pods per plant, number of secondary branches per plant, kernel width and pod yield per plant displayed a higher level of coefficient of variation both at phenotypic and genotypic level. Genetic advance with higher heritability indicated preponderance of additive variance for pod length, pod yield per plant and number of pods per plant. Therefore, stringent screening of accessions based on these economic traits will ensure high variability and fixation of traits in subsequent generations.

2.2 Correlation coefficient

Correlation analysis provides the mutual relationship between various plant characters and determines the component character on which selection can be based for genetic improvement in yield. The concept of correlation was first given by Galton (1889) and later it was elaborated by Fisher (1918). A brief review of work related to correlation analysis in groundnut has been reviewed as under;

Venkataravana *et al.* (2000a) carried out correlation analysis in 144 germplasm lines of groundnut for pod yield per plant and 14 other characters. The genotypic correlation coefficients were observed to be relatively of higher magnitude than the corresponding phenotypic correlation coefficients, indicating strong inherent association between the characters. Pod yield had positive and significant association with plant height, number of branches per plant, total number of pods per plant, number of matured pods per plant, shelling out turn, haulm yield, 100-kernel weight, sound matured kernel percentage, harvest index, kernel yield and oil yield.

Jayalakshmi and Lakshmikantha (2003) evaluated 21 diverse genotypes of groundnut to study character association for yield and its related traits. Pod yield per plant had significant and positive correlation with specific leaf area, number of matured pods per plant, number of immature pods per plant and harvest index.

Golakia *et al.* (2004) carried out an experiment in 35 genotypes of groundnut and reported that the genotypic correlation coefficients were higher in magnitude than phenotypic correlation coefficients. Pod yield was strongly associated with biomass yield per plant and harvest index. The characters like oil content, 100-kernel weight and days to maturity were found to be correlated among them as well as with pod yield.

Nagda and Joshi (2004) carried-out correlation analysis in 52 genotypes of groundnut for seven characters. They reported that genotypic correlations were higher than the phenotypic correlations. Dry pod yield exhibited positive and significant correlation with harvest index at both the genotypic and phenotypic levels. Haulm yield was positively and significantly correlated with shelling out-turn and negatively correlated with harvest index at both the levels.

Siddiquey *et al.* (2006) performed correlation analysis to assess the relationship in 74 groundnut genotypes for nine yield contributing characters and they reported that pod yield was significantly and positively related with number of pods per plant, 100-pod weight and oil content.

Mane *et al.* (2008) carried-out correlation analysis to evaluate the relationship among different characters in bunch groundnut. They reported that pod yield per plant exhibited significant and positive correlation with sound mature kernel percentage, number of pegs per plant, number of pods per plant and shelling percentage. However, it showed negative and non-significant correlation with hundred kernel weight and days to 50 % flowering.

Giri *et al.* (2009) carried out correlation analysis to evaluate the relationship among different characters in 20 genotypes of groundnut and reported that the pod yield showed positive significant association with days to 50 % flowering, days to maturity, kernel yield and oil content.

Kadam *et al.* (2009) evaluated 40 germplasm accessions of groundnut to determine the degree of association between pod yield and its components. Pod yield was positively and significantly correlated with number of matured pods per plant, harvest index, 100-kernel weight, numbers of branches per plant, plant height and oil content. These traits also possessed positive and highly significant association between themselves indicating that selection for these traits would be effective in improving the pod yield in groundnut.

Sonone and Thaware (2009) carried-out correlation analysis in groundnut. The genotypic correlation coefficients were somewhat higher than the phenotypic correlation coefficients for most of the characters. The range of genotypic and phenotypic correlation coefficients was maximum and positive between dry pod yield per plant and kernel yield per plant followed by number of kernels per plant. Positive correlation was also noticed between dry pod yield per plant and days to 50 per cent flowering, days to maturity and 100-seed weight, while negative correlation was observed with oil content, pod length and plant height.

Meta and Monpara (2010) evaluated 50 elite genotypes of bunch groundnut to determine the degree of association between different characters. The pod yield per plant was associated strongly and positively with kernel yield per plant, pods per plant, shelling out-turn and oil content but, its correlation was significant and negative with 100-pod weight, days to 50 % flowering and days to maturity.

Vaithiyalingan *et al*. (2010) assessed correlation coefficients for nine traits involving 40 crosses and 14 parents in groundnut for early season drought tolerance. They reported that pod yield exhibited significant positive association with number of pods per plant, dry matter production and harvest index, while plant height, biological yield per plant, number of pods per plant and days to maturity was significantly and positively correlated with each other, whereas significant negative association was observed for days to 50 % flowering with plant height; biological yield per plant with harvest index and 100-kernel weight.

Vekariya *et al.* (2010) evaluated 50 diverse genotypes of bunch groundnut to accomplish correlation coefficient. They reported that the magnitude of genotypic correlation coefficient was higher as compared to the corresponding phenotypic correlation coefficients. The pod yield per plant had highly significant and positive correlation at phenotypic level with number of matured pods per plant, kernel yield per plant, biological yield per plant and harvest index.

Bhosale (2011) performed correlation analysis in 108 different genotypes of groundnut and stated that the pod yield per plant exhibited significant positive association with number of pods per plant, kernel yield per plant, number of pegs per plant, number of matured pods per plant, 100-pod weight, 100-kernel weight and harvest index at both genotypic and phenotypic levels, while pod yield per plant exhibited highly significant and negative correlation with days to maturity, plant height, number of secondary branches per plant and haulm yield per plant at both the genotypic and phenotypic levels. The pod yield per plant also showed positive and highly significant correlation with days to 50 % flowering and shelling out-turn at genotypic level.

Channayya *et al.* (2011) evaluated 50 elite genotypes of bunch groundnut for different characters and reported that the pod yield was positively and significantly associated with number of primary branches, pod weight per plant, 100-kernel weight, sound mature kernel percentage and oil yield. These results clearly indicated that indirect selection for yield in groundnut is possible through simultaneous improvement of these yield components.

Babariya and Dobariya (2012) evaluated 100 genotypes of spanish bunch groundnut to estimate correlation coefficients for pod yield and its component characters and reported that pod yield per plant had positive and significant association with number of pods per plant, number of matured pods per plant, biological yield per plant, harvest index and 100 kernel weight. They also reported that plant height had significant and negative correlation with days to 50 % flowering and significant and positive correlation with days to maturity.

Narasimhulu *et al.* (2012) carried-out association analysis among nine characters in 18 selected groundnut genotypes. The correlation study revealed that pod yield per plant had significant positive association with kernel yield per plant, shelling percentage and sound mature kernel percent at both genotypic and phenotypic levels.

Choudhary *et al.* (2013) assessed correlation in 27 groundnut genotypes for 13 characters. Pod yield was positively and significantly correlated with number of pegs per plant, number of matured pods per plant, kernel yield per plant, biological yield per plant and harvest index.

Thakur *et al.* (2013) evaluated 25 groundnut genotypes to study correlation analysis. The pod yield showed highly significant and positive association with days to maturity, sound mature kernel and kernel length but, the highly significant and negative association was shown with days to flowering, pods per plant, shelling per cent and specific leaf area whereas, day to flowering was negatively correlated with days to maturity, sound mature kernel and 100-kernel weight.

Kumar *et al.* (2014) evaluated 66 elite genotypes of groundnut to determine the degree of association between different characters. Correlation studies revealed that kernel yield was significantly and positively associated with pod yield per plant, number of matured pods per plant, shelling percentage, harvest index, sound mature kernel percentage and oil content.

Yadlapalli (2014) assessed correlation coefficients among different yield components. Pod yield exhibited significant and positive genotypic correlations with number of pods per plant, 100-seed weight, number of branches per plant and days to 50 % flowering.

Bhargavi *et al.* (2015) evaluated 20 genotypes of groundnut for correlation studies. Pod yield showed significant positive association with days to maturity, number of matured pods per plant, biological yield per plant, harvest index, 100-kernel weight and oil content of both phenotypic and genotypic levels.

Gupta *et al.* (2015b) evaluated 60 diverse genotypes of groundnut to study character association for yield and its related traits. The magnitudes of genotypic correlation coefficient were higher as compared to the corresponding phenotypic correlation coefficient. The pod yield per plant had highly significant and positive correlation at both the levels with sound mature kernel, 100-kernel weight, shelling out-turn, biological yield per plant and harvest index. They also reported that significant and positive association was observed for plant height with biological yield per plant; number of branches per plant with shelling out turn; 100-kernel weight with harvest index, while significant and negative correlation was observed for number of branches per plant with 100-kernel weight and sound mature kernels.

Nirmala and Jayalakshmi (2015) studied the character association among physiological and drought tolerant attributes with 30 groundnut genotypes. The results indicated that the characters pod yield per plant, shelling out turn, harvest index, number of matured pods per plant, number of sound mature kernel, plant height and specific leaf area were significantly and positively interrelated among themselves and also with the kernel yield per plant.

Sanjeevakumar *et al.* **(**2015) conducted an experiment on 49 genotypes of groundnut for 16 characters to study character association for yield and its related traits and reported that genotypic correlation coefficients were higher in magnitude than phenotypic correlation coefficients. Pod yield had positive and significant correlation with number matured pods per plant, number of primary branches per plant and days to 50 % flowering, while significant and negative correlation was observed for 100 kernel weight and shelling per cent. They also reported that days to 50 % flowering was significantly and positively correlated with number of branches per plant, while negatively correlated with plant height. Significant and negative correlation was observed for days to maturity with number of matured pods per plant and plant height with shelling out turn.

Jain *et al*. (2016) evaluated 24 diverse genotypes of groundnut to accomplish correlation coefficients for pod yield and its component characters. The genotypic correlation coefficients were found to be of relatively higher magnitude than the corresponding phenotypic correlation coefficients, indicating strong inherent association between the characters. Pod yield per plant displayed significant positive association with kernel yield per plant, matured pods per plant and plant height. They also reported significant negative correlation of plant height with oil content.

Namrata *et al.* (2016) evaluated 30 genotypes of groundnut to study the character association for different component characters. Association estimates revealed that dry pod yield per plant was positively correlated at both genotypic and phenotypic levels with biological yield per plant, harvest index, 100-kernel weight, sound mature kernels and oil content.

Sandhya *et al.* (2016) performed correlation analysis under different environments and reported that there was a strong positive association between pod yield per plant and oil content. The magnitude and direction of association of pod yield with other characters varied from environment to environment. Inter correlation estimates for yield components revealed that plant height, 100-kernel weight, kernel yield per plant, oil content, number of matured pods per plant, harvest index and plant height were significantly associated with one another and also with pod yield per plant, which indicated that these characters were important components for improvement of pod yield..

Ashutosh *et al*. (2017) evaluated 29 breeding lines of groundnut to accomplish correlation coefficients for pod yield and its component characters. Pod yield per plant exhibited significant positive correlation with hundred kernel weight, number of pods per plant and harvest index at both genotypic and phenotypic levels.

Mallikarjun and Savithramma (2017) evaluated four genotypes of groundnut to study the character association for different component characters. Association estimates revealed that dry pod yield per plant was positively and significantly correlated at both levels with number of pods per plant, kernel yield per plant, kernels per plant and SCMR. Pod yield per plant and SCMR had significant negative association with specific leaf area and shelling out turn.

Mukesh and Lal (2017) assessed correlation coefficients among different yield and its contributing traits in 40 genotypes of groundnut. The results of phenotypic and genotypic correlation analysis revealed that pod yield was significantly and positively correlated with plant height and hundred kernel weight.

Om and Nadaf (2017) evaluated advanced breeding lines of groundnut to study association between different component characters. Pod yield was positively correlated with 100-seed weight and shelling out turn. They also reported that shelling out turn had significant and positive association with 100-seed weight and 100-seed weight had significant and positive association with oil content.

Singh *et al.* (2017) evaluated 15 genotypes of groundnut to study association between different component characters. Dry pod yield per plant registered positive and significant genotypic and phenotypic correlations with kernel yield per plant and 100-kernel weight, while significant and negative association was observed with days to flowering, days to maturity and oil content.

Sushree *et al.* (2017) evaluated 32 genotypes of groundnut for association analysis. Association estimates revealed that the values of genotypic correlations were higher than their corresponding phenotypic correlations indicating that there was high degree of association between two variables. Pod yield per plant exhibited highly significant positive correlations with number of branches per plant, haulm yield per plant, number of pods and hundred kernel weight at both phenotypic and genotypic levels.

Trivikrama *et al.* (2017) assessed character association in six parents and their 15 crosses of groundnut for yield and its component characters. The genotypic correlation coefficients were relatively higher in magnitude than the corresponding phenotypic correlation coefficients indicating strong inherent association between the characters. Pod yield per plant possessed significant positive association with number of pegs per plant, number of matured pods per plant and number of pods per plant. They also reported significant negative association of plant height with harvest index;

number of hanging pegs per plant with shelling out turn, while number of hanging pegs per plant showed significant and positive correlation with number of matured pods per plant and number of pods per plant.

Tulsi *et al*. (2017) evaluated 90 genotypes of groundnut for association analysis. Association estimates revealed that dry pod yield per plant showed positive and significant correlations at both genotypic and phenotypic levels with kernel yield per plant, 100-kernel weight, sound mature kernels and biological yield per plant.

Mahesh *et al.* (2018) evaluated 144 genotypes of groundnut for 13 characters to assess the correlation. The pod yield per plant had significant positive correlation with kernel yield per plant, matured pods per plant and sound mature kernel percentage at both phenotypic and genotypic levels. They also reported that significant and positive correlation was observed for days to 50 % flowering with days to maturity; number of branches per plant with shelling out turn and biological yield per plant; days to maturity with plant height and biological yield per plant while, plant height was significantly and negatively correlated with SCMR and oil content.

Wadikar *et al.* (2018) evaluated 40 diverse genotypes of groundnut to measure character association and reported highly significant and positive association of pod yield with kernel yield per plant, harvest index, test weight and number of pods per plant at both genotypic and phenotypic levels. They also reported significant and negative association of number of branches per plant with oil content.

Solanki *et al.* (2019) evaluate 60 genotypes of groundnut to assess correlation coefficient. The observations were recorded on 14 characters. Pod yield per plant was significantly and positively correlated at both genotypic and phenotypic levels with number of matured pods per plant, number of pods per plant, sound mature kernel, 100-kernel weight, biological yield per plant and harvest index. So these characters should be given more weightage in selection process. The results indicated the importance of the characters towards contribution of pod yield per plant.

Kumari and Sasidharan (2020) studied fifty *Arachis* genotypes belonging to different botanical types *viz*., spanish bunch, virginia bunch, valencia, *peruviana* and *aequatoriana* for 28 quantitative characters to assess the correlation coefficient. Characters such as number of matured pods per plant, pod yield per plant and hundred pod mass showed positive and significant genotypic correlation with kernel yield per plant.

Mitra *et al.* (2021) carried out an experiment to assess correlation coefficient in 31 groundnut genotype. Significant positive correlation was recorded between number of secondary branches per plant, pod length, number of pods per plant as well as kernel width, individually with pod yield per plant suggesting simultaneous improvement in both the characters. Alternatively, a significant negative correlation was observed both for plant height and shelling out turn with pod yield per plant.

2.3 Path coefficient analysis

The concept of partitioning of correlation into direct and indirect effects through path analysis was originally developed by Wright (1921), but the technique was first used for plant selection by Dewey and Lu (1959). It measures the interrelationships of major yield contributing characters with yield and amongst them with their direct and indirect effects on yield for making the selection more effective. Brief reviews of work related to path analysis in groundnut have been reviewed as under;

Methews *et al.* (2001) assessed path coefficient analysis for different component characters. They reported that maximum direct effect on pod yield was exhibited by kernel yield per plant followed by plant height. The days to 50 % flowering and plant height had positive indirect effect through kernel yield per plant.

Nagda and Joshi (2004) assessed path coefficient analysis and reported that the harvest index had positive and the highest direct effect followed by haulm yield. Among the indirect effects, the influence of 100-kernel weight through harvest index was positive and strong followed by indirect effect of shelling out-turn through haulm yield.

Suneetha *et al.* (2004) assessed path coefficient analysis for different component characters and stated that harvest index exerted the highest positive direct effect on pod yield per plant followed by total dry matter per plant, sound mature kernels and 100-kernel weight. Days to maturity, number of primary branches, number of matured pods, shelling percentage and 100-pod weight also exhibited low direct effect on pod yield, while days to 50 % flowering and plant height had high and negative direct effect.

Patil *et al.* (2006) evaluated 13 genotypes of groundnut for path analysis at six different locations and reported that three traits *viz.*, number of pods per plant, shelling per cent and sound mature kernels percentage had the maximum direct effect on pod yield per plant.

Siddiquey *et al.* (2006) evaluated 74 genotypes of groundnut to determine the path coefficient for nine yield contributing characters and reported that number of pods per plant, 100-pod weight and oil content had the highest direct positive effects on pod yield per plant and contributed the highest variation in pod yield of groundnut. The other direct positive effects were observed from days to maturity and plant height.

Mane *et al.* (2008) performed path coefficient analysis to assess the relationship among different characters in summer bunch groundnut. The characters; sound mature kernels percentage, shelling percentage and number of pods per plant recorded high magnitude of direct effect. The direct negative effects were observed for number of pegs per plant and days to 50 % flowering.

Awatade *et al.* (2009) studied path coefficient analysis for 13 component characters in 40 genotypes of groundnut. Path analysis revealed that number of pods per plant, shelling percentage, pod length, 100-seed weight and kernel yield per plant had positive direct effect on dry pod yield.

Giri *et al.* (2009) performed path coefficient analyses to assess the relationship among different characters in 20 genotypes of groundnut and stated that kernel yield exerted the highest positive direct effect on pod yield per plant, while other characters *viz.* oil content, strong matured kernel, days to 50 per cent flowering, test weight and days to maturity exhibited high indirect effect on dry pod yield *via* kernel yield.

Khanpara *et al.* (2010) evaluated ten genotypes of groundnut to accomplish path coefficient analysis for pod yield and its component characters. Number of matured pods per plant manifested maximum direct effect towards the pod yield per plant followed by days to maturity, biological yield per plant and 100-kernel weight.

Meta and Monpara (2010) evaluated 50 elite genotypes of bunch groundnut for different characters and reported that the pods per plant manifested maximum direct effect towards pod yield per plant followed by 100-pod weight and 100-kernel weight. Pods per plant and kernel yield per plant also contributed major share to pod yield per plant indirectly through other traits.

Vaithiyalingan *et al*. (2010) assessed path coefficients for nine traits involving 40 crosses and 14 parents in groundnut for early season drought tolerance. Path analysis revealed maximum direct effect of number of pods per plant followed by dry matter production and kernel weight on pod yield per plant.

Vekariya *et al.* (2010) evaluated 50 diverse genotypes of bunch groundnut for path analysis and stated that the kernel yield per plant, biological yield per plant and harvest index had high and positive direct effect on pod yield per plant.

Zaman *et al.* (2011) assessed path coefficient analysis for different yield and yield component characters. The number of matured pods per plant had high positive direct effect on seed yield per hectare followed by shelling percentage, days to 50 % flowering and days to maturity.

Babariya and Dobariya (2012) evaluated 100 genotypes of groundnut to study direct and indirect effects by path analysis for pod yield per plant and its components.

Biological yield per plant and harvest index exhibited high and positive direct effect on pod yield per plant. Whereas, kernel yield per plant, number of pods per plant and days to maturity showed moderate and positive direct effect on pod yield per plant.

Sadeghi and Seyyed (2012) evaluated 23 groundnut genotypes to investigate the relationship among different traits under drought stress and irrigated conditions. Path analysis suggested that in irrigated condition; total number of kernels per plant, 100-kernel weight and total number of pods per plant and in drought stress condition; 100-kernel weight, total number of kernels per plant, total number of pods per plant and biomass had greatest positive direct effect on seed yield. High direct effects were contributed by 100-kernel weight and total number of kernels per plant. Moreover, it was noticed that high indirect contribution was *via* 100-kernel weight and total number of kernels per plant by most of the yield components.

Choudhary *et al.* (2013) evaluated 27 genotypes of groundnut to determine the path coefficient for 13 yield contributing characters and reported that kernel yield per plant, biological yield per plant and harvest index had maximum positive direct effect on dry pod yield per plant.

Thakur *et al*. (2013) evaluated 25 groundnut genotypes to study path analysis. Days to maturity, shelling out turn and oil content recorded positive direct effect on pod yield per plant, while days to 50 % flowering, number of pods per plant and 100-kernel weight recorded negative direct effect on pod yield per plant.

Yadlapalli (2014) performed path coefficient analysis to assess the relationship among different characters in groundnut. Number of pods per plant showed positive direct effect on pod yield per plant followed by 100-seed weight, number of branches per plant and days to 50 % flowering.

Gupta *et al.* (2015b) evaluated 60 diverse genotypes of groundnut to assess the path coefficient analysis for pod yield and its component characters. Number of matured pods per plant, sound mature kernel, biological yield per plant, days to maturity and number of branches per plant exhibited positive direct effect on pod yield per plant.

Nirmala and Jayalakshmi (2015) studied the path analysis among physiological and drought tolerant attributes with 30 groundnut genotypes. The results indicated that the pod yield per plant exerted high positive direct effect on kernel yield per plant followed by shelling out turn. Plant height, number of matured pods per plant, number of sound mature kernels and harvest index exerted their indirect effect through source contributions for several other characters.

Sanjeevakumar *et al.* **(**2015) conducted an experiment on 49 genotypes of groundnut for 16 plant characters to study path association for yield and its related traits and reported that number of immature pods per plant, number of matured pods per plant, 100-kernel weight and oil content exhibited positive direct effect on pod yield per plant, while shelling out turn and days to 50 % flowering exhibited negative direct effect on pod yield per plant.

Jain *et al*. (2016) evaluated 24 diverse genotypes of groundnut to study path coefficient analysis for pod yield and its component characters. Analysis revealed positive direct effect of kernel yield per plant, plant height, days to maturity, number of pods per plant and matured pods per plant on pod yield per plant.

Namrata *et al.* (2016) evaluated 30 genotypes of groundnut to study the path coefficient analysis for different component characters. Path coefficient analysis revealed direct effect biological yield per plant and 100-kernel weight of on pod yield, while other characters *viz.,* biological yield per plant, number of branches per plant and 100-kernel weight exhibited high indirect effect on dry pod yield *via* kernel yield per plant.

Sandhya *et al.* (2016) performed path analysis under different environments and reported that days to 50 % flowering, kernel yield per plant and oil content had positive direct effect toward pod yield, while negative direct effect was exerted by plant height, number of matured pods per plant and days to maturity.

Anusha and Savithramma (2017) studied the path coefficient analysis related to water use efficiency in 230 RILS of groundnut. Path coefficient analysis indicated that plant height, kernel yield and primary branches per plant had positive direct effect toward pod yield per plant, while specific leaf area, sound mature kernel and number of pods per plant had negative direct effect on pod yield per plant.

Ashutosh *et al*. (2017) evaluated 29 breeding lines of groundnut to accomplish path coefficients for pod yield and its component characters. Harvest index and haulm yield had high positive direct effect toward pod yield per plant. Kernel yield per plant, hundred kernel weight, number of pods per plant and plant height were observed to be the major indirect contributor towards pod yield through harvest index.

Gouranga *et al.* (2017) evaluated 19 genotypes of groundnut to study the path coefficient for different component characters and stated that plant height, number of pods per plant, shelling percentage, sound mature kernel percentage and harvest index had positive direct effects on pod yield, while shelling out turn had negative direct effect on pod yield per plant.

Kamdi *et al.* (2017) evaluated 18 local collections of groundnut for path analysis and reported that number of matured pods per plant, number of primary branches per plant and days to 50 % flowering had positive direct effect on yield of dry pods.

Mukesh and Lal (2017) assessed path coefficient analysis for yield and its contributing traits in 40 genotypes of groundnut. Days to 50 % flowering, number of branches per plant, days to maturity, shelling out turn, 100-kernel weight and sound mature kernel had negative direct effect toward pod yield per plant.

Singh *et al.* (2017) conducted an experiment on 15 genotypes of groundnut to study path coefficient for yield and its related traits. The path coefficient analysis revealed that the kernel yield per plant, oil content, sound mature kernel and shelling percentage exhibited positive direct effect on dry pod yield per plant, while days to 50 % flowering and 100-kernel weight exhibited negative direct effect on dry pod yield per plant.

Sushree *et al*. (2017) evaluated 32 F_6 progenies along with four released varieties as parents to assess path coefficient analysis for pod yield and its component characters in groundnut. Path analysis revealed that the kernel yield per plant had the highest direct positive effect on pod yield per plant followed by number of kernels per plant and 100-kernel weight. All other characters made major indirect contribution towards pod yield through these three characters. Plant height, number of branches per plant and number of pods per plant exhibited greater influence on pod yield per plant.

Trivikrama *et al.* (2017) assessed path association in six parents and their 15 crosses of groundnut for yield and its component characters. Days to 50 % flowering and days to maturity exhibited positive direct effect on pod yield while, number of pods per plant, number of hanging pegs per plant, number of mature pods per plant and number of branches per plant exhibited negative direct effect toward pod yield per plant.

Tulsi *et al*. (2017) evaluated 90 genotypes of groundnut for path coefficient analysis. The highest positive direct effect on dry pod yield was exhibited by kernel yield per plant, days to maturity, oil content and days to 50 % flowering.

Mahesh *et al*. (2018) evaluated 144 genotypes of groundnut for different 13 characters to assess the path analysis and reported that the kernel yield, biological yield per plant, sound mature kernel, number of matured pods per plant, 100-kernel weight and harvest index exhibited high and positive direct effect on pod yield per plant whereas, shelling out turn and number of immature pods per plant had low and negative direct effect toward pod yield per plant.

Solanki *et al.* (2019) conducted an experiment to assess the path analysis in 60 genotypes of groundnut. The observations were recorded on 14 characters. Matured pods per plant 100-kernel weight, biological yield and harvest index showed high positive direct effects on pod yield per plant. Thus, these characters were identified as the most important yield components and due emphasis should be placed on these characters while selecting for high yielding genotypes in Virginia groundnut.

Kumari and Sasidharan (2020) evaluate fifty *Arachis* genotypes belonging to different botanical types *viz*., spanish bunch, virginia bunch, valencia, *peruviana* and *aequatoriana* for 28 quantitative characters to study the path analysis. Pod yield per plant had the highest and positive direct effect on kernel yield per plant followed by days to maturity, plant height, number of matured pods per plant, oil content, SMK % and number of primary branches.

Mitra *et al.* (2021) carried out an experiment to assess path analysis in 31 groundnut genotype. The highest direct effects of kernel width, followed by number of pods per plant, and pod length with pod yield per plant in a positive manner. Conversely, the highest negative direct effect on pod yield per plant was registered by shelling out-turn. Plant height exhibited major negative indirect effects on pod yield per plant that was expressed *via* pod length. Shelling out-turn exhibited major positive indirect effect on pod yield per plant *via* pod width. Kernel width displayed least indirect effects on pod yield per plant.

2.4 Genotype x Environment interaction and stability

Development of high yielding genotypes with wide adaptability has been the universal goal of plant breeders. A genotype is known to show a differential phenotypic response in the development when introduced in different environments. Different measures of stability have been used by various workers. Finlay and Wilkinson (1963) considered linear regression slope as a measure of stability. Eberhart and Russell (1966) realized the need of considering both linear (b_i) and non-linear (S^2d_i) components of genotype x environment interaction in judging the phenotypic stability of a genotype. Comstock and Moll (1963), Allard and Bradshaw (1964), Eberhart and Russell (1966) have emphasized the importance of evaluating genotypes under different agro-climatic conditions to obtain reliable information on stability parameters of breeding material. Later, Breece (1969) and Paroda and Hayes (1971) advocated that linear regression could simply be regarded as a measure of responsiveness for a particular genotype, whereas deviation around regression lines (S^2d_i) were considered as a better measure of stability. They concluded that genotype with the lowest standard deviation were the most stable and *vice-versa*. The available literature pertaining to genotype x environment interaction and stability parameters in groundnut has been reviewed as under:

Mahto and Mahto (2000) studied stability of nine promising groundnut cultivars (TG 24, BG 3, JL 24, GG 2, GG85 1, TG 2, AK 12-24, Kisan and Gangapuri) under four environments (*kharif* 1990-93) for days to 50 % flowering, shelling percentage, 100-kernel weight and pod yield per plant. G x E interactions were significant for all the traits. All the traits were controlled by non-linear component of environment. They concluded that among the cultivars, JL 24 and BG 3 were the most stable genotypes for pod yield and for most of the other characters and are therefore suitable for cultivation in wide range of environmental conditions.

Minimol *et al.* (2000) evaluated ten groundnut genotypes (AK-107, AK-135, AK-143, AK-159, AK-205, AK-237, AK-240, AK-247, TAG-24, and TG-26) grown in Akola, Maharashtra, India, during summer 1997-98 and *kharif* 1998-99 under six environments for stability in yield and yield contributing components. G x E interactions were significant for all the traits. Nonlinear components of G x E interactions were important for shelling percentage, pod yield per plot and oil content. Linear and nonlinear components were significant for seed weight per plant and 100-pod weight. AK-205, AK-135, AK-237, AK-240, and AK-159 were stable for pod yield and most of the yield-contributing traits.

Venkataravana *et al.* (2000b) performed genetic stability analysis for plant height, days to 50 % flowering, days to maturity, number of branches per plant, matured pods per plant, pod yield per plant, shelling percentage, 100-kernel weight, and oil yield per plant for 30 groundnut cultivars grown during 1996 (*kharif*) and 1997 (*rabi* and *kharif*) in Kolar and Karnataka. The analysis of variance indicated the significant effect of environments on all the characters. G x E interaction (linear) was significant for plant height, number of matured pods per plant, pod yield per plant and oil yield per plant. The nonlinear component was significant for all the traits except plant height. The number of branches per plant, 100-kernel weight, oil yield per plant, pod yield per plant and shelling percentage were the most stable characters. ICG(FDR)S-10, JSSP-6, and ICGV-86590 were most stable with regard to the number of pods per plant, pod yield per plant and oil yield per plant.

Naazar *et al.* (2001) in their investigations on stability analysis for pod yield in groundnut (*Arachis hypogaea* L.) evaluated 10 promising groundnut genotypes for their adaptability and stability. The genotypes, BM 28 and ICGV 86550 with above average performance, unit slope and non-significant deviation from regression were suggested to be suitable for wide range of environments. Four genotypes, Gori, ICG-7326, Cina and Chinese 68-4 possessing b_i values less than unity and below average mean performance were declared to be suitable for poor environment. The genotype, ICG-4993 having greater than unit regression coefficient (b_i = 1.14) and deviation from the regression (S^2d_i) was highly significant (0.82). Hence, this genotype was unsuitable for wider cultivation.

Viswanathan *et al.* (2001) studied phenotypic stability analysis in groundnut. Ten genotypes of groundnut were evaluated during *kharif* and *rabi* seasons of 1997 and 1998. The analysis of variance indicated significant differences among four environments. G x E interaction was significant for number of matured pods and pod yield. The environment (linear) and G x E (linear) component were significant for number of matured pods and pod yield. But, G x E (linear) was not significant for these two traits when tested against pooled deviation indicating the preponderance of nonlinearity. The genotype VGN 24 recorded high mean value, average responsiveness and stability.

Joshi *et al.* (2003) performed stability analysis for morpho-physiological traits in 44 genotypes of groundnut. They found mean squares due to G x E interaction to be significant for haulm yield per plant, biological yield and harvest index. The genotype, DSP 20 exhibited wider adaptability and stability for pod yield, while seven other genotypes, namely; DSP 4, DSP 13, DSP 21, DSP 22, DSP 26, DSP 28, and DSP 32 showed adaptability to favourable environments.

Bentur *et al.* (2004) performed stability analysis on 13 groundnut large seeded cultivars for pod yield and its component traits. Significant G x E interactions were noticed for pod yield and its component traits like shelling percentage and sound mature kernel percentage. They found that none of the cultivars were stable for pod yield or kernel yield, whereas cultivars; M 13, KGV 86564, ICGV 94217, TGLPS 3 and TGLPS 7 were stable for shelling percentage across different environments.

Senapathi *et al.* (2004) in their experiment on stability analysis of summer groundnut (*Arachis hypogaea* L.) under coastal saline zone of West Bengal evaluated 24 groundnut genotypes for their stability and found that mean squares due to genotype × environment interaction were highly significant for pod yield per plant. Further, the linear and non-linear components of G x E interactions were significant for pod yield. Among the genotypes, MCAC 17051, MC 7129, ASKI 9502, TAG 24 and IBKI 9502 were found to be stable for pod yield.

Sahay and Sarma (2005) studied 67 groundnut genotypes for stability analysis and observed that the genotype, ICGV 87867 was the most stable performer across different environments. Further, genotypes, ICGV 86326, ICGV 88348, ICGV 88338 and ICGV 87415 performed well in favourable environments, whereas NRCG 1752 performed well in unfavourable environments.

Chuni Lal *et al.* (2006) evaluated six groundnut varieties across different environments for stability analysis and reported that mean squares due to G x E (linear) interaction were significant for pod yield and 100-pod weight traits. Further, the variety, B 95 had registered highest pod yield, 100-pod weight and 100-kernel weight consistently across the various environments studied and hence was identified as a potential variety for widespread cultivation.

Mekontchou *et al*. (2006) evaluated six advanced Cameroonian peanut breeding lines; two introductions from Kano (Nigeria) and one traditionally cultivated variety (control) were grown at four locations during three seasons, giving a total of twelve locations × year combinations. The purpose was to evaluate yield stability and a number of yield components. Significant lines x environment interactions were detected for all traits. Results revealed that most Cameroonian breeding lines including 82Ds 479, 854, 1809 and 1632 had above average results for pod and seed yields, good stability shown by their regression coefficients (b_i) close to unity and low non-significant deviations from regression. Lines 82D22P-466 and 82D14S-1809 with mean yields and yield components higher than average and b_i values lower or close to unity are expected to perform well for these traits in less favourable environments. The introduced line K2044-80 was stable for seed yield but had below average yields. Such, a line can be utilized in a breeding programme for transferring stability characters into high yielding cultivars.

Ahmad *et al*. (2008) conducted an experiment using nine promising genotypes of groundnut to evaluate their adaptiveness and stability performance. They grown material at two different locations during *kharif* 2006 & 2007. Variance due to genotypes, environment, G x E, environment + (variety x environment), environment (linear) and variety x environment (linear) components were significant for pod yield per plot. The regression coefficient (b_i) ranged from -1.019 to 3.288 and deviation from regression (S^2d_i) ranged from -0.026 to 0.066. The genotype BAU-18 and BAU-20 were found to be desirable and stable for total yield over the environments, while genotype M-335 was suited for favourable environment. The genotype Birsa Groundnut-1 and BAU-13 were might be suitable for poor environment.

Hariprasanna *et al*. (2008) studied large seeded groundnut genotypes for three years in a single location to examine the existence of G x E interaction for pod yield and related traits. Significant G x E interaction was noticed for pod and kernel yield, indicating differential response of the genotypes in different years or environments, while for seed size, shelling percentage and proportion of sound mature kernels, the interaction was non-significant. Stability analysis revealed that two genotypes (PBS 29010 and GG 20) had near unity regression coefficient (b_i) for pod and kernel yield indicating general adaption, but only GG 20 had positive phenotypic index. Another released cultivar TKG 19A exhibited significantly low b_i, which indicates above average stability and low sensitivity to environmental changes, but had poor mean pod and kernel yield. The genotype ICGV 99101 recorded the highest pod and kernel yield with 21 % and 10 % yield advantage over the best check, GG 20, respectively. It exhibited the highest phenotypic index for pod and kernel yield, significant b_i value and deviation from unity, thereby portraying the highly sensitive nature of the genotype to environmental fluctuation. The 100-seed mass in ICGV 99101 (51.3 g) was numerically superior to TKG 19A that had the highest seed size among the checks.

Chavan *et al*. (2009) evaluated 16 groundnut genotypes along with three checks in three replications under three environmental locations to know the role of G x E interaction and also to study the stability of the same genotypes. Environments in which genotypes were grown, differed significantly for days to maturity, number of mature pods per plant, shelling percentage, strong mature kernels, 100-kernel weight and late leaf spot severity. G x E interaction variances were also highly significant for all the characters studied. The genotypes LGN-107, LGN-110, LGN-121, LGN-125, LGN-126, LGN-128, LGN-129, LGN-130, LGN-117, LGN-162, LGN-1 and AK-159 were stable over the environments for pod yield per plant. Among them, LGN-110, LGN-112, LGN-115 and LGN-163 showed wider adaptability for shelling percentage. While, LGN-111 and LGN-115 were adapted specifically to better environment and showed a high degree of stability for 100-kernel weight.

Malik *et al*. (2009) studied eight promising genotypes of groundnut at 10 locations across Pakistan during 2004 for stability analysis. They reported highly significant genotype x location interaction. BARD 479, 2KCG017 and Australian genotypes were found to be suitable for favourable environments, while 02CG005 genotype was noticed to be suitable for unfavourable environments.

Sreekala and Kumar (2009) investigate 22 groundnut's prerelease and released genotypes to identify the stable genotypes for characters that contribute to kernel yield. *Kharif* inceptisols (Environment I), *rabi* inceptisols (Environment II) and summer alfisols (Environment III) served as the three contrasting environments. The genotypes ICG-11386 and ICGV-86584 exhibited stable performance for four characters *viz.*, harvest index, sound mature kernels, pod yield per plant and kernel yield per plant. ICG-3542 expressed stability for harvest index, pod yield per plant and kernel yield per plant whereas TPT-4 was stable for sound mature kernels, pod yield per plant and kernel yield per plant. For shelling percentage two genotypes ICG-2184 and JL-24 were found to be stable. The genotype K-134 was stable for protein content. For total biomass per plant ICG-3509 was considered as stable. The genotypes (ICG-3509, ICG-3542, ICGV-86584, ICG-11386, ICG-2184, JL-24 and K-134) exhibited stable performance across environments for above characters may be incorporated in breeding programme for developing a general adoptable variety.

Thaware (2009) evaluate 24 genotypes of groundnut for stability of dry pod yield in groundnut. All the genotypes differed significantly revealed enough genetic variability for dry pod yield. Linear component of G x E interaction was higher than that of non-linear. The genotype No.123 recorded high dry pod yield with regression co-efficient (b_i) nearer to unity and deviation from the regression (S^2d_i) nearer to zero. Hence, this genotype was stable. The maximum dry pod yield was recorded by genotype No.119, regression co-efficient (b_i) value nearer to unity but, deviation from the regression (S^2d_i) was highly significant. The genotypes No.114 performed better under favourable environment as they showed high regression co-efficient (b_i) value. The genotype No.116 showed lower regression co-efficient (b_i) value than unity. Hence, it will perform better under poorer environmental conditions. The four genotypes No.103, No.119, No.114 and No.109 can be used as donor parents for dry pod yield in future breeding programme in groundnut.

Mothilal *et al.* (2010) performed stability analysis for kernel yield in 16 Spanish bunch groundnut genotypes in four seasons. Among the 16 genotypes, genotypes ICGV 92206 and ICGV 93392 recorded non significant squared deviation from regression and considered as stable genotypes. Both these genotypes recorded unity regression (non significant regression coefficient from unity) and hence considered as average responsive genotypes. Though the genotypes recorded low yield (1277 kg/ha and 1209 kg/ha), they respond consistently well in a wide range of environments. Hence from the foregoing discussion, it can be concluded that the genotype ICGV 92206 and ICGV 93392 were found to be stable genotypes and average responsive genotypes. These genotypes can be recommended to wide range of seasons with consistent yield. These two genotypes can be utilized in breeding programme for developing varieties with general stability.

Pradhan *et al.* (2010) conducted experiment to determine G x E interaction for pod yield and yield components of groundnut varieties in warm sub-humid climate and moderately acidic soil. The experimental materials comprised of fourteen groundnut varieties grown during *kharif* 2007, 2008 (rainfed), *rabi* 2007-08 (irrigated) and *rabi* 2007-08 (irrigated and mulched @ 55 kg paddy straw/100 m^2). The magnitude of linear component was quite higher than the non-linear component for most of the characters revealing that the prediction of stability could be reliable though it may get affected to some extent. The varieties AK 12-24, TG 37 A, JL 24, TMV 2, GPBD 4 and R 2001-3 having regression value nearer to unity and non significant deviation from regression for pod yield and kernel yield were highly stable for *kharif* (unfavorable) and *rabi* (favorable) season. Among these stable varieties, R2001-3 exhibited highest mean pod and kernel yield. While AK 159 and Kissan having high mean pod and kernel yield along with b_i more than unity and non significant deviation (S^2d_i) signifies their stability for *rabi* season (irrigated and straw mulched). In the present investigation, stable varieties identified (AK 12-24 and R2001-3) could be used to develop new strains with combinations of stable characters.

Patil *et al*. (2014) conducted an experiment at three different dates of sowing of the year 2010-2011 *viz*., two summer season dates i.e. 3rd February and 23rd

February (E1, E2) and one *kharif* season date i.e. 1st June (E3) for stability analysis on 58 Spanish bunch groundnut genotypes for 16 plant characters. The material was evaluated in randomized block design with three replications at Anand Agricultural University, Anand. The mean squares due to G × E interactions were significant for the characters; days to 50 % flowering, number of primary branches per plant, days to maturity, plant height (cm), number of mature pods per plant, dry pod yield per plant (g), kernel yield per plant (g), haulm yield per plant (g), dormancy (days), oil content (%) and protein content (%) except 100-pod weight (g), 100-kernel weight (g), sound mature kernel (%), shelling (%) and harvest index (%) indicating the influence of environmental conditions on the genotypes evaluated except for above five traits. The mean squares due to G×E (linear) were significant for days to 50 % flowering, days to maturity, dry pod yield per plant (g), 100-kernel weight (g), sound mature kernel (%), shelling (%) and protein content (%). On further perusal of genotypes in relation to overall performance revealed that genotypes *viz.* AG-2008-7, AG-2008-9, ICGV-99181 and J-68 were found stable for unfavourable environments (b_i <1 and high mean). These genotypes also exhibited stability for most of the yield contributing characters.

Kasno and Trustinah (2015) studied genotype x environment interaction of peanut in Indonesia. The experimental material included 18 breeding lines from crosses and local varieties, and two checks of improved varieties (Jerapah and Talam 1). Genotype G16 was found to be stable according to regression and AMMI method to environmental changes. Stability analysis based on the stability parameters (mean yield, linear regression, and deviation from regression) and biplot graph indicated that the genotypes, G2, G3, G4, had stability below average followed with pod yield above general mean, and therefore adapted for favourable environments.

Reddy *et al*. (2016) conducted a field experiment with 30 rainfed groundnut genotypes in randomized complete block design with two replications to study the stability and performance for yield, physiological and quality traits across three sowing dates (environments) during the *kharif* groundnut growing season in 2015. Eberhart and Russel (1966) model was used for estimating the stability parameters. The results revealed significant G x E interaction for the traits studied. Partitioning of the environment + (genotype x environment) component into environment (linear) revealed the significance of environment (linear) component for all the traits studied.

Further, normal *kharif* season was observed to be congenial for pod yield per plant, sound mature kernel per cent, kernel yield per plant, 100-kernel weight, SCMR, SLA, haulm yield per plant, oil and protein content, while early *kharif* was noticed to be favourable for days to 50 % flowering, pods per plant and free proline. Results on stability parameters revealed the potential of K1717 and K1802 genotypes for pod yield per plant; K1899 and K1884 for kernel yield per plant; K1809 and Anantha for oil content for cultivation across the groundnut growing *kharif* seasons studied. The genotype, K1717, however, had recorded high kernel yield per plant, in addition to regression coefficient greater than unity and non-significant deviation from regression, indicating its suitability for cultivation during normal *kharif* season.

Goudar *et al*. (2017) evaluated eleven genotypes of groundnut for its stable performance over different dated of sowing. Substantial variation in mean performance of genotypes over different dates of sowing was observed. The mean squares due to G x E interactions were significant for dry pod yield indicating the environmental influence on the performance of genotypes. All the genotypes except ICGV-0724, Dh-245 and TMV-2 deviated non-significantly from zero (S^2d_i =0) hence they were stable. Among these genotypes, Dh-230, Dh-241, Dh-246 and Dh-247 shown average responsive as they deviated non-significantly from unity (b_i =1) and zero (S^2d_i =0) with above average performance and were more suited to all three dates of sowing. Among the stable genotypes which shown average stable performance across the dates of sowing, Dh-230 (3749.22 kg/ha) followed by Dh-246 (3660.78 kg/ha) and Dh-247 (3598.56 kg/ha) showed higher mean dry pod yield compared to overall mean dry pod yield (3541.08 kg/ha). However the genotype ICGV-0724 was more suitable only for early sowing (4261.33 kg/ha) and G2-52 was more suited for early as well as mid late sowing (4069.78 kg/ha).

Minde *et al*. (2017) performed stability analysis using Eberhart and Russel (1966) model in order to quantify G x E interaction effect on yield in groundnut. They grown 10 groundnut genotypes in Randomized Block Design with three replications on three different sowing dates, thus, creating three environments. G x E interactions were significant for all the characters under study indicating influence of environmental conditions. Stability analysis showed that both linear and non-linear components of G x E interactions were highly significant for all the characters. Environment (E1) was observed to be most suitable for better expression of yield and its contributing characters. None of the genotypes was found to be average stable for all the characters. Of all the genotypes, JL-24 and Phule Unnati exhibited regression co-efficient near to unity with non-significant deviation from the regression (S^2d_i) and higher mean performance than population mean indicating general adaptability to fresh pod yield per plant. Similarly, TPG-41 and JL-24 exhibited average stability for dry pod yield per plant. The genotypes AK-303 and RHRG-6055 exhibited significant regression co-efficient and non-significant deviation from regression indicating their suitability in rich environments for fresh pod yield per plant.

Khan *et al*. (2018) evaluated ten promising groundnut varieties under farmer's participatory varietal selection method to know the G x E interaction at five different locations. Analysis of variance revealed that the mean squares due to genotype were highly significant for all the characters studied. Variance due to environments was significant for all the characters studied except shelling percentage, sound mature kernels and hundred kernel weight. Significance of variance due to G x E interaction was recorded for days to maturity, plant height, shelling percentage, sound mature kernels and hundred kernel weight. A perusal of data for dry pod yield revealed that six out of the 10 genotypes, (Kadiri-9, Dharani, TG-51, TMV-2, G2-52 and GPBD-5) exhibited non-significant deviation from regression. Genotype Kadiri-9 recorded higher mean (1514 kg/ha) than population mean (1405 kg/ha) with regression coefficient of 0.85 for dry pod yield, indicating this genotype performs well under different environments. Genotype Kadiri-9 found stable for major traits like dry pod yield, haulm yield and sound mature kernels indicating the potentiality of this line to exploit the hybrid vigour for pod and haulm yield.

CHAPTER – III

MATERIALS AND METHODS

The present investigation was conducted to assess the genetic variability, correlation and path analysis along with to know genotype x environment interaction and stability of fifty Virginia bunch groundnut genotypes sown under four different environments. The field experiment was conducted during *kharif* 2019 and *kharif* 2020 at two locations; Main Oilseeds Research Station, JAU, Junagadh and Oilseeds Research Station, JAU, Manavadar. Geographically, Junagadh is situated at 21.52^0 N latitude and 70.47^0 E longitudes with an elevation of 61 meters above the mean sea level and Manavadar is situated at 21.22^0 N latitude and 70.16^0 E longitudes with an elevation of 24 meters above the mean sea level. The soil of both the experimental sites was medium black calcareous. The meteorological data for both the cropping seasons are presented in Appendix-I (*Kharif*-2019-Junagadh), Appendix-II (*Kharif*-2020-Junagadh), Appendix-III (*Kharif*-2019-Manavadar) and Appendix-IV (*Kharif*-2020-Manavadar).

3.1 EXPERIMENTAL MATERIALS

The experimental materials consisted of fifty genotypes of Virginia bunch groundnut. The pure seeds of these genotypes were obtained from Main Oilseeds Research Station, Junagadh Agricultural University, Junagadh. The detail of genotypes is given in Table 3.1.

Table 3.1. List of fifty pure genotypes used in present study with their parentage

Sr. No.	Name of genotypes	Parentage
1	JSSP-59	GG-20 x TGP-41
2	JSSP-60	JVB-503 x ALG-234
3	JSSP-62	JSSP-35 x Faizapur
4	JSSP-63	GJG-9 x GG-20
5	JVB-2453	JSSP-46 x GG-16
6	JVB-2483	GJG-22 x JL-501
7	JVB-2486	GJG-22 x RG-510

(*Contd.*)

Table 3.1. (*Contd.*)

Sr. No.	Name of genotypes	Parentage
8	JVB-2489	NRCGCS 25-1-8
9	JVB-2494	NRCGCS 25-7-39
10	JSSP-LS-61	SGL-4233 x JSSP-HPS-3
11	JVB-LS-2436	Selection from farmer sample, Devli, Kodinar
12	JVB-LS-2373	Dh-28 x TG-37A
13	JVB-LS-2501	VG-009366 x ICGV-00440
14	JVB-LS-2502	VG-009366 x ICGV-00440
15	JVB-LS-2505	VG-009366 x ICGV-00440
16	JVB-LS-2506	VG-009366 x ICGV-00440
17	JVB-LS-2507	GJG-22 x RG-510
18	JVB-2508	(GJG-22 x KDG-123) x ICGV-86325
19	JVB-2509	(GJG-22 x KDG-123) x ICGV-86325
20	JVB-2510	(GJG-22 x KDG-123) x ICGV-86325
21	JVB-2511	(GJG-22 x KDG-123) x ICGV-86325
22	JVB-2512	(GJG-22 x KDG-123) x ICGV-86325
23	JVB-2513	(TG-37A x ICGV-86564) x GG-20
24	JVB-2514	(TG-37A x ICGV-86564) x GG-20
25	JVB-2515	JB-1250 x ICGV-91114
26	JVB-2516	GG-20 x ICGV-86325
27	JVB-2517	GG-20 x ICGV-86325
28	JVB-2518	GG-20 x ICGV-86325
29	JVB-2519	GJG-22 x CS-19
30	JVB-2520	GJG-22 x CS-19
31	JVB-2521	GJG-22 x CS-19
32	JVB-2522	JSSP-35 x KDG-123
33	JVB-2523	JSSP-35 x KDG-123
34	JVB-2524	JSSP-35 x KDG-123
35	JVB-2525	JSSP-35 x KDG-123
36	JVB-2526	JSSP-35 x KDG-123
37	JVB-2527	JSSP-35 x TAG-24

(*Contd.*)

Table 3.1. (*Contd.*)

Sr. No.	Name of genotypes	Parentage
38	JVB-2528	GJG-22 x KDG-123
39	JVB-2529	GG-20 x ICGV-86325
40	JVB-2530	GG-20 x ICGV-86325
41	JVB-2531	JVB-2114 x GPBD-4
42	JVB-2532	JVB-2114 x GPBD-4
43	JVB-2533	AG-2006-6 x ICGV-05155
44	JVB-2534	J-73 x RG-510
45	Kaushal	Selection from T-28
46	GG-20	GAUG-10 x R-33-1
47	GJG-22	JSSP-17 x GG-20
48	GG-HPS-2	JVB-HSP-2 x GG-20
49	ICGV-86564	Ah-114 x NC-Ac-1107
50	BAU-13	BAU-6 x M-13

3.2 EXPERIMENTAL DETAILS

Fifty genotypes of Virginia bunch groundnut were sown at two locations for two years, in a Randomized Block Design with three replications, which created four environments to study variability, correlation, path coefficient and stability of genotypes over the years and locations. Each line was sown in a single row plot of 1.5 m length with a spacing of 60 x 15 cm. All the recommended crop production and protection practices were followed timely for the successful raising of crop. The detail of locations, date of sowing and year of experimentation is given below:

Location of experiment	Detail of environments	Date of sowing
Junagadh	E_1: *Kharif*-2019	19^{th} June, 2019
	E_2: *Kharif*-2020	15^{th} June, 2020
Manavadar	E_3: *Kharif*-2019	25^{th} July, 2019
	E_4: *Kharif*-2020	3^{rd} July, 2020

3.3 OBSERVATIONS RECORDED

The observations were recorded on five randomly selected plants from each genotype and replication (except days to 50 % flowering and days to maturity); their mean values were used for statistical analysis. The procedure adopted for recording the observations is described as under:

3.3.1 Days to 50 % flowering

Number of days from the date of sowing to date on which flowers appeared in 50 percent of plants on the plot basis was recorded.

3.3.2 Days to maturity

The total number of days was recorded from sowing to physiological maturity on plot basis.

3.3.3 Number of primary branches per plant

The primary branches arising on main axis were counted of each selected plant at the time of harvesting.

3.3.4 Number of secondary branches per plant

The secondary branches arising from primary branches were counted of each selected plant at the time of harvesting.

3.3.5 Plant height (cm)

Height was measured in centimeters from ground level to the tip of main axis for selected plant at the time of harvesting.

3.3.6 Number of matured pods per plant

The number of fully developed kernel bearing matured pods was counted for selected plant at the time of harvesting.

3.3.7 Number of immature pods per plant

The number of immature kernel bearing pods was counted for selected plant at the time of harvesting.

3.3.8 Sound mature kernel (SMK) %

Fully matured and immature kernels counted from representative sample obtained from each plot and expressed as percent sound mature kernel were calculated by following formula;

$$\text{Sound Mature Kernel (\%)} = \frac{\text{Number of well matured kernels}}{\text{Total number of kernels}} \times 100$$

3.3.9 100-kernel weight (g)

Hundred kernels were counted from random sample from each plot and weighed in grams.

3.3.10 Shelling out-turn (%)

The shelling out-turn based on the weight of kernels recovered from the pods was calculated as under;

$$\text{Shelling out turn (\%)} = \frac{\text{Weight of kernels (g)}}{\text{Weight of pod sample (g)}} \times 100$$

3.3.11 Pod yield per plant (g)

The fully developed dry pods were weighed in grams from selected plant at the time of harvesting.

3.3.12 Kernel yield per plant (g)

The kernels obtained by deshelling of pods of each selected plant were weighed in grams.

3.3.13 Biological yield per plant (g)

The biological yield was measured by weighting the plant including roots, pods and dry plant parts in grams for each selected plant.

3.3.14 Harvest index (%)

This character was derived by using following formula;

$$\text{Harvest index (\%)} = \frac{\text{Pod yield per plant (g)}}{\text{Biological yield per plant (g)}} \times 100$$

3.3.15 Oil content (%)

Kernel samples drawn randomly from each plot were used to measure oil content through Nuclear Magnetic Resonance (N.M.R.).

3.4 STATISTICAL ANALYSIS

The replication-wise mean values of five randomly selected plants in each entry were used for the statistical analysis for different characters under study. The data recorded for various characters were statistically analyzed at the Computer Cell, Department of Genetics and Plant Breeding, College of Agriculture, Junagadh Agricultural University, Junagadh for the various parameters *viz*., genetic variability, genotypic and phenotypic correlation, path coefficient analysis and stability.

3.4.1 Analysis of variance for experimental design

The analysis of variance for randomized block design (RBD) was done for each character as per Panse and Sukhatme (1985). The statistical model used for analysis of variance was based on the following linear model;

$$Y_{ij} = \mu + g_i + r_j + \varepsilon_{ij}$$

Where,

Y_{ij} = Yield of i^{th} genotype in j^{th} replication

μ = General mean

g_i = Effect of i^{th} genotype

r_j = Effect of j^{th} replication

ε_{ij} = Uncontrolled random error associated with i^{th} genotype in j^{th} replication

Table 3.2. Analysis of variance

The format of analysis of variance is given as under:

Source of variation	**d.f.**	**Mean squares**	**Expected mean squares**
Replications	(r-1)	M_r	$\sigma_e^2 + g\,\sigma_r^2$
Genotypes	(g-1)	M_g	$\sigma_e^2 + r\,\sigma_g^2$
Error	(r-1) (g-1)	M_e	σ_e^2

Significance of replication mean sum of square (M_r) and genotype mean sum of square (M_g) was tested against error mean sum of square (M_e).

3.4.2 Estimation of components of variance

The phenotypic, genotypic and error variances were estimated as follows:

$$\sigma_e^2 = M_e$$

$$\sigma_g^2 = (M_g - M_e)/r$$

$$\sigma_p^2 = \sigma_g^2 + \sigma_e^2$$

Where,

r = Number of replications

g = Number of genotypes

M_g = Mean sum of square due to genotypes

M_r = Mean sum of square due to replications

M_e = Mean sum of square due to error

σ_e^2 = Error variance

σ_g^2 = Genotypic variance

σ_p^2 = Phenotypic variance

The standard error of mean (S.Em.) was calculated using following formula:

$$S.Em. \pm = \sqrt{\frac{\sigma_e^2}{r}}$$

The critical difference (C.D.) for comparing mean of any two genotypes was computed using following formula:

$$C.D. = S.Em. \times \sqrt{2} \times \text{'t'}$$

Where,

't'= Table value of 't' at 5 % level of significance and error degree of freedom.

The coefficient of variation (CV) was determined as per under

$$CV\ \% = \frac{\sqrt{\sigma_e^2}}{\bar{X}} \times 100$$

Where,

$\bar{X}$ = Mean of the character

1) Phenotypic Range

It is the difference between maximum value and minimum value in a particular trait.

Range = Maximum value – Minimum value

While comparing the range of different traits, it is necessary to make it unitless. Hence, coefficient of range was calculated as per the following formula:

$$\text{Coefficient of range (\%)} = \frac{\text{Range}}{\text{Maximum value} + \text{Minimum value}} \times 100$$

2) Phenotypic coefficient of variation (PCV %)

The phenotypic coefficient of variation, which measures the magnitude of phenotypic variation present in a particular character, was estimated as per the formula suggested by Burton (1952).

$$PCV\ (\%) = \frac{\sqrt{\sigma_p^2}}{\bar{X}} \times 100$$

Where,

PCV (%) = Phenotypic coefficient of variation

σ_p^2 = Phenotypic variance

$\bar{X}$ = Mean of the character

3) Genotypic coefficient of variation (GCV %)

The genotypic coefficient of variation, which measures the magnitude of genotypic variation present in a particular character, was estimated as per the formula suggested by Burton (1952).

$$\text{GCV (\%)} = \frac{\sqrt{\sigma_g^2}}{\bar{X}} \times 100$$

Where,

GCV (%) = Genotypic coefficient of variation

σ_g^2 = Genotypic variance

$\bar{X}$ = Mean of the character

The GCV and PCV values were classified as described by Sivasubramanian and Menon (1973).

GCV and PCV values (%)	Classification
0-10	Low
10- 20	Medium
20 and above	High

4) Heritability (Broad sense)(h_{bs}^2)

Heritability in broad sense, which is the ratio of genotypic variance (σ_g^2) and phenotypic variance (σ_p^2), was calculated by using the formula suggested by Allard (1960).

$$h^2 = \frac{\sigma_g^2}{\sigma_p^2} \times 100$$

Where,

σ_g^2= Genotypic variance

σ_p^2= Phenotypic variance

Heritability estimates were classified into low, medium and high by following Hanson *et al*. (1956).

Heritability (%)	Classification
0-30	Low
30- 60	Medium
60 and above	High

5) Genetic advance (GA)

The expected genetic advance at 5 % selection intensity was estimated by using formula as suggested by Allard (1960).

$$GA = k \times \sigma_p \times h^2_{bs}$$

Where,

GA = Genetic advance under selection

k = Selection differential (value of k at 5 % selection intensity is 2.06)

σ_p = Phenotypic standard deviation

h^2 = Heritability value of the character

6) Genetic advance % of mean (GAM %)

The genetic advance expressed as per cent of mean was calculated as under:

$$\text{Genetic advance as per cent of mean} = \frac{\text{Genetic advance (GA)}}{\text{Mean of character }(\bar{X})} \times 100$$

The classification of expected genetic advance as per cent of mean was computed as described by Johnson *et al.* (1955).

GAM (%)	Classification
0-10	Low
10- 20	Medium
20 and above	High

3.4.3 Correlation coefficients

Correlation coefficient is the measurement of relationship between two or more series of variables. The genotypic correlation coefficient provides a measure of genotypic association between different characters, while phenotypic correlation includes both genotypic as well as environmental influences.

The phenotypic and genotypic correlation coefficients of all the pair of characters were worked out as per Al- Jibouri *et al.* (1958). The data were subjected to covariance analysis from which different components of mean sum of products were estimated. The format of analysis of covariance is given as under:

Table 3.3. Analysis of covariance between two characters

Source of variation	df	Mean sum of products	Expectations of mean sum of products
Replications	(r-1)	MP_r	--
Genotypes	(g-1)	MP_g	$Cov_{e1.2} + r\ Cov_{g1.2}$
Error	(r-1) (g-1)	MP_e	$Cov_{e1.2}$

Where,

r = Number of replications

g = Number of genotypes

$Cov_{e1.2}$ = Environment covariance between first and second characters

$Cov_{g1.2}$ = Genotypic covariance between first and second characters

1) Genotypic covariance ($Cov_{g1.2}$)

$$Cov_{g1.2} = (MP_g - MP_e)/r$$

Where,

MP_g = Mean sum of products due to genotypes between first and second characters

MP_e = Mean sum of products due to error between first and second characters

r = Number of replications

2) Error covariance ($Cov_{e1.2}$)

$$Cov_{e1.2} = MP_e$$

Where,

MP_e = Mean sum of products due to error between first and second characters.

3) Phenotypic covariance ($Cov_{p1.2}$)

$$Cov_{p1.2} = Cov_{g1.2} + Cov_{e1.2}$$

The genotypic and phenotypic variances and covariances were used for calculating the genotypic and phenotypic correlation coefficients, respectively (Al-Jibouri *et al.*, 1958).

a) Genotypic correlation coefficient ($r_{g\,1.2}$)

$$r_{g\,1.2} = \frac{Cov_{g\,1.2}}{\sqrt{\sigma^2_{g\,1}.\sigma^2_{g\,2}}}$$

Where,

$Cov_{g1.2}$ = Genotypic covariance between first and second characters

σ^2_{g1} = Genotypic variance for first character

σ^2_{g2} = Genotypic variance for second character

b) Phenotypic correlation coefficient ($r_{p\,1.2}$)

$$r_{p\,1.2} = \frac{Cov_{p\,1.2}}{\sqrt{\sigma^2_{p\,1}.\sigma^2_{p\,2}}}$$

Where,

$Cov_{p1.2}$ = Phenotypic covariance between first and second characters

σ^2_{p1} = Phenotypic variance for first character

σ^2_{p2} = Phenotypic variance for second character

c) Test of significance

The significance of the correlation values at (n-2) degrees of freedom was tested by adopting the formula suggested by Panse and Sukhatme (1985) as per below written:

$$t = \frac{r}{\sqrt{1-r^2}} \times \sqrt{n-2}$$

Where,

t = Calculated value of 't'

r = Correlation coefficient

n = Total number of observations

3.4.4 Path coefficient analysis

Path coefficient is a standardized partial regression coefficient and measures the direct and indirect influence of one variable upon another thereby permitting the separation of correlation coefficient into the component of direct and indirect effects. The original concept of path coefficient analysis was given by Smith (1936).

The path coefficient analysis was carried out as per the method suggested by Dewey and Lu (1959). Genotypic and phenotypic correlation coefficients of fourteen variables with pod yield per plant were used to estimate the path coefficients for the direct effects of various independent characters on pod yield per plant.

The path coefficients were obtained by solving simultaneous equation which represents the basic relationship between correlation and path coefficient of the formula given below:

$r_{ny} = P_{ny} + r_{n2y2} + r_{n3y3} + \ldots,\ldots,\ldots, + r_{nx}P_{xy}$

Where,

r_{ny} = Correlation coefficient between one component character and pod yield per plant

P_{ny} = Path coefficient between the character and pod yield per plant

The following correlation matrix was formed,

Matrix-A Matrix-B Matrix-C

$$\begin{pmatrix} r_{1y} \\ r_{2y} \\ r_{3y} \\ , \\ , \\ , \\ r_{ny} \end{pmatrix} = \begin{pmatrix} 1 & r_{12} & r_{13} & \ldots,\ldots,\ldots,\ldots & r_{1n} \\ r_{21} & 1 & r_{23} & \ldots,\ldots,\ldots,\ldots & r_{2n} \\ r_{31} & r_{32} & 1 & \ldots,\ldots,\ldots,\ldots & r_{3n} \\ , & , & , & \ldots\ldots\ldots\ldots\ldots & , \\ , & , & , & \ldots\ldots\ldots\ldots\ldots & , \\ , & , & , & \ldots\ldots\ldots\ldots\ldots & , \\ r_{n1} & r_{n2} & r_{n3} & \ldots\ldots\ldots\ldots\ldots & 1 \end{pmatrix} \begin{pmatrix} P_{y} \\ P_{2y} \\ P_{3y} \\ , \\ , \\ , \\ P_{ny} \end{pmatrix}$$

Where,

r_{12}, r_{21} and so on = Correlation between two component characters

r_{1y}, r_{2y} and so on = Correlation between component characters and pod yield per plant

P_{12}, P_{21} and so on = Path coefficient of character on pod yield per plant.

The technique given by Goulden (1962) was followed for inversion of the ‘B’ matrix using partitioning method of matrix inversion.

Path coefficients (Pij) were obtained as follows:

$$P_{ij} = (B^{-1}) \times (A)$$

The indirect effect for a particular character through other character was obtained by multiplication of direct path and particular correlation coefficient between those two characters, respectively.

Indirect effect = $r_{ij} . P_{ij}$

Where,

$i = 1,\ldots,\ldots,\ldots,\ldots n$

$j = 1,\ldots,\ldots,\ldots,\ldots n$

$P_{ij} = P_{1y} + P_{2y} + \ldots,\ldots,\ldots, + P_{ny}$

The residual variable was computed from the following formula:

$$\text{Residual variable (X)} = 1 - R^2$$

Where,

$R^2 = P_{1y}.r_{1y} + P_{2y}.r_{2y} + \ldots,\ldots,\ldots, + P_{ny}.r_{ny}$

Following scales were used for the rating of path coefficients as per Lenka and Mishra (1973).

Scales	**Classification**
>1.0	Very high
0.30 - 0.99	High
0.20 - 0.29	Moderate
0.10 - 0.19	Low
0.00 – 0.09	Very low

3.4.5 Genotype x Environment interaction and stability parameters

(1) Analysis of variance for G x E interactions

The statistical analysis for genotype x environment interaction and phenotypic stability was carried out according to Eberhart and Russell (1966) for pod yield and its components.

According to Eberhart and Russell (1966), the mean performance of the i^{th} genotype in j^{th} environment, Y_{ij} is defined as

$$Y_{ij} = \mu_i + \beta_i I_j + \delta_{ij}$$

Where,

Y_{ij} = Phenotypic expression of a particular genotype (i) in specific environment (j)

i= 1, 2, ... , g genotypes and j = 1, 2, ... , l environments

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

β_i = Regression coefficient that measures the linear response of the i^{th} genotype to varying environments

I_j = Environment index obtained as the mean of all the genotypes at the j^{th} environment minus the grand mean i.e., [Note that $\Sigma I_j = 0$]

I_j = $(\sum_j Y_{.j} / g) - \sum_j \Sigma Y_{ij} / gl$

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

The model provides means of partitioning the genotype x environment interactions into two parts.

I. The variation due to the response of the i^{th} genotype to varying environmental indices i.e. sum of squares due to regression and

II. The deviation from the linear regression.

The analysis of variance for Eberhart and Russel (1966) model is given in Table 3.4.

Table 3.4. Analysis of variance for G x E interaction as per Eberhart and Russel (1966) model

Source of variation	d.f.	S.S.	M.S.	F
Genotypes (G)	(g-1)	$1/e (\sum_j y^2_i) - (\sum_i \sum_j Y_{ij})^2/gl$	M_1	M_1/M_7
Environments (E)	(l-1)	$1/g \sum_j y^2_i - (\sum_i \sum_j Y_{ij})^2/gl$	M_2	M_2/M_7
G x E	(g-1) (l-1)	$(\sum_i \sum_j Y^2_{ij}) + (\Sigma Y_{ij})^2/ge$ – Envi.S.S.- Geno.S.S.	M_3	M_3/M_7
E + (G x E)	g(l-1)	$(\sum_i \sum_j Y^2_{ij}) - (\Sigma Y_i)^2/l$	M_4	M_4/M_7
E (linear)	1	$(1/g) \sum_j (Y_{.j} l_i)^2 / \sum_j l^2_j$	M_5	M_5/M_7
G x E (linear)	(g-1)	$\sum_i [\sum_j (Yi_j l_i)]^2 / \sum_j l^2_j]$ - Envi.(linear) S.S.	M_6	M_6/M_7
Pooled deviation	g(l-2)	$\sum_i \sum_j \delta^2_{ij}$	M_7	M_7/M_8
Genotype…1	(l-2)	$[\sum_j Y^2_{ij} - (Y_{i.})^2/e] - [(\sum_j Y_{ij} l_i)^2/\sum_j l^2_j]$	-	-
Genotype...g	(l-2)	$[\sum_j Y^2_{gj} - (Y_{g.})^2/e] - [(\sum_j Y_{gj} l_i)^2/\Sigma l^2_j] = \sum_j \delta^2_{gj}$	-	-
Pooled error	l(g-1) (r-1)	S^2_e	M_8	-

Where,

r = number of replications,

g = number of genotypes,

l = number of environments,

l_j = environmental index,

Y_{ij} = mean of the i^{th} genotype over replications in j^{th} environment

The term S^2_e represents mean square due to pooled error such that,

$$\sigma^2_e = [\sum_j \sigma^2_j / r(r-1)(g-1)] / lr$$

Where, σ^2_j = Error sum of square at j^{th} environment (j = 1, 2, . . .l)

r = Number of replications within each environment

g = Number of genotypes

Error variances were assumed to be homogenous for all the genotypes over environments and thus do not influence the ranking of varieties or various stability parameters.

For the 'F' test, the mean square due to pooled deviation (M_7) was first tested against pooled error (M_8). The appropriate 'F' test for testing the significance of difference among genotypic means was obtained as

$$F \cong M_1 / M_7$$

and the hypothesis that there is no genetic difference among genotypes for the regression of their means on environment indices can also be tested approximately by 'F' test

$H_0 = B_1 = B_2 = \ldots\ldots = B_g$ can be tested by

$$F = M_2 / M_7$$

(2) Estimation of stability parameters

According to Eberhart and Russell (1966), the ideal genotype is one which has high mean **(** $\bar{X}_i$**)**, unit regression coefficient (b_i=1) and the least deviation from regression (S^2d_i=0).

The following stability parameters were calculated for each genotype as under:

(i) Mean ($\bar{X}$): The mean value of i^{th} genotype over all environments

$$= \sum_j Y_{ij} / l$$

(ii) Regression coefficient (b) = Regression of Y_{ij} on I_j

The regression coefficient (b_i) is the regression of the performance of each genotype under different environments on the environmental means over all the genotypes.

$$= \sum_j Y_{ij} I_j / \sum (I^2_j)$$

Where,

I_j = Environment index = $\bar{X}_{.j} - \bar{X}_{..}$ such that $\sum I_j = 0$

Where,

$\overline{X}_{.j}$ = Environmental mean

$\overline{X}_{..}$ = Grand mean = $\sum_i \sum_j Y_{ij} / gl$

The appropriate test for the mean squares due to individual b_i values was obtained as:

To test b_i when deviate from "0" : $t = b_i / SE(b_i)$

To test b_i when deviate from "1" : $t = (1 - b_i) / SE(b_i)$

This value is compared with table 't' value at $g \cdot (l - 2)$ degrees of freedom for testing significance at 5 and 1 % levels, respectively.

Where,

$SE(b_i)$ = Standard error of b_i

$$SE(b_i) = \sqrt{[\sum_j \delta^2_{ij} / (l-2)] / [\sum_j (I^2_j)]}$$

(iii)Deviation from regression (S^2_{di})

Non-linear component of stability can be estimated as under:

$$\mathbf{S^2d_i = [\sum_j \delta^2_{ij} / (l-2)] - \sigma^2_e}$$

The appropriate test of significance for deviation from regression of each genotype was provided by the following formula.

$$\mathbf{F \cong [\sum_j \delta^2_{ij} / (l-2)] / \sigma^2_e]}$$

The calculated 'F' values of each genotype were compared with table values of 'F' at (l – 2) and pooled error degrees of freedom.

CHAPTER – IV

EXPERIMENTAL RESULTS

The experimental results presented in this chapter comprised of different aspects undertaken during the present investigation on "Genetic variability, character association and stability analysis in Virginia bunch groundnut (*Arachis hypogaea* L.)" These aspects are:

4.1 Analysis of variance

4.2 Genetic variability

4.3 Correlation coefficients

4.4 Path coefficient analysis

4.5 Stability parameters

4.1 ANALYSIS OF VARIANCE

The data obtained for 15 characters from both the locations Junagadh (E_1: *Kharif*-2019 and E_2: *Kharif*-2020) and Manavadar (E_3: *Kharif*-2019 and E_4: *Kharif*-2020) were subjected to Randomized Block Design statistical analysis. Results revealed that mean squares due to fifty genotypes of Virginia bunch groundnut were highly significant for all the characters studied in both the locations and years indicating presence of high genetic variability among the genetic material tested in the experiment. The mean squares due to various sources of variation with regards to different traits are presented in Table 4.1 to 4.4.

4.2 GENETIC VARIABILITY PARAMETERS

The results obtained on various parameters of genetic variability are presented as under:

4.2.1 Mean performance and range of variation

The mean values of fifty genotypes of Virginia bunch groundnut for all the fifteen characters studied at Junagadh (E_1 and E_2) and Manavadar (E_3 and E_4) during *Kharif*-2019 and *Kharif*-2020 along with standard error of mean (S.Em.), critical difference (C.D.) and coefficient of variation (C.V. %) are given in Appendix V. The summary is also presented in Table 4.5 to 4.8.

Table 4.1: Analysis of variance showing mean squares for various characters in 50 genotypes of groundnut at Junagadh during *Kharif*-2019 (E_1)

		Junagadh, *Kharif*-2019 (E_1)							
Source	**d. f.**	**Days to 50 % flowering**	**Days to maturity**	**No. of primary branches per plant**	**No. of secondary branches per plant**	**Plant height (cm)**	**No. of matured pods per plant**	**No. of immature pods per plant**	**Sound mature kernel (%)**
Replications	2	4.88	0.85	0.15	0.04	12.70	3.27	0.03	3.30
Genotypes	49	20.71**	9.45**	1.13**	4.25**	50.88**	64.81**	4.63**	149.56**
Error	98	2.12	3.91	0.15	0.12	5.89	3.54	0.12	5.64

Source	**d. f.**	**100-kernel weight (g)**	**Shelling out-turn (%)**	**Pod yield per plant (g)**	**Kernel yield per plant (g)**	**Biological yield per plant (g)**	**Harvest index (%)**	**Oil content (%)**
Replications	2	6.77	1.95	3.90	2.09	6.04	6.33	0.01
Genotypes	49	199.36**	59.04**	50.14**	27.25**	200.56**	121.51**	13.62**
Error	98	5.97	6.85	4.65	2.48	13.10	11.53	0.52

***, ** Significant at 5 % and 1 % levels, respectively**

Table 4.2: Analysis of variance showing mean squares for various characters in 50 genotypes of groundnut at Junagadh during *Kharif*-2020 (E_2)

		Junagadh, *Kharif*-2020 (E_2)							
Source	**d. f.**	**Days to 50 % flowering**	**Days to maturity**	**No. of primary branches per plant**	**No. of secondary branches per plant**	**Plant height (cm)**	**No. of matured pods per plant**	**No. of immature pods per plant**	**Sound mature kernel (%)**
Replications	2	4.01	3.21	0.15	0.04	13.55	0.11	0.12	21.22
Genotypes	49	17.26**	14.32**	1.52**	3.18**	52.84**	50.39**	8.37**	136.74**
Error	98	1.58	3.34	0.17	0.15	8.13	4.36	0.27	7.01

Source	**d. f.**	**100-kernel weight (g)**	**Shelling out-turn (%)**	**Pod yield per plant (g)**	**Kernel yield per plant (g)**	**Biological yield per plant (g)**	**Harvest index (%)**	**Oil content (%)**
Replications	2	2.20	0.22	2.26	0.94	0.19	10.18	0.08
Genotypes	49	154.36**	82.98**	39.99**	20.58**	230.93**	112.73**	10.96**
Error	98	2.70	6.71	3.67	1.91	25.04	9.62	0.51

***, ** Significant at 5 % and 1 % levels, respectively**

Table 4.3: Analysis of variance showing mean squares for various characters in 50 genotypes of groundnut at Manavadar during *Kharif*-2019 (E_3)

Manavadar, *Kharif*-2019 (E_3)									
Source	**d. f.**	**Days to 50 % flowering**	**Days to maturity**	**No. of primary branches per plant**	**No. of secondary branches per plant**	**Plant height (cm)**	**No. of matured pods per plant**	**No. of immature pods per plant**	**Sound mature kernel (%)**
Replications	2	0.05	3.73	0.01	0.20	0.76	1.95	0.63	20.16
Genotypes	49	24.10**	8.83**	1.35**	2.61**	36.60**	45.48**	6.74**	138.70**
Error	98	2.22	4.69	0.17	0.13	9.46	3.12	0.21	9.15

Source	**d. f.**	**100-kernel weight (g)**	**Shelling out-turn (%)**	**Pod yield per plant (g)**	**Kernel yield per plant (g)**	**Biological yield per plant (g)**	**Harvest index (%)**	**Oil content (%)**
Replications	2	2.54	0.18	0.17	0.02	9.80	11.27	0.04
Genotypes	49	152.19**	47.87**	53.99**	27.15**	239.55**	101.58**	8.67**
Error	98	1.85	9.40	2.89	1.62	19.86	10.00	0.51

***, ** Significant at 5 % and 1 % levels, respectively**

Table 4.4: Analysis of variance showing mean squares for various characters in 50 genotypes of groundnut at Manavadar during *Kharif*-2020 (E_4)

Manavadar, *Kharif*-2020 (E_4)									
Source	**d. f.**	**Days to 50 % flowering**	**Days to maturity**	**No. of primary branches per plant**	**No. of secondary branches per plant**	**Plant height (cm)**	**No. of matured pods per plant**	**No. of immature pods per plant**	**Sound mature kernel (%)**
Replications	2	1.14	6.08	0.23	0.03	1.95	2.17	0.02	20.13
Genotypes	49	14.34**	9.82**	1.22**	2.66**	43.25**	38.32**	3.78**	122.15**
Error	98	1.68	5.49	0.15	0.17	7.65	2.83	0.23	8.11

Source	**d. f.**	**100-kernel weight (g)**	**Shelling out-turn (%)**	**Pod yield per plant (g)**	**Kernel yield per plant (g)**	**Biological yield per plant (g)**	**Harvest index (%)**	**Oil content (%)**
Replications	2	2.80	1.12	3.81	1.96	47.99	17.00	0.94
Genotypes	49	124.42**	56.93**	38.02**	18.15**	127.59**	97.64**	9.18**
Error	98	2.75	9.19	3.54	1.91	17.32	9.23	0.95

***, ** Significant at 5 % and 1 % levels, respectively**

4.2.1.1 Days to 50 % flowering

In case of environment E_1 (Junagadh, *Kharif*-2019), the range for days to 50 % flowering was observed from 23.33 days (JVB-2494) to 35.00 days (JVB-LS-2507). The genotype JVB-2494 (23.33 days) found the earliest in days to 50 % flowering followed by JVB-2526 (24.00 days) and JVB-2518 (25.00 days). The genotype JVB-LS-2507 (35.00 days) was late for days to 50 % flowering followed by JVB-2528 (34.00 days) and JVB-2512, JVB-2520 & Kaushal (33.00 days). The coefficient of range was 20.00 %. The overall mean for days to 50% flowering was 29.36 days (Table 4.5 and Appendix V).

In *Kharif*-2020 at Junagadh (E_2) days to 50 % flowering was ranged from 24.67 days (JVB-2494) to 34.67 days (JVB-2519). The genotype JVB-2494 (24.67 days) was earliest in days to 50 % flowering followed by JVB-2518 & JVB-2533 (25.33 days) and JVB-2534 (25.67 days). The genotype JVB-2519 (34.67 days) was late for 50 % flowering followed by JSSP-63 (34.33 days) and JVB-LS-2506 (34.00 days). The coefficient of range was 16.85 %. The overall mean for days to 50 % flowering was 28.97 days (Table 4.6 and Appendix V).

In *Kharif*-2019 at Manavadar (E_3), again the same genotype JVB-2494 registered the lowest 25.33 number of days to 50 % flowering followed by JVB-2518 (26.00 days) and JVB-2526 & GG-20 (27.67 days). The highest number of days (38.00 days) was taken by genotype JVB-2528 followed by JVB-LS-2507 (36.67 days) and JSSP-63 as well as Kaushal (36.00 days). The coefficient of range was 20.00 %. The overall mean for days to 50 % flowering was 32.07 days (Table 4.7 and Appendix V).

At Manavadar during *Kharif*-2020 (E_4) days to 50 % flowering was ranged from 25.00 days (JVB-2494) to 34.67 days (JVB-LS-2507). The genotype JVB-2494 (25.00 days) was earliest in days to 50 % flowering followed by JVB-2518 & JVB-2526 (25.67 days) and JVB-2534 (26.00 days). The genotype JVB-LS-2507 (34.67 days) was the highest for days to 50% flowering followed by JVB-2519 & JVB-2528 (33.00 days) and JSSP-63, JVB-LS-2506, JVB-2512 & JVB-2520 (32.67 days). The coefficient of range was 16.20 %. The overall mean for days to 50 % flowering was 29.40 days (Table 4.8 and Appendix V).

On the basis of pooled genotype JVB-2494 (24.58 days) was earliest in days to 50 % flowering followed by JVB-2518 (25.50 days) and JVB-2526 (26.00 days). The genotype JVB-LS-2507 (34.92 days) was the highest for days to 50 % flowering followed by JVB-2528 (34.33 days) and JSSP-63 (33.75 days). The overall mean for days to 50 % flowering on the basis of pooled was 29.95 days (Appendix V).

4.2.1.2 Days to maturity

Mean values of days to maturity in *Kharif*-2019 at Junagadh (E_1) ranged from 117.00 days (GG-20) to 124.00 days (BAU-13). The coefficient of range was 2.90 %. The genotype GG-20 (117.00 days) was the earliest in maturity followed by JVB-2508 & Kaushal (117.33 days) and JVB-2518, JVB-2521 & JVB-2529 (117.67 days). The genotype BAU-13 (124.00 days) took maximum days to mature followed by JVB-LS-2507, JVB-2513 & JVB-2520 (123.00 days) and JVB-2523, JVB-2527 & JVB-2528 (122.33 days). The overall mean for days to maturity was 120.27 days (Table 4.5 and Appendix V).

In *Kharif*-2020 at Junagadh (E_2) days to maturity was ranged from 116.00 days (JVB-2533) to 123.67 days (JSSP-63). The coefficient of range was 3.20 % and overall mean for days to maturity was 119.81 days. The genotypes JVB-2533 (116.00 days) was the earliest in maturity followed by JVB-2530 (116.33 days) and JVB-LS-2505, JVB-2513 & JVB-2534 (117.00 days). The genotype JSSP-63 (123.67 days) had taken comparatively long time to mature followed by JVB-LS-2506 (123.33 days) and JVB-2515 (123.00 days) (Table 4.6 and Appendix V).

Mean values of days to maturity in *Kharif*-2019 at Manavadar (E_3) ranged from 117.00 days (JVB-2529, GG-20) to 124.33 days (JSSP-63). The coefficient of range was 3.04 %. The genotypes JVB-2529 & GG-20 (117.00) was the earliest in maturity followed by Kaushal (118.00 days) and JVB-2521 (118.67 days). The genotype JSSP-63 (124.33 days) was the late in maturity followed by JSSP-60 (124.00 days) and JSSP-LS-2507 (123.67 days). The overall mean for days to maturity was 121.01 days (Table 4.7 and Appendix V).

In *Kharif*-2020 at Manavadar (E_4) days to maturity was ranged from 116.33 days (JVB-2533) to 123.33 days (JSSP-63). The coefficient of range was 2.92 % and overall mean for days to maturity was 120.08 days. The genotypes JVB-2533 (116.33 days) was the earliest in maturity followed by JVB-2531, JVB-2534 & GG-20 (117.33 days) and JVB-2513 & JVB-2530 (117.67 days). The genotype JSSP-63 (123.33 days) was taken comparatively long time to mature followed by JVB-LS-2506 & JVB-2517 (123.00 days) and JVB-2515, JVB-2528 & BAU-13 (122.33 days) (Table 4.8 and Appendix V).

On the basis of pooled genotype GG-20 (117.17 days) was earliest in days to maturity followed by JVB-2533 (117.50 days) and JVB-2508 (118.17 days). The genotype JSSP-63 (123.00 days) was late in days to maturity followed by BAU-13 (122.83 days) and JVB-2523 (122.42 days). The overall mean for days to maturity on the basis of pooled was 120.30 days (Appendix V).

4.2.1.3 Number of primary branches per plant

The mean values for numbers of primary branches per plant exhibited 27.27 % coefficient of range in E_1. The genotype JVB-2509 (6.07) had the maximum numbers of primary branches per plant followed by JVB-2532 (6.00) and JVB-2528 (5.87). The genotype BAU-13 (3.47) had lowest mean value for this character followed by JVB-2515 (3.73) and JVB-2517 (3.87). The overall mean for this character was 4.84 (Table 4.5 and Appendix V).

The mean values for numbers of primary branches per plant exhibited 29.17 % coefficient of variation in E_2. The genotype JVB-2509 (6.20) had the maximum numbers of primary branches per plant followed by JVB-2534 (6.13) and JVB-2532 (6.07). The genotype BAU-13 (3.40) had the lowest mean value for this character followed by JVB-2515 & JVB-2489 (3.47) and JVB-2508 (3.73). The overall mean for this character was 4.80 (Table 4.6 and Appendix V).

In *Kharif*-2019 at Manavadar (E_3), coefficient of range was 28.67 % with mean value 4.79. The genotype JVB-2509 & JVB-2532 (6.13) had the maximum numbers of primary branches per plant followed by JVB-2534 (5.87) and JVB-2528 (5.80). The genotype JVB-2515 & JVB-2508 (3.40) had lowest mean value for this character followed by JVB-2519 & JSSP-60 (3.53) and BAU-13 (3.67) (Table 4.7 and Appendix V).

In case of E_4 environment, coefficient of range was 30.00 % with a mean value of 4.74. The genotype JVB-2534 (6.07) had the maximum numbers of primary branches per plant followed by JVB-2528 (6.00) and JVB-2532 (5.87). The genotype BAU-13 (3.27) had lowest mean value for this character followed by JSSP-60 (3.40) and JVB-2515 (3.60) (Table 4.8 and Appendix V).

Table 4.5: Phenotypic range, coefficient of range, mean ± S.Em, phenotypic and genotypic coefficients of variation, heritability (Broad sense), genetic advance and genetic advance expressed as percentage of mean for various characters in 50 genotypes of groundnut at Junagadh during *Kharif*-2019 (E_1)

Character	Phenotypic range of variation	Coefficient of range (%)	Mean ± S.Em	Genotypic coefficient of variation (%)	Phenotypic coefficient of variation (%)	Heritability (Broad sense) (%)	Genetic advance	Genetic advance expressed as percent of mean
Days to 50 % flowering	23.33-35.00	20.00	29.36 ± 0.84	8.48	8.95	89.70	4.86	16.54
Days to maturity	117.00-124.00	2.90	120.27 ± 1.14	1.13	1.48	58.70	2.15	1.78
No. of primary branches per plant	3.47-6.07	27.27	4.84 ± 0.22	11.83	12.68	87.00	1.10	22.72
No. of secondary branches per plant	8.20-12.33	20.13	9.87 ± 0.20	11.89	12.06	97.20	2.38	24.14
Plant height (cm)	25.49-45.78	28.47	34.24 ± 1.40	11.31	12.03	88.40	7.50	21.91
No. of matured pods per plant	8.13-25.07	51.00	16.12 ± 1.09	28.04	28.84	94.50	9.05	56.16
No. of immature pods per plant	2.67-8.07	50.31	4.51 ± 0.20	27.18	27.55	97.40	2.49	55.26
Sound mature kernel (%)	63.46-92.32	18.53	80.67 ± 1.37	8.59	8.75	96.20	14.00	17.35
100-kernel weight (g)	23.60-59.57	43.24	41.30 ± 1.41	19.44	19.74	97.00	16.29	39.44
Shelling out-turn (%)	55.43-76.24	15.80	68.25 ± 1.51	6.11	6.50	88.40	8.08	11.84
Pod yield per plant (g)	8.41-23.35	47.02	15.06 ± 1.24	25.86	27.15	90.70	7.64	50.75
Kernel yield per plant (g)	5.70-16.98	49.73	10.31 ± 0.91	27.86	29.22	90.90	5.65	54.73
Biological yield per plant (g)	28.10-63.06	38.34	40.85 ± 2.09	19.35	20.02	93.50	15.74	38.54
Harvest index (%)	25.66-52.44	34.29	36.72 ± 1.96	16.49	17.33	90.50	11.87	32.32
Oil content (%)	46.11-55.18	8.95	50.66 ± 0.42	4.13	4.21	96.20	4.22	8.33

Table 4.6: Phenotypic range, coefficient of range, mean ± S.Em, phenotypic and genotypic coefficients of variation, heritability (Broad sense), genetic advance and genetic advance expressed as percentage of mean for various characters in 50 genotypes of groundnut at Junagadh during *Kharif*-2020 (E_2)

Character	Phenotypic range of variation	Coefficient of range (%)	Mean ± S.Em	Genotypic coefficient of variation (%)	Phenotypic coefficient of variation (%)	Heritability (Broad sense) (%)	Genetic advance	Genetic advance expressed as percent of mean
Days to 50 % flowering	24.67-34.67	16.85	28.97 ± 0.73	7.89	8.28	90.80	4.49	15.49
Days to maturity	116.00-123.67	3.20	119.81 ± 1.05	1.60	1.82	76.70	3.45	2.88
No. of primary branches per plant	3.40-6.20	29.17	4.80 ± 0.23	14.03	14.85	89.20	1.31	27.28
No. of secondary branches per plant	8.33-12.20	18.83	9.71 ± 0.23	10.34	10.60	95.20	2.02	20.78
Plant height (cm)	25.75-45.59	27.81	33.75 ± 1.65	11.44	12.44	84.60	7.32	21.67
No. of matured pods per plant	8.60-25.20	49.11	16.19 ± 1.21	24.20	25.32	91.30	7.71	47.64
No. of immature pods per plant	2.07-9.00	62.65	4.46 ± 0.30	36.87	37.47	96.80	3.33	74.72
Sound mature kernel (%)	62.93-90.12	17.77	78.54 ± 1.53	8.37	8.60	94.90	13.20	16.80
100-kernel weight (g)	24.38-55.55	39.00	39.36 ± 0.95	18.06	18.22	98.20	14.52	36.88
Shelling out-turn (%)	53.33-76.46	17.82	68.68 ± 1.50	7.34	7.66	91.90	9.96	14.50
Pod yield per plant (g)	8.34-23.20	47.11	15.31 ± 1.11	22.73	23.85	90.80	6.83	44.61
Kernel yield per plant (g)	5.92-15.70	45.22	10.52 ± 0.80	23.72	24.90	90.70	4.89	46.53
Biological yield per plant (g)	27.21-65.50	41.30	41.94 ± 2.89	19.75	20.92	89.20	16.11	38.42
Harvest index (%)	27.37-52.37	31.35	36.77 ± 1.79	15.94	16.67	91.50	11.55	31.41
Oil content (%)	45.38-54.23	8.88	50.42 ± 0.41	3.70	3.79	95.30	3.75	7.45

Table 4.7: Phenotypic range, coefficient of range, mean ± S.Em, phenotypic and genotypic coefficients of variation, heritability (Broad sense), genetic advance and genetic advance expressed as percentage of mean for various characters in 50 genotypes of groundnut at Manavadar during *Kharif*-2019 (E_3)

Character	Phenotypic range of variation	Coefficient of range (%)	Mean ± S.Em	Genotypic coefficient of variation (%)	Phenotypic coefficient of variation (%)	Heritability (Broad sense) (%)	Genetic advance	Genetic advance expressed as percent of mean
Days to 50 % flowering	25.33-38.00	20.00	32.07 ± 0.86	8.42	8.84	90.80	5.30	16.53
Days to maturity	117.00-124.33	3.04	121.01 ± 1.25	0.97	1.42	46.90	1.66	1.37
No. of primary branches per plant	3.40-6.13	28.67	4.79 ± 0.24	13.08	14.01	87.10	1.21	25.14
No. of secondary branches per plant	8.27-11.53	16.50	9.55 ± 0.21	9.51	9.76	94.90	1.82	19.09
Plant height (cm)	22.87-40.72	28.08	28.92 ± 1.78	10.40	12.08	74.10	5.34	18.45
No. of matured pods per plant	8.13-22.60	47.07	14.40 ± 1.02	26.10	27.04	93.10	7.47	51.89
No. of immature pods per plant	2.07-8.20	59.74	4.13 ± 0.27	35.76	36.33	96.80	2.99	72.48
Sound mature kernel (%)	61.15-88.37	18.21	76.47 ± 1.75	8.59	8.89	93.40	13.08	17.11
100-kernel weight (g)	28.34-59.36	35.38	39.10 ± 0.79	18.11	18.22	98.80	14.49	37.07
Shelling out-turn (%)	57.32-74.45	13.00	69.03 ± 1.77	5.19	5.79	80.40	6.61	9.58
Pod yield per plant (g)	7.44-22.48	50.28	14.50 ± 0.98	28.47	29.26	94.60	8.27	57.05
Kernel yield per plant (g)	4.96-15.78	52.16	10.02 ± 0.74	29.11	30.02	94.00	5.83	58.14
Biological yield per plant (g)	23.21-66.22	48.09	39.45 ± 2.57	21.69	22.65	91.70	16.88	42.79
Harvest index (%)	27.37-51.97	31.00	36.64 ± 1.83	15.08	15.88	90.20	10.81	29.50
Oil content (%)	47.24-54.21	6.87	50.44 ± 0.41	3.27	3.37	94.10	3.30	6.53

Table 4.8: Phenotypic range, coefficient of range, mean ± S.Em, phenotypic and genotypic coefficients of variation, heritability (Broad sense), genetic advance and genetic advance expressed as percentage of mean for various characters in 50 genotypes of groundnut at Manavadar during *Kharif*-2020 (E_4)

Character	Phenotypic range of variation	Coefficient of range (%)	Mean ± S.Em	Genotypic coefficient of variation (%)	Phenotypic coefficient of variation (%)	Heritability (Broad sense) (%)	Genetic advance	Genetic advance expressed as percent of mean
Days to 50 % flowering	25.00-34.67	16.20	29.40 ± 0.75	6.99	7.44	88.30	3.98	13.52
Days to maturity	116.33-123.33	2.92	120.08 ± 1.35	1.00	1.51	44.10	1.64	1.37
No. of primary branches per plant	3.27-6.07	30.00	4.74 ± 0.23	12.54	13.42	87.30	1.14	24.13
No. of secondary branches per plant	8.33-12.07	18.30	9.72 ± 0.23	9.38	9.69	93.80	1.82	18.71
Plant height (cm)	22.22-38.20	26.44	29.23 ± 1.60	11.78	12.99	82.30	6.44	22.02
No. of matured pods per plant	8.27-22.40	46.09	13.48 ± 0.97	25.52	26.52	92.60	6.82	50.59
No. of immature pods per plant	2.13-7.80	57.05	3.93 ± 0.28	27.69	28.59	93.80	2.17	55.23
Sound mature kernel (%)	61.14-88.47	18.26	75.66 ± 1.64	8.15	8.43	93.40	12.27	16.22
100-kernel weight (g)	26.48-53.34	33.66	39.06 ± 0.96	16.30	16.49	97.80	12.97	33.21
Shelling out-turn (%)	54.36-74.48	15.62	67.78 ± 1.75	5.89	6.43	83.80	7.52	11.10
Pod yield per plant (g)	8.38-23.44	47.34	14.61 ± 1.09	23.20	24.36	90.70	6.65	45.51
Kernel yield per plant (g)	5.79-15.10	44.59	9.90 ± 0.80	23.51	24.85	89.50	4.53	45.82
Biological yield per plant (g)	29.43-59.31	33.67	40.31 ± 2.40	15.04	16.18	86.40	11.61	28.80
Harvest index (%)	26.28-52.33	33.14	36.11 ± 1.75	15.04	15.80	90.60	10.64	29.47
Oil content (%)	46.31-54.17	7.82	50.51 ± 0.56	3.28	3.46	89.60	3.23	6.39

On the basis of pooled genotype JVB-2532 (6.02) had the maximum numbers of primary branches per plant followed by JVB-2534 (5.97) and JVB-2528 (5.93). The genotype BAU-13 (3.45) had lowest mean value for this character followed by JVB-2515 (3.55) and JSSP-60 (3.68). The overall mean for number of primary branches per plant on the basis of pooled was 4.79 (Appendix V).

4.2.1.4 Number of secondary branches per plant

The mean values for numbers of secondary branches per plant exhibited 20.13 % coefficient of range in E_1. The genotype JVB-2532 (12.33) had the maximum numbers of secondary branches per plant followed by JVB-2509 (12.27) and JVB-2508 (12.20). The genotype JVB-2518 (8.20) had lowest mean value for this character followed by JVB-2524 (8.33) and JVB-2453, JVB-2494, JVB-2517 & JVB-2529 (8.47). The overall mean for this character was 9.87 (Table 4.5 and Appendix V).

The mean values for numbers of secondary branches per plant exhibited 18.83 % coefficient of variation in E_2. The genotype JVB-2528 (12.20) had the maximum numbers of secondary branches per plant followed by JVB-2508 (11.93) and JVB-2509 (11.87). The genotype JVB-2489 (8.33) had the lowest mean value for this character followed by JVB-2515 (8.40) and JVB-2483 (8.47). The overall mean for this character was 9.71 (Table 4.6 and Appendix V).

In *Kharif*-2019 at Manavadar (E_3), coefficient of range was 16.50 % with mean value 9.55. The genotype JVB-2528 (11.53) had the maximum numbers of secondary branches per plant followed by JVB-2508 (11.33) and JVB-2509 (11.20). The genotype JVB-2515 (8.27) had lowest mean value for this character followed by JVB-2520 (8.40) and JSSP-62, JVB-2489, JVB-2530 & GG-HPS-2 (3.47) (Table 4.7 and Appendix V).

In case of E_4 environment, coefficient of range was 18.30 % with a mean value of 9.72. The genotype JVB-2528 (12.07) had the maximum numbers of secondary branches per plant followed by JVB-2509 (11.60) and JVB-2508 & JVB-2532 (11.20). The genotype JSSP-60, JVB-LS-2507, JVB-2515 & BAU-13 (8.33) had lowest mean value for this character followed by JVB-LS-2501 (8.40) and ICGV-86564 (8.60) (Table 4.8 and Appendix V).

On the basis of pooled genotype JVB-2528 (11.97) had the maximum numbers of secondary branches per plant followed by JVB-2509 (11.73) and JVB-2508 (11.67). The genotype JVB-2515 (8.52) had lowest mean value for this character followed by BAU-13 (8.60) and JVB-2518 (8.68). The overall mean for number of secondary branches per plant on the basis of pooled was 9.71 (Appendix V).

4.2.1.5 Plant height (cm)

The mean values of plant height varied from 25.49 cm (JVB-2515) to 45.78 cm (JVB-LS-2436) in case of E_1. The genotype JVB-LS-2436 (45.78 cm) was found the tallest followed by JVB-LS-2506 (43.67 cm) and JVB-2517 (42.31 cm). The genotype JVB-2515 (25.49 cm) registered the shortest plant height followed by JVB-2529 (27.79 cm) and GG-HPS-2 (28.27 cm). The coefficient of range was 28.47 %. The overall mean for plant height was 34.27 cm (Table 4.5 and Appendix V).

The mean values of plant height ranged from 25.75 cm (JVB-2515) to 45.59 cm (JVB-2494) in case of E_2. The genotype JVB-2494 (45.59 cm) was the tallest among the fifty genotypes followed by JVB-2489 (43.05 cm) and JVB-2524 (42.11 cm). The genotype JVB-2515 (25.75 cm) has recorded the shortest plant height followed by JVB-2522 (28.30 cm) and JVB-2528 (28.91 cm). The coefficient of range for this character was 27.81 %. The overall mean for the plant height was 33.75 cm (Table 4.6 and Appendix V).

The mean values of plant height varied from 22.87 (JVB-2515) to 40.72 cm (JVB-2513) in case of E_3. The genotype JVB-2513 (40.72 cm) had the tallest plant height followed by JSSP-LS-61 (38.36 cm) and JVB-2509 (35.33 cm). The genotype JVB-2515 (22.87 cm) had shortest plant height followed by JSSP-63 (23.61 cm) and JVB-2524 (24.12 cm). The coefficient of range was 28.08 %. The overall mean for plant height was 28.92 cm (Table 4.7 and Appendix V).

The mean values of plant height ranged from 22.22 cm (JVB-2517) to 38.20 cm (JVB-2513) in case E_4. The genotype JVB-2513 (38.20 cm) was tallest among the fifty genotypes studied followed by JVB-2509 (37.41 cm) and JSSP-LS-61 (36.20 cm). The genotype JVB-2517 (22.22 cm) had the shortest plant height followed by JVB-2523 (23.19 cm) and JVB-LS-2502 (23.86 cm). The coefficient of range and mean value of this trait were 26.44 % and 29.23 cm, respectively (Table 4.8 and Appendix V).

Examination of pooled results indicated that the genotype JVB-2514 (37.56 cm) was tallest among the fifty genotypes studied followed by JSSP-LS-61 (36.90 cm) and JVB-2513 (36.89 cm). The genotype JVB-2515 (24.70 cm) had the shortest plant height followed by JVB-2522 (28.28 cm) and JSSP-60 (28.37 cm). The overall mean for plant height on the basis of pooled was 31.53 (Appendix V).

4.2.1.6 Number of matured pods per plant

The mean for number of matured pods per plant ranged from 8.13 (JVB-LS-2502) to 25.07 (JVB-2516) in case of E_1. The genotype JVB-2516 (25.07) showed the maximum number of matured pods per plant followed by JVB-2510 (24.00) and JVB-2509 (23.80). The genotype JVB-LS-2502 (8.13) had the minimum number of matured pods per plant followed by JVB-2453 (8.40) and JSSP-59 (8.53). The coefficient of range for the trait was 51.00 %. The overall mean for number of matured pods per plant was 16.12 (Table 4.5 and Appendix V).

The mean for number of matured pods per plant ranged from 8.60 (JVB-2515) to 25.20 (JVB-2534) in case of E_2. The genotype JVB-2534 (25.20) showed the maximum number of matured pods per plant followed by JVB-2532 (24.60) and JVB-2528 (24.27). The genotype JVB-2515 (8.60) had the minimum number of matured pods per plant followed by JVB-LS-2505 (9.67) and JSSP-63 (10.20). The coefficient of range for the trait was 49.11 %. The overall mean for number of matured pods per plant was 16.19 (Table 4.6 and Appendix V).

The mean for number of matured pods per plant ranged from 8.13 (JVB-2513) to 22.60 (JVB-2532) in case of E_3. The genotype JVB-2532 (22.60) showed the maximum number of matured pods per plant followed by JVB-2516 (22.33) and JVB-2528 (21.47). The genotype JVB-2513 (8.13) had the minimum number of matured pods per plant followed by JVB-2515 (8.40) and GG-HPS-2 (9.13). The coefficient of range for the trait was 47.07 % with overall mean 14.40 (Table 4.7 and Appendix V).

Under E_4, the genotype JVB-2516 (22.40) showed the maximum number of matured pods per plant followed by JVB-2508 (21.47) and JVB-2532 (21.40). The genotype JVB-LS-2501 (8.27) had the minimum number of matured pods per plant followed by JVB-2453 & JVB-LS-2505 (8.40) and JVB-LS-2502 (9.27). The coefficient of range for the trait was 46.09 %. The overall mean for number of matured pods per plant was 13.48 (Table 4.8 and Appendix V).

In overall results (pooled results), genotype JVB-2516 (23.23) showed the maximum number of matured pods per plant followed by JVB-2532 (22.77) and JVB-2528 (22.28). The genotype JVB-2515 (9.30) had the minimum number of matured pods per plant followed by JVB-LS-2505 (9.57) and JVB-2453 (9.97). The overall mean for number of matured pods per plant on the basis of pooled was 15.05 (Appendix V).

4.2.1.7 Number of immature pods per plant

The mean for number of immature pods per plant ranged from 2.67 (JVB-LS-2505) to 8.07 (JVB-2519) in case of E_1. The genotype JVB-LS-2505 (2.67) showed the minimum number of immature pods per plant followed by JVB-2513 & ICGV-86564

(2.87) and JVB-2489 (3.00). The genotype JVB-2519 (8.07) had the maximum number of immature pods per plant followed by JVB-2520 (7.73) and JVB-2508 (6.93). The coefficient of range for the trait was 50.31 %. The overall mean for number of immature pods per plant was 4.51 (Table 4.5 and Appendix V).

The mean for number of immature pods per plant ranged from 2.07 (JVB-2518) to 9.00 (JVB-2534) in case of E_2. The genotype JVB-2518 (2.07) showed the minimum number of immature pods per plant followed by BAU-13 (2.13) and JVB-2512 (2.20). The genotype JVB-2534 (9.00) had the maximum number of immature pods per plant followed by JVB-2486 (8.27) and JVB-2529 (8.00). The coefficient of range for the trait was 62.65 %. The overall mean for number of immature pods per plant was 4.46 (Table 4.6 and Appendix V).

The mean for number of immature pods per plant ranged from 2.07 (JVB-2515) to 8.20 (JVB-2516) in case of E_3. The genotype JVB-2515 (2.07) showed the minimum number of immature pods per plant followed by JVB-LS-2506 & ICGV-86564 (2.20) and JVB-2513 (2.27). The genotype JVB-2516 (8.20) had the maximum number of immature pods per plant followed by JVB-2524 (7.53) and JVB-2532 (7.47). The coefficient of range for the trait was 59.74 % with overall mean 4.13 (Table 4.7 and Appendix V).

Under E_4, the genotype JVB-LS-2501 (2.13) showed the minimum number of immature pods per plant followed by Kaushal (2.20) and ICGV-86564 (2.27). The genotype JVB-2528 (7.80) had the maximum number of immature pods per plant followed by JVB-2529 (6.47) and JVB-2524 (6.13). The coefficient of range for the trait was 57.05 %. The overall mean for number of immature pods per plant was 3.93 (Table 4.8 and Appendix V).

In overall results (pooled results), genotype JVB-LS-2505 (2.93) showed the minimum number of immature pods per plant followed by JVB-LS-2502 (3.05) and JVB-25121 (3.07). The genotype JVB-2486 (6.12) had the maximum number of immature pods per plant followed by JVB-2529 (5.70) and JVB-2524 (5.68). The overall mean for number of immature pods per plant on the basis of pooled was 4.26 (Appendix V).

4.2.1.8 Sound mature kernel (SMK) %

The mean for sound mature kernel ranged from 63.46 % (JSSP-59) to 92.32 % (JVB-2509) in case of E_1. The genotype JVB-2509 (92.32 %) showed the highest value for sound mature kernel followed by JVB-2486 (91.43 %) and JVB-2508 (90.39 %).

The genotype JSSP-59 (63.46 %) had the lowest value for sound mature kernel followed by JVB-2513 (65.32 %) and JVB-LS-2502 (68.32 %). The coefficient of range for the trait was 18.53 %. The overall mean for sound mature kernel was 80.67 % (Table 4.5 and Appendix V).

The mean for sound mature kernel ranged from 62.93 % (JVB-LS-2505) to 90.12 % (JVB-2528) in case of E_2. The genotype JVB-2528 (90.12 %) showed the highest value for sound mature kernel followed by JVB-2516 (88.43 %) and JVB-2524 (87.72 %). The genotype JVB-LS-2505 (62.93 %) had the lowest value for sound mature kernel followed by JVB-2514 (64.44 %) and JSSP-59 (64.76 %). The coefficient of range for the trait was 17.77 %. The overall mean for sound mature kernel was 78.54 (Table 4.6 and Appendix V).

The mean for sound mature kernel ranged from 61.15 % (JVB-LS-2505) to 88.37 % (JVB-2509) in case of E_3. The genotype JVB-2509 (88.37 %) showed the highest value for sound mature kernel followed by JVB-2508 (88.29 %) and JVB-2528 (86.45 %). The genotype JVB-LS-2505 (61.15 %) had the lowest value for sound mature kernel followed by JVB-LS-2436 (64.99 %) and JVB-LS-2501 (65.07 %). The coefficient of range for the trait was 18.21 % with overall mean 76.47 % (Table 4.7 and Appendix V).

Under E_4, the genotype JVB-2528 (88.47 %) showed the highest value for sound mature kernel followed by JVB-2516 (87.24 %) and JVB-2508 (85.35 %). The genotype JVB-LS-2501 (61.14 %) had the lowest value for sound mature kernel followed by JVB-2526 (63.67 %) and JVB-LS-2502 (64.36 %). The coefficient of range for the trait was 18.26 %. The overall mean for sound mature kernel was 75.66 % (Table 4.8 and Appendix V).

In overall results (pooled results), genotype JVB-2528 (88.79 %) showed the highest value for sound mature kernel followed by JVB-2508 (87.73 %) and JVB-2516 (86.87 %). The genotype JSSP-59 (64.96 %) had the lowest value for sound mature kernel followed by JVB-2514 (68.90 %) and JVB-2513 (69.38 %). The overall mean for sound mature kernel on the basis of pooled was 77.84 % (Appendix V).

4.2.1.9 100-kernel weight (g)

The mean value for 100-kernel weight range from 23.60 g (JVB-2519) to 59.57 g (JVB-LS-2505) in case of E_1 with 43.24 % coefficient of range. The genotype JVB-LS-2505 (59.57 g) had highest 100-kernel weight followed by JVB-LS-2501 (57.96 g) and GG-HPS-2 (52.71 g). The genotype JVB-2519 (23.60 g) had the lowest 100-kernel weight followed by JVB-2513 (27.33 g) and JVB-2516 (27.43 g). The overall mean for 100-kernel weight was 41.30 g (Table 4.5 and Appendix V).

The mean value for 100-kernel weight range from 24.38 g (JVB-2519) to 55.55 g (JVB-LS-2505) in case of E_2. Both these genotypes also registered minimum and maximum kernel weight of 100-kernels under E_1. The genotype JVB-LS-2505 (55.55 g) had the maximum 100 kernel weight followed by JVB-LS-2501 (52.42 g) and GJG-22 (49.42 g). The genotype JVB-2519 (24.38 g) had the minimum 100-kernel weight followed by Kaushal (26.78 g) and JVB-2516 (27.45 g). The coefficient of range for the trait was 39.00 %. The overall mean for 100-kernel weight was 39.36 g (Table 4.6 and Appendix V).

The mean value for 100-kernel weight range from 28.34 g (JVB-2519) to 59.36 g (JVB-LS-2501) in case of E_3. The genotype JVB-LS-2501 (59.36 g) had highest 100-kernel weight followed by JVB-LS-2505 (57.49 g) and GG-20 (49.38 g). The genotype JVB-2519 (28.34 g) had lowest 100-kernel weight followed by JVB-2524 (28.36 g) and Kaushal (28.53 g). The coefficient of range for the trait was 35.38 %. The overall mean for 100-kernel weight was 39.10 g (Table 4.7 and Appendix V).

The mean value for 100-kernel weight range from 26.48 g (JVB-2519) to 53.34 g (JVB-LS-2501) in case of E_4. The genotype JVB-LS-2501 (53.34 g) had highest 100-kernel weight followed by JVB-LS-2505 (52.26 g) and GG-20 (49.32 g). The genotype JVB-2519 (26.48 g) had lowest 100-kernel weight followed by JVB-2524 (27.51 g) and JSSP-59 (30.35 g). The coefficient of range for the trait was 33.66 %. The overall mean for 100-kernel weight was 39.06 g (Table 4.8 and Appendix V).

Examination of pooled results indicated that the genotype JVB-LS-2505 (56.22 g) had highest 100-kernel weight among the fifty genotypes studied followed by JVB-LS-2501 (55.77 g) and GG-20 (49.36 g). The genotype JVB-2519 (25.70 g) had lowest 100-kernel weight followed by JVB-2516 (29.21 g) and JVB-2513 (29.43 g). The overall mean for 100-kernel weight on the basis of pooled was 39.71 g (Appendix V).

4.2.1.10 Shelling out-turn (%)

The mean for shelling out-turn ranged from 55.43 % (GG-HPS-2) to 76.24 % (JVB-2520) in case of E_1. The genotype JVB-2520 (76.24 %) showed the highest value for shelling out-turn followed by JVB-2522 (74.39 %) and JVB-2523 (73.56 %). The genotype GG-HPS-2 (55.43 %) had the lowest value for shelling out-turn followed by JVB-2515 (55.56 %) and JSSP-59 (60.36 %). The coefficient of range for the trait was

15.80 %. The overall mean for shelling out-turn was 68.25 % (Table 4.5 and Appendix V).

The mean for shelling out-turn ranged from 53.33 % (JVB-2515) to 76.46 % (JVB-2522) in case of E_2. The genotype JVB-2522 (76.46 %) showed the highest value for shelling out-turn followed by JVB-2453 (76.39 %) and JVB-2521 (75.33 %). The genotype JVB-2515 (53.33 %) had the lowest value for shelling out-turn followed by GG-HPS-2 (58.49 %) and JVB-2524 (59.35 %). The coefficient of range for the trait was 17.82 %. The overall mean for shelling out-turn was 68.68 % (Table 4.6 and Appendix V).

The mean for shelling out-turn ranged from 57.32 % (JVB-2515) to 74.45 % (JVB-2523) in case of E_3. The genotype JVB-2523 (74.45 %) showed the highest value for shelling out-turn followed by JVB-2453 (74.27 %) and JVB-LS-2501 (73.50 %). The genotype JVB-2515 (57.32 %) had the lowest value for shelling out-turn followed by JVB-2530 (58.42 %) and GG-HPS-2 (60.47 %). The coefficient of range for the trait was 13.00 % with overall mean 69.03 % (Table 4.7 and Appendix V).

Under E_4, the genotype JVB-2520 (74.48 %) showed the highest value for shelling out-turn followed by JVB-LS-2502 (73.36 %) and JVB-2521 (73.34 %). The genotype JVB-2515 (54.36 %) had the lowest value for shelling out-turn followed by GG-HPS-2 (57.09 %) and JVB-2530 (57.33 %). The coefficient of range for the trait was 15.62 %. The overall mean for shelling out-turn was 67.78 % (Table 4.8 and Appendix V).

In overall results (pooled results), genotype JVB-2522 (74.10 %) showed the highest value for shelling out-turn followed by JVB-2520 (74.09 %) and JVB-2453 (73.62 %). The genotype JVB-2515 (55.14 %) had the lowest value for shelling out-turn followed by GG-HPS-2 (57.87 %) and JVB-2530 (59.86 %). The overall mean for shelling out-turn on the basis of pooled was 68.43 % (Appendix V).

4.2.1.11 Pod yield per plant (g)

The mean value for pod yield per plant range from 8.41 g (JVB-LS-2502) to 23.35 g (JVB-2534) in case of E_1 with 47.02 % coefficient of range. The genotype JVB-2534 (23.35 g) had highest value for pod yield per plant followed by JVB-2483 (22.42 g) and JVB-2528 (22.08 g). The genotype JVB-LS-2502 (8.41 g) had the lowest value for pod yield per plant followed by JVB-LS-2436 (9.31 g) and JSSP-59 (9.43 g). The overall mean for pod yield per plant was 15.06 g (Table 4.5 and Appendix V).

The mean value for pod yield per plant range from 8.34 g (JVB-2513) to 23.20 g (JVB-2512) in case of E_2. The genotype JVB-2512 (23.20 g) had highest value for pod yield per plant followed by JVB-2528 (22.42 g) and JVB-2509 (22.38 g). The genotype JVB-2513 (8.34 g) had lowest value for pod yield per plant followed by JSSP-59 (10.19 g) and JVB-2527 (10.27 g). The coefficient of range for the trait was 47.11 %. The overall mean for pod yield per plant was 15.31 g (Table 4.6 and Appendix V).

The mean value for pod yield per plant range from 7.44 g (JVB-2494) to 22.48 g (JVB-2518) in case of E_3. The genotype JVB-2518 (22.48 g) had highest value for pod yield per plant followed by JVB-2528 (22.39 g) and JVB-2512 (22.10 g). The genotype JVB-2494 (7.44 g) had lowest value for pod yield per plant followed by JVB-LS-2373 (8.62 g) and JVB-2520 (9.29 g). The coefficient of range for the trait was 50.28 %. The overall mean for pod yield per plant was 14.50 g (Table 4.7 and Appendix V).

The mean value for pod yield per plant range from 8.38 g (JVB-2494) to 23.44 g (JVB-2509) in case of E_4. The genotype JVB-2509 (23.44 g) had highest value for pod yield per plant followed by JVB-2528 (22.36 g) and JVB-2516 (21.57 g). The genotype JVB-2494 (8.38 g) had lowest value for pod yield per plant followed by JVB-2526 (9.49 g) and JVB-LS-2501 (9.52 g). The coefficient of range for the trait was 47.34 %. The overall mean for pod yield per plant was 14.61 g (Table 4.8 and Appendix V).

Examination of pooled results indicated that the genotype JVB-2528 (22.31 g) had highest value for pod yield per plant among the fifty genotypes studied followed by JVB-2532 (21.47 g) and JVB-2509 (21.19 g). The genotype JVB-2527 (10.79 g) had lowest value for pod yield per plant followed by JVB-2494 (10.94 g) and JVB-LS-2501 (11.16 g). The overall mean for pod yield per plant on the basis of pooled was 14.87 g (Appendix V).

4.2.1.12 Kernel yield per plant (g)

The mean value for kernel yield per plant range from 5.70 g (JSSP-59) to 16.98 g (JVB-2534) in case of E_1 with 49.73 % coefficient of range. The genotype JVB-2534 (16.98 g) had highest value for kernel yield per plant followed by JVB-2522 (15.92 g) and JVB-2532 (15.53 g). The genotype JSSP-59 (5.70 g) had the lowest value for kernel yield per plant followed by JVB-LS-2502 & GG-HPS-2 (5.72 g) and JVB-LS-2436 (6.73 g). The overall mean for kernel yield per plant was 10.31 g (Table 4.5 and Appendix V).

The mean value for kernel yield per plant range from 5.92 g (JVB-2513) to 15.70 g (JVB-2512) in case of E_2. The genotype JVB-2512 (15.70 g) had highest value for kernel yield per plant followed by JVB-2532 (15.36 g) and JVB-2528 (14.88 g). The genotype JVB-2513 (5.92 g) had lowest value for kernel yield per plant followed by JVB-2515 (6.05 g) and JSSP-59 (6.20 g). The coefficient of range for the trait was 45.22 %. The overall mean for kernel yield per plant was 10.52 g (Table 4.6 and Appendix V).

The mean value for kernel yield per plant range from 4.96 g (JVB-2494) to 15.78 g (JVB-2518) in case of E_3. The genotype JVB-2518 (15.78 g) had highest value for kernel yield per plant followed by JVB-2532 (15.44 g) and JVB-2512 (15.30 g). The genotype JVB-2494 (4.96 g) had lowest value for kernel yield per plant followed by JVB-2515 (5.43 g) and JVB-LS-2373 (5.78 g). The coefficient of range for the trait was 52.16 %. The overall mean for kernel yield per plant was 10.02 g (Table 4.7 and Appendix V).

The mean value for kernel yield per plant range from 5.79 g (JVB-2494) to 15.10 g (JVB-2509) in case of E_4. The genotype JVB-2509 (15.10 g) had highest value for kernel yield per plant followed by JVB-2528 (14.89 g) and JVB-2516 (14.56 g). The genotype JVB-2494 (5.79 g) had lowest value for kernel yield per plant followed by JVB-2526 (6.46 g) and JVB-2524 (6.56 g). The coefficient of range for the trait was 44.59 %. The overall mean for kernel yield per plant was 9.90 g (Table 4.8 and Appendix V).

Examination of pooled results indicated that the genotype JVB-2532 (15.22 g) had highest value for kernel yield per plant among the fifty genotypes studied followed by JVB-2528 (14.85 g) and JVB-2508 (14.35 g). The genotype JVB-2515 (6.39 g) had lowest value for kernel yield per plant followed by JSSP-59 (7.09 g) and GG-HPS-2 (7.35 g). The overall mean for kernel yield per plant on the basis of pooled was 10.19 g (Appendix V).

4.2.1.13 Biological yield per plant (g)

The mean value for biological yield per plant range from 28.10 g (JSSP-59) to 63.06 g (JVB-2483) in case of E_1 with 38.34 % coefficient of range. The genotype JVB-2483 (63.06 g) had highest value for biological yield per plant followed by JVB-2522 (56.59 g) and JVB-2516 (54.47 g). The genotype JSSP-59 (28.10 g) had the lowest value for biological yield per plant followed by JSSP-62 (30.08 g) and Kaushal (30.29

g). The overall mean for biological yield per plant was 40.85 g (Table 4.5 and Appendix V).

The mean value for biological yield per plant range from 27.21 g (JVB-2513) to 65.50 g (JVB-2512) in case of E_2. The genotype JVB-2512 (65.50 g) had highest value for biological yield per plant followed by JVB-2516 (59.11 g) and JVB-LS-2506 (57.31 g). The genotype JVB-2513 (27.21 g) had lowest value for biological yield per plant followed by JVB-2486 (27.30 g) and JVB-LS-2501 (27.50 g). The coefficient of range for the trait was 41.30 %. The overall mean for biological yield per plant was 41.94 g (Table 4.6 and Appendix V).

The mean value for biological yield per plant range from 23.21 g (JVB-2489) to 66.22 g (JVB-2512) in case of E_3. The genotype JVB-2512 (66.22 g) had highest value for biological yield per plant followed by JVB-2519 (58.03 g) and JVB-LS-2502 (56.27 g). The genotype JVB-2489 (23.21 g) had lowest value for biological yield per plant followed by JVB-LS-2373 (25.97 g) and JVB-2494 (27.19 g). The coefficient of range for the trait was 48.09 %. The overall mean for biological yield per plant was 39.45 g (Table 4.7 and Appendix V).

The mean value for biological yield per plant range from 29.43 g (JVB-LS-2501) to 59.31 g (JVB-2516) in case of E_4. The genotype JVB-2516 (59.31 g) had highest value for biological yield per plant followed by JVB-2509 (58.01 g) and JSSP-60 (48.12 g). The genotype JVB-LS-2501 (29.43 g) had lowest value for biological yield per plant followed by JVB-LS-2507 (29.91 g) and JVB-2494 (30.46 g). The coefficient of range for the trait was 33.67 %. The overall mean for biological yield per plant was 40.31 g (Table 4.8 and Appendix V).

Examination of pooled results indicated that the genotype JVB-2516 (56.16 g) had highest value for biological yield per plant among the fifty genotypes studied followed by JVB-2512 (52.97 g) and JVB-2509 (52.63 g). The genotype JVB-2527 (30.34 g) had lowest value for biological yield per plant followed by Kaushal (31.85 g) and JVB-LS-2501 (31.93 g). The overall mean for biological yield per plant on the basis of pooled was 40.64 g (Appendix V).

4.2.1.14 Harvest index (%)

With respect to harvest index mean value ranged from 25.66 % (JVB-2453) to 52.44 % (JVB-2532) in case of E_1. The genotype JVB-2532 (52.44 %) showed the highest value for harvest index followed by JVB-2534 (50.49 %) and JVB-2528 (47.49 %). The genotype JVB-2453 (25.66 %) had the lowest value for harvest index followed by JVB-2519 (26.57 %) and JVB-LS-2502 (26.67 %). The coefficient of range for the trait was 34.29 %. The overall mean for harvest index was 36.72 % (Table 4.5 and Appendix V).

The mean for harvest index ranged from 27.37 % (JVB-2453) to 52.37 % (JVB-2534) in case of E_2. The genotype JVB-2534 (52.37 %) showed the highest value for harvest index followed by JVB-2532 (50.40 %) and JVB-2528 (47.70 %). The genotype JVB-2453 (27.37 %) had the lowest value for harvest index followed by JVB-2494 (27.46 %) and JVB-2515 (28.42 %). The coefficient of range for the trait was 31.35 %. The overall mean for harvest index was 36.77 % (Table 4.6 and Appendix V).

In the case of E_3 mean for harvest index ranged from 27.37 % (JVB-2494) to 51.97 % (JVB-2532). The genotype JVB-2532 (51.97 %) showed the highest value for harvest index followed by JVB-2534 (50.45 %) and JVB-2528 (47.34 %). The genotype JVB-2494 (27.37 %) had the lowest value for harvest index followed by JVB-2526 (27.42 %) and JSSP-LS-61 (27.43 %). The coefficient of range for the trait was 31.00 % with overall mean 36.64 % (Table 4.7 and Appendix V).

Under E_4, the genotype JVB-2532 (52.33 %) showed the highest value for harvest index followed by JVB-2534 (50.36 %) and JVB-2528 (47.32 %). The genotype JVB-2453 (26.28 %) had the lowest value for harvest index followed by JVB-LS-2506 (27.29 %) and JVB-2526 (27.42 %). The coefficient of range for the trait was 33.14 %. The overall mean for harvest index was 36.11 % (Table 4.8 and Appendix V).

In overall results (pooled results), genotype JVB-2532 (51.78 %) showed the highest value for harvest index followed by JVB-2534 (50.92 %) and JVB-2528 (47.47 %). The genotype JVB-2453 (27.43 %) had the lowest value for harvest index followed by JVB-2494 (27.45 %) and JVB-LS-2506 (28.45 %). The overall mean for harvest index on the basis of pooled was 36.56 % (Appendix V).

4.2.1.15 Oil content (%)

With respect to oil content mean value ranged from 46.11 % (GG-HPS-2) to 55.18 % (JVB-2513) in case of E_1. The genotype JVB-2513 (55.18 %) showed the highest value for oil content followed by JVB-2511 (53.26 %) and JVB-2534 (53.25 %). The genotype GG-HPS-2 (46.11 %) had the lowest value for oil content followed by JVB-LS-2505 (46.16 %) and JVB-LS-2506 (46.24 %). The coefficient of range for the trait was 8.95 %. The overall mean for oil content was 50.66 % (Table 4.5 and Appendix V).

The mean for oil content ranged from 45.38 % (GG-HPS-2) to 54.23 % (JVB-2508) in case of E_2. The genotype JVB-2508 (54.23 %) showed the highest value for oil content followed by JVB-2513 (54.20 %) and JVB-2512 (53.24 %). The genotype GG-HPS-2 (45.38 %) had the lowest value for oil content followed by JVB-LS-2505 (47.22 %) and JVB-LS-2501 (47.25 %). The coefficient of range for the trait was 8.88 %. The overall mean for oil content was 50.42 % (Table 4.6 and Appendix V).

In the case of E_3 mean for oil content ranged from 47.24 % (GG-HPS-2) to 54.21 % (JVB-2534). The genotype JVB-2534 (54.21 %) showed the highest value for oil content followed by JVB-2519 (54.11 %) and JVB-2513 (53.25 %). The genotype GG-HPS-2 47.24 %) had the lowest value for oil content followed by JVB-LS-2501 (48.13 %) and JVB-LS-2506 (48.17 %). The coefficient of range for the trait was 6.87 % with overall mean 50.44 % (Table 4.7 and Appendix V).

Under E_4, the genotype JVB-2513 (54.17 %) showed the highest value for oil content followed by JVB-2519 & JVB-2534 (53.49 %) and JVB-2508 (53.36 %). The genotype GG-HPS-2 (46.31 %) had the lowest value for oil content followed by JVB-LS-2501 (47.12 %) and JVB-LS-2506 (47.51 %). The coefficient of range for the trait was 7.82 %. The overall mean for oil content was 50.66 % (Table 4.8 and Appendix V).

In overall results (pooled results), genotype JVB-LS-2501 (54.20 %) showed the highest value for oil content followed by JVB-2508 & JVB-2534 (53.31 %) and JVB-2519 (53.21 %). The genotype GG-HPS-2 (46.26 %) had the lowest value for oil content followed by JVB-LS-2501 (47.28 %) and JVB-LS-2506 (47.30 %). The overall mean for oil content on the basis of pooled was 50.54 % (Appendix V).

4.2.2 Phenotypic coefficient of variation (PCV)

The estimates of phenotypic coefficient of variation were of higher magnitude than the estimates of genotypic coefficient of variation for all the characters studied at both the locations Junagadh (E_1: *Kharif*-2019 and E_2: *Kharif*-2020) and Manavadar (E_3: *Kharif*-2019 and E_4: *Kharif*-2020), (Table 4.5 to 4.8).

At Junagadh during *Kharif*-2019 (E_1), the high phenotypic coefficient of variation was observed for kernel yield per plant (29.22 %), number of matured pods per plant (28.84 %), number of immature pods per plant (27.55 %), pod yield per plant (27.15 %) and biological yield per plant (20.02 %). The moderate phenotypic coefficient of variation was found for 100-kernel weight (19.74 %), harvest index (17.33 %), number of primary branches per plant (12.68 %), number of secondary branches per plant (12.06 %) and plant height (12.03 %). While, estimated values of phenotypic coefficient of variation were low in case of days to 50 % flowering (8.95 %), sound mature kernel (8.75 %), shelling out-turn (6.50 %), oil content (4.21 %) and days to maturity (1.48 %) (Table 4.5).

At Junagadh during *Kharif*-2020 (E_2), the high phenotypic coefficient of variation was observed for number of immature pods per plant (37.47 %), number of matured pods per plant (25.32 %), kernel yield per plant (24.90 %), pod yield per plant (23.85 %) and biological yield per plant (20.92 %). The moderate phenotypic coefficient of variation was found for 100-kernel weight (18.22 %), harvest index (16.67 %), number of primary branches per plant (14.85 %), plant height (12.44 %) and number of secondary branches per plant (10.60 %). While, estimated values of phenotypic coefficient of variation were low in case of sound mature kernel (8.60 %), days to 50 % flowering (8.28 %), shelling out-turn (7.66 %), oil content (3.79 %) and days to maturity (1.82 %) (Table 4.6).

In case of E_3, the high phenotypic coefficient of variation was observed for number of immature pods per plant (36.33 %), kernel yield per plant (30.02 %), pod yield per plant (29.26 %), number of matured pods per plant (27.04 %) and biological yield per plant (22.65 %). The moderate phenotypic coefficient of variation was found for 100-kernel weight (18.22 %), harvest index (15.88 %), number of primary branches per plant (14.01 %) and plant height (12.08 %). While, estimated values of phenotypic coefficient of variation were low in case of number of secondary branches per plant (9.76 %), sound mature kernel (8.89 %), days to 50 % flowering (8.84 %), shelling out-turn (5.79 %), oil content (3.37 %) and days to maturity (1.42 %) (Table 4.7).

While in case of E_4, the high phenotypic coefficient of variation was observed for number of immature pods per plant (28.59 %), number of matured pods per plant (26.52 %), kernel yield per plant (24.85 %) and pod yield per plant (24.36 %). The moderate phenotypic coefficient of variation was found for 100-kernel weight (16.49 %), biological yield per plant (16.18 %), harvest index (15.80 %), number of primary branches per plant (13.42 %) and plant height (12.99 %). While, estimated values of phenotypic coefficient of variation were low in case of number of secondary branches per plant (9.69 %), sound mature kernel (8.43 %), days to 50 % flowering (7.44 %), shelling out-turn (6.43 %), oil content (3.46 %) and days to maturity (1.51 %) (Table 4.8).

4.2.3 Genotypic coefficient of variation (GCV)

At Junagadh during *Kharif*-2019 (E_1), the high genotypic coefficient of variation was observed for number of matured pods per plant (28.04 %), kernel yield per plant (27.86 %), number of immature pods per plant (27.18 %) and pod yield per plant (25.86 %). The moderate genotypic coefficient of variation was found for 100-kernel weight (19.44 %), biological yield per plant (19.35 %), harvest index (16.49 %), number of secondary branches per plant (11.89 %), number of primary branches per plant (11.83 %) and plant height (11.31 %). While, estimated values of genotypic coefficient of variation were low in case of sound mature kernel (8.59 %), days to 50 % flowering (8.48 %), shelling out-turn (6.11 %), oil content (4.13 %) and days to maturity (1.13 %) (Table 4.5).

At Junagadh during *Kharif*-2020 (E_2), the high genotypic coefficient of variation was observed for number of immature pods per plant (36.87 %), number of matured pods per plant (24.20 %), kernel yield per plant (23.72 %) and pod yield per plant (22.73 %). The moderate genotypic coefficient of variation was found for biological yield per plant (19.75 %), 100-kernel weight (18.06 %), harvest index (15.94 %), number of primary branches per plant (14.03 %), plant height (11.44 %) and number of secondary branches per plant (10.34 %). While, estimated values of genotypic coefficient of variation were low in case of sound mature kernel (8.37 %), days to 50 % flowering (7.89 %), shelling out-turn (7.34 %), oil content (3.70 %) and days to maturity (1.60 %) (Table 4.6).

In case of E_3, the high genotypic coefficient of variation was observed for number of immature pods per plant (35.76 %), kernel yield per plant (29.11 %), pod yield per plant (28.47 %), number of matured pods per plant (26.10 %) and biological yield per plant (21.69 %). The moderate genotypic coefficient of variation was found for 100-kernel weight (18.11 %), harvest index (15.08 %), number of primary branches per plant (13.08 %) and plant height (10.40 %). While, estimated values of genotypic coefficient of variation were low in case of number of secondary branches per plant (9.51 %), sound mature kernel (8.59 %), days to 50 % flowering (8.42 %), shelling out-turn (5.19 %), oil content (3.27 %) and days to maturity (0.97 %) (Table 4.7).

While in case of E_4, the high genotypic coefficient of variation was observed for number of immature pods per plant (27.69 %), number of matured pods per plant (25.52 %), kernel yield per plant (23.51 %) and pod yield per plant (23.20 %). The moderate genotypic coefficient of variation was found for 100-kernel weight (16.30 %), biological yield per plant (15.04 %), harvest index (15.04 %), number of primary branches per plant (12.54 %) and plant height (11.78 %). While, estimated values of genotypic coefficient of variation were low in case of number of secondary branches per plant (9.38 %), sound mature kernel (8.15 %), days to 50 % flowering (6.99 %), shelling out-turn (5.89 %), oil content (3.28 %) and days to maturity (1.00 %) (Table 4.8).

4.2.4 Heritability

The broad sense heritability estimates for different characters studied under E_1 are furnished in Table 4.5. High heritability estimates were observed for number of immature pods per plant (97.40 %), number of secondary branches per plant (97.20 %), 100-kernel weight (97.00 %), sound mature kernel (96.20 %), oil content (96.20 %), number of matured pods per plant (94.50 %), biological yield per plant (93.50 %), kernel yield per plant (90.90 %), pod yield per plant (90.70 %), harvest index (90.50 %), days to 50 % flowering (89.70 %), plant height (88.40 %), shelling out-turn (88.40 %) and number of primary branches per plant (87.00 %). Heritability estimate was found moderate for days to maturity (58.70 %).

Under E_2 high heritability estimates were observed for 100-kernel weight (98.20 %), number of immature pods per plant (96.80 %), oil content (95.30 %), number of secondary branches per plant (95.20 %), sound mature kernel (94.90 %), shelling out-turn (91.90 %), harvest index (91.50 %), number of matured pods per plant (91.30 %), days to 50 % flowering (90.80 %), pod yield per plant (90.80 %), kernel yield per plant (90.70 %), number of primary branches per plant (89.20 %), biological yield per plant (89.20 %), plant height (84.60 %) and days to maturity (76.70 %) (Table 4.6).

Under E_3 heritability was the highest for 100-kernel weight (98.80 %) followed by number of immature pods per plant (96.80 %), number of secondary branches per plant (94.90 %), pod yield per plant (94.60 %), oil content (94.10 %), kernel yield per plant (94.00 %), sound mature kernel (93.40 %), number of matured pods per plant (93.10 %), biological yield per plant (91.70 %), days to 50 % flowering (90.80 %), harvest index (90.20 %), number of primary branches per plant (87.10 %), shelling out-turn (80.40 %) and plant height (74.10 %). Heritability estimate was found moderate for days to maturity (46.90 %) (Table 4.7).

The broad sense heritability estimates for different characters studied under E_4 are furnished in Table 4.8. High heritability estimates were observed for 100-kernel weight (97.80 %), number of secondary branches per plant (93.80 %), number of immature pods per plant (93.80 %), sound mature kernel (93.40 %), number of matured pods per plant (92.60 %), pod yield per plant (90.70 %), harvest index (90.60 %), oil content (89.60 %), kernel yield per plant (89.50 %), days to 50 % flowering (88.30 %), number of primary branches per plant (87.30 %), biological yield per plant (86.40 %), shelling out-turn (83.80 %) and plant height (82.30 %). Heritability estimate was found moderate for days to maturity (44.10 %).

4.2.5 Genetic advance expressed as percentage of mean

The genetic advance expressed as percentage of mean for different characters studied under E_1 were found high for number of matured pods per plant (56.16 %), number of immature pods per plant (55.26 %), kernel yield per plant (54.73 %), pod yield per plant (50.75 %), 100-kernel weight (39.44 %), biological yield per plant (38.54 %), harvest index (32.32 %), number of secondary branches per plant (24.14 %), number of primary branches per plant (22.72 %) and plant height (21.91 %). Moderate value for genetic advance expressed as percentage of mean were found for sound mature kernel (17.35 %), days to 50 % flowering (16.54 %) and shelling out-turn (11.84 %). Genetic advance expressed as percentage of mean were found low for oil content (8.33 %) and days to maturity (1.78 %) (Table 4.5).

Under E_2 genetic advance expressed as percentage of mean were found high for number of immature pods per plant (74.72 %), number of matured pods per plant (47.64 %), kernel yield per plant (46.53 %), pod yield per plant (44.61 %), biological yield per plant (38.42 %), 100-kernel weight (36.88 %), harvest index (31.41 %), number of primary branches per plant (27.28 %), plant height (21.67 %) and number of secondary branches per plant (20.78 %). Moderate value for genetic advance expressed as percentage of mean were found for sound mature kernel (16.80 %), days to 50 % flowering (15.49 %) and shelling out-turn (14.50 %). Genetic advance expressed as percentage of mean were found low for oil content (7.45 %) and days to maturity (2.88 %) (Table 4.6).

High values for genetic advance expressed as percentage of mean under E_3 were found for number of immature pods per plant (72.48 %), kernel yield per plant (58.14 %), pod yield per plant (57.05 %), number of matured pods per plant (51.89 %), biological yield per plant (42.79 %), 100-kernel weight (37.07 %), harvest index (29.50 %) and number of primary branches per plant (25.14 %). Moderate value for genetic advance expressed as percentage of mean were found for number of secondary branches per plant (19.09 %), plant height (18.45 %), sound mature kernel (17.11 %) and days to 50 % flowering (16.53 %). Genetic advance expressed as percentage of mean were found low for shelling out-turn (9.58 %), oil content (6.53 %) and days to maturity (1.37 %) (Table 4.7).

Under E_4 genetic advance expressed as percentage of mean were found high for number of immature pods per plant (55.23 %), number of matured pods per plant (50.59 %), kernel yield per plant (45.82 %), pod yield per plant (45.51 %), 100-kernel weight (33.21 %), harvest index (29.47 %), biological yield per plant (28.80 %), number of primary branches per plant (24.13 %) and plant height (22.02 %). Moderate value for genetic advance expressed as percentage of mean were found for number of secondary branches per plant (18.71 %), sound mature kernel (16.22 %), days to 50 % flowering (13.52 %) and shelling out-turn (11.10 %). Genetic advance expressed as percentage of mean were found low for oil content (6.39 %) and days to maturity (1.37 %) (Table 4.8).

4.3 CORRELATION COEFFICIENTS

The correlation coefficients were estimated among 15 characters to find out association of pod yield per plant with its components at genotypic (r_g) and phenotypic (r_p) levels. The data given in Table 4.9 to Table 4.12 revealed that, in general, the genotypic correlation coefficients were relatively higher than their corresponding phenotypic correlation coefficients. The results obtained on correlation coefficients between different pairs of characters are presented below:

4.3.1 Pod yield per plant

The pod yield per plant exhibited highly significant and positive correlation for all environment both at genotypic and phenotypic levels with number of secondary branches per plant (E_1, r_g = 0.572, r_p = 0.536) (E_2, r_g = 0.562, r_p = 0.521) (E_3, r_g = 0.399, r_p = 0.373) (E_4, r_g = 0.596, r_p = 0.550), number of matured pods per plant (E_1, r_g = 0.928, r_p = 0.866) (E_2, r_g = 0.639, r_p = 0.589) (E_3, r_g = 0.525, r_p = 0.497) (E_4, r_g = 0.767, r_p = 0.734), kernel yield per plant (E_1, r_g = 0.982, r_p = 0.980) (E_2, r_g = 0.959, r_p = 0.958) (E_3, r_g = 0.988, r_p = 0.985) (E_4, r_g = 0.969, r_p = 0.9663), biological yield per plant (E_1, r_g = 0.756, r_p = 0.957) (E_2, r_g = 0.701, r_p = 0.706) (E_3, r_g = 0.832, r_p = 0.824) (E_4, r_g = 0.761, r_p = 0.762) and harvest index (E_1, r_g = 0.688, r_p = 0.699) (E_2, r_g = 0.583, r_p = 0.571) (E_3, r_g = 0.692, r_p = 0.669) (E_4, r_g = 0.778, r_p = 0.762).

Pod yield per plant exhibited significant and negative correlations at genotypic level with days to 50% flowering (E_1, r_g = -0.306) under E_1 only, while highly significant and positively correlated both at genotypic and phenotypic level with sound mature kernel (E_1, r_g = 0.507, r_p = 0.478) (E_2, r_g = 0.583, r_p = 0.571) (E_4, r_g = 0.778, r_p = 0.762) under E_1, E_2 and E_4. In case of E_1 and E_2 pod yield per plant exhibited significant and positive correlation at genotypic and phenotypic level with 100-kernel weight (E_1, r_g = 0.384, r_p = 0.356) (E_2, r_g = 0.384, r_p = 0.356). Correlation with oil content of pod yield per plant was highly significant and positive both at genotypic and phenotypic level under E_3 (E_3, r_g = 0.384, r_p = 0.356), while it was significant and positive at genotypic level only under E_4 (E_4, r_g = 0.384).

4.3.2 Days to 50 % flowering

Days to 50 % flowering exhibited highly significant and positive correlation for all environment both at genotypic and phenotypic levels with days to maturity (E_1, r_g = 0.454, r_p = 0.349) (E_2, r_g = 0.465, r_p = 0.389) (E_3, r_g = 0.542, r_p = 0.335) (E_4, r_g = 0.450, r_p = 0.298). In case of E_1 days to 50 % flowering exhibited significant and positive correlation at genotypic level with plant height (E_1, r_g = 0.290), while significant and negatively correlated at genotypic level with kernel yield per plant (E_1, r_g = -0.293) and at genotypic and phenotypic level both with biological yield per plant (E_1, r_g = -0.313, r_p = -0.287).

4.3.3 Days to maturity

In case of E_2 and E_4 days to maturity exhibit significant and negative correlation at genotypic level only with plant height (E_2, r_g = -0.328) (E_4, r_g = -0.343), at genotypic and phenotypic level both with harvest index (E_2, r_g = -0.411, r_p = -0.339) (E_4, r_g = -0.476, r_p = -0.285) and at genotypic level only with oil content (E_2, r_g = -0.292) (E_4, r_g = -0.337). In case of E_3 days to maturity exhibit significant and negative correlation at genotypic level only with number of primary branches per plant (E_3, r_g = -0.298) and at genotypic and phenotypic level both with number of secondary branches per plant (E_3, r_g = -0.474, r_p = -0.333). Under E_4 days to maturity exhibit significant and positive correlation at genotypic level only with biological yield (E_4, r_g = 0.294).

4.3.4 Number of primary branches per plant

For all environments number of primary branches per plant was highly significant and positively correlated at genotypic and phenotypic level both with number of secondary branches per plant (E_1, r_g = 0.450, r_p = 0.412) (E_2, r_g = 0.475, r_p = 0.444) (E_3, r_g = 0.446, r_p = 0.401) (E_4, r_g = 0.624, r_p = 0.562). Under E_2, E_3 and E_4 environments number of primary branches per plant was significantly and positively

Table 4.9: Genotypic (r_g) and phenotypic (r_p) correlation coefficients among 15 characters in 50 genotypes of groundnut at Junagadh during *Kharif*-2019 (E_1)

Characters		Days to maturity	No. of primary branches per plant	No. of secondary branches per plant	Plant height (cm)	No. of matured pods per plant	No. of immature pods per plant	Sound mature kernel (%)	100-kernel weight (g)	Shelling out-turn (%)	Kernel yield per plant (g)	Biological yield per plant (g)	Harvest index (%)	Oil content (%)	Pod yield per plant (g)
Days to 50 % flowering	r_g	0.454**	0.099	-0.007	0.290*	-0.237	0.161	-0.164	-0.228	0.010	-0.293*	-0.313*	-0.136	-0.232	-0.306*
	r_p	0.349*	0.086	-0.008	0.269	-0.216	0.150	-0.158	-0.222	0.020	-0.255	-0.287*	-0.110	-0.221	-0.270
Days to maturity	r_g		-0.283	-0.058	0.076	-0.187	0.002	-0.135	-0.155	-0.113	-0.130	0.007	-0.198	-0.065	-0.110
	r_p		-0.222	-0.044	0.074	-0.135	0.018	-0.091	-0.134	-0.069	-0.114	-0.023	-0.143	-0.041	-0.104
No. of primary branches per plant	r_g			0.450**	-0.109	0.232	-0.007	0.099	-0.044	0.224	0.167	0.002	0.159	0.077	0.127
	r_p			0.412**	-0.096	0.211	0.002	0.093	-0.034	0.194	0.151	0.022	0.127	0.070	0.119
No. of secondary branches per plant	r_g				-0.282	0.548**	0.143	0.286*	0.106	0.096	0.556**	0.247	0.580**	0.233	0.572**
	r_p				-0.255	0.528**	0.138	0.277	0.109	0.095	0.523**	0.235	0.543**	0.229	0.536**
Plant height (cm)	r_g					-0.192	-0.102	-0.227	-0.013	0.111	-0.123	-0.068	-0.121	-0.135	-0.137
	r_p					-0.176	-0.095	-0.209	-0.013	0.121	-0.105	-0.064	-0.104	-0.118	-0.123
No. of matured pods per plant	r_g						0.201	0.568**	0.111	0.283	0.923**	0.687**	0.673**	0.369*	0.928**
	r_p						0.191	0.540**	0.113	0.258	0.861**	0.651**	0.625**	0.348*	0.866**
No. of immature pods per plant	r_g							0.191	-0.217	0.195	0.106	-0.033	0.148	0.179	0.069
	r_p							0.188	-0.218	0.181	0.108	-0.028	0.151	0.172	0.075
Sound mature kernel (%)	r_g								0.403**	0.015	0.462**	0.478**	0.285*	0.097	0.507**
	r_p								0.390**	0.022	0.437**	0.456**	0.268	0.099	0.478**
100-kernel weight (g)	r_g									-0.101	0.347*	0.245	0.322*	-0.382**	0.384**
	r_p									-0.091	0.322*	0.227	0.300*	-0.369*	0.356*
Shelling out-turn (%)	r_g										0.393**	0.126	0.170	0.454**	0.217
	r_p										0.386**	0.111	0.165	0.425**	0.201
Kernel yield per plant (g)	r_g											0.723**	0.691**	0.306*	0.982**
	r_p											0.722**	0.701**	0.282	0.980**
Biological yield per plant (g)	r_g												0.051	0.170	0.756**
	r_p												0.071	0.163	0.757**
Harvest index (%)	r_g													0.169	0.688**
	r_p													0.152	0.699**
Oil content (%)	r_g														0.237
	r_p														0.217

***, ** Significant at 5 % and 1 % levels, respectively**

Table 4.10: Genotypic (r_g) and phenotypic (r_p) correlation coefficients among 15 characters in 50 genotypes of groundnut at Junagadh during *Kharif*-2020 (E_2)

Characters		Days to maturity	No. of primary branches per plant	No. of secondary branches per plant	Plant height (cm)	No. of matured pods per plant	No. of immature pods per plant	Sound mature kernel (%)	100-kernel weight (g)	Shelling out-turn (%)	Kernel yield per plant (g)	Biological yield per plant (g)	Harvest index (%)	Oil content (%)	Pod yield per plant (g)
Days to 50 % flowering	r_g	0.465**	0.119	-0.046	-0.046	-0.090	-0.181	0.098	-0.194	-0.104	-0.126	-0.016	-0.100	-0.221	-0.079
	r_p	0.389**	0.112	-0.033	-0.069	-0.080	-0.168	0.094	-0.184	-0.093	-0.094	0.007	-0.092	-0.209	-0.053
Days to maturity	r_g		-0.067	-0.191	-0.328*	-0.201	-0.263	-0.014	-0.153	-0.062	-0.170	0.152	-0.411**	-0.292*	-0.176
	r_p		-0.086	-0.175	-0.271	-0.164	-0.205	-0.017	-0.131	-0.063	-0.124	0.154	-0.339*	-0.269	-0.122
No. of primary branches per plant	r_g			0.475**	-0.047	0.527**	0.133	0.317*	-0.010	0.114	0.264	0.206	0.158	-0.026	0.266
	r_p			0.444**	-0.055	0.461**	0.111	0.294*	-0.004	0.094	0.218	0.152	0.151	-0.018	0.221
No. of secondary branches per plant	r_g				0.032	0.485**	0.405**	0.527**	0.123	0.134	0.567**	0.246	0.488**	0.246	0.562**
	r_p				0.033	0.452**	0.384**	0.499**	0.122	0.127	0.526**	0.220	0.458**	0.231	0.521**
Plant height (cm)	r_g					-0.103	0.191	-0.008	-0.143	0.249	0.141	0.187	-0.086	0.104	0.076
	r_p					-0.097	0.174	-0.004	-0.123	0.230	0.110	0.147	-0.076	0.099	0.049
No. of matured pods per plant	r_g						0.201	0.572**	0.059	0.125	0.637**	0.327*	0.513**	0.399**	0.639**
	r_p						0.197	0.535**	0.058	0.115	0.587**	0.302*	0.471**	0.371**	0.589**
No. of immature pods per plant	r_g							0.143	0.019	0.240	0.115	-0.197	0.320*	0.277	0.050
	r_p							0.140	0.019	0.224	0.125	-0.169	0.310*	0.263	0.066
Sound mature kernel (%)	r_g								-0.023	0.177	0.531**	0.316*	0.384**	0.228	0.526**
	r_p								-0.024	0.167	0.499**	0.295*	0.360**	0.217	0.493**
100-kernel weight (g)	r_g									0.030	0.369*	0.084	0.431**	-0.353*	0.367*
	r_p									0.031	0.342*	0.070	0.408**	-0.339*	0.339*
Shelling out-turn (%)	r_g										0.284	-0.122	0.161	0.196	0.005
	r_p										0.283	-0.107	0.146	0.230	0.004
Kernel yield per plant (g)	r_g											0.638**	0.602**	0.214	0.959**
	r_p											0.647**	0.585**	0.207	0.958**
Biological yield per plant (g)	r_g												-0.165	0.030	0.701**
	r_p												-0.169	0.026	0.706**
Harvest index (%)	r_g													0.173	0.583**
	r_p													0.155	0.571**
Oil content (%)	r_g														0.167
	r_p														0.148

***, ** Significant at 5% and 1% levels, respectively**

Table 4.11: Genotypic (r_g) and phenotypic (r_p) correlation coefficients among 15 characters in 50 genotypes of groundnut at Manavadar during *Kharif*-2019 (E_3)

Characters		Days to maturity	No. of primary branches per plant	No. of secondary branches per plant	Plant height (cm)	No. of matured pods per plant	No. of immature pods per plant	Sound mature kernel (%)	100-kernel weight (g)	Shelling out-turn (%)	Kernel yield per plant (g)	Biological yield per plant (g)	Harvest index (%)	Oil content (%)	Pod yield per plant (g)
Days to 50 % flowering	r_g	0.542**	0.028	-0.015	0.186	-0.166	-0.047	-0.093	-0.109	0.116	0.005	0.137	-0.133	-0.275	0.001
	r_p	0.335*	0.025	-0.019	0.151	-0.153	-0.043	-0.076	-0.100	0.099	0.001	0.115	-0.113	-0.251	-0.004
Days to maturity	r_g		-0.298*	-0.474**	0.102	-0.270	-0.141	-0.088	-0.056	-0.266	-0.240	-0.082	-0.216	-0.095	-0.188
	r_p		-0.205	-0.333*	0.037	-0.196	-0.082	-0.095	-0.044	-0.102	-0.142	-0.040	-0.144	-0.051	-0.118
No. of primary branches per plant	r_g			0.446**	0.196	0.365*	0.271	0.251	0.232	0.152	0.203	0.035	0.290*	0.048	0.187
	r_p			0.401**	0.172	0.333*	0.238	0.217	0.223	0.155	0.189	0.029	0.259	0.030	0.169
No. of secondary branches per plant	r_g				0.155	0.526**	0.103	0.262	0.306*	0.250	0.428**	0.167	0.487**	0.167	0.399**
	r_p				0.129	0.500**	0.097	0.241	0.293*	0.205	0.396**	0.148	0.450**	0.154	0.373**
Plant height (cm)	r_g					0.037	-0.035	0.094	-0.095	0.015	0.047	0.222	-0.190	0.180	0.050
	r_p					0.037	-0.035	0.080	-0.077	-0.006	0.035	0.174	-0.150	0.146	0.042
No. of matured pods per plant	r_g						0.536**	0.517**	-0.067	0.149	0.539**	0.287*	0.546**	0.518**	0.525**
	r_p						0.520**	0.483**	-0.061	0.133	0.508**	0.271	0.497**	0.490**	0.497**
No. of immature pods per plant	r_g							0.182	-0.149	0.164	0.155	0.040	0.161	0.089	0.125
	r_p							0.179	-0.148	0.148	0.141	0.033	0.142	0.087	0.112
Sound mature kernel (%)	r_g								-0.134	-0.093	0.143	-0.013	0.302*	0.255	0.161
	r_p								-0.128	-0.090	0.131	-0.012	0.269	0.235	0.150
100-kernel weight (g)	r_g									-0.029	0.230	0.063	0.359*	-0.258	0.247
	r_p									-0.024	0.219	0.059	0.337*	-0.246	0.236
Shelling out-turn (%)	r_g										0.243	0.043	0.155	0.367*	0.095
	r_p										0.251	0.053	0.121	0.309*	0.086
Kernel yield per plant (g)	r_g											0.817**	0.698**	0.506**	0.988**
	r_p											0.810**	0.667**	0.474**	0.985**
Biological yield per plant (g)	r_g												0.182	0.293*	0.832**
	r_p												0.139	0.269	0.824**
Harvest index (%)	r_g													0.406**	0.692**
	r_p													0.380**	0.669**
Oil content (%)	r_g														0.454**
	r_p														0.429**

***, ** Significant at 5 % and 1 % levels, respectively**

Table 4.12: Genotypic (r_g) and phenotypic (r_p) correlation coefficients among 15 characters in 50 genotypes of groundnut at Manavadar during *Kharif*-2020 (E_4)

Characters		Days to maturity	No. of primary branches per plant	No. of secondary branches per plant	Plant height (cm)	No. of matured pods per plant	No. of immature pods per plant	Sound mature kernel (%)	100-kernel weight (g)	Shelling out-turn (%)	Kernel yield per plant (g)	Biological yield per plant (g)	Harvest index (%)	Oil content (%)	Pod yield per plant (g)
Days to 50 % flowering	r_g	0.450**	0.014	0.125	-0.023	-0.081	-0.130	-0.004	0.019	0.131	0.000	0.115	-0.144	-0.279	-0.023
	r_p	0.298*	-0.011	0.100	-0.018	-0.063	-0.117	-0.003	0.013	0.114	0.002	0.111	-0.135	-0.243	-0.019
Days to maturity	r_g		-0.047	-0.249	-0.343*	-0.257	-0.186	-0.139	-0.260	-0.164	-0.173	0.294*	-0.476**	-0.337*	-0.133
	r_p		-0.097	-0.138	-0.227	-0.151	-0.091	-0.071	-0.163	-0.101	-0.101	0.182	-0.285*	-0.219	-0.077
No. of primary branches per plant	r_g			0.624**	0.191	0.433**	0.291*	0.319*	0.041	0.189	0.311*	0.121	0.287*	0.109	0.275
	r_p			0.562**	0.164	0.386**	0.245	0.275	0.033	0.197	0.271	0.097	0.239	0.089	0.230
No. of secondary branches per plant	r_g				0.390**	0.598**	0.338*	0.335*	0.203	0.277	0.655**	0.444**	0.455**	0.178	0.596**
	r_p				0.321*	0.553**	0.318*	0.317*	0.201	0.251	0.602**	0.388**	0.433**	0.155	0.550**
Plant height (cm)	r_g					0.090	-0.029	0.111	0.112	0.007	0.157	0.353*	-0.114	0.146	0.164
	r_p					0.063	-0.023	0.107	0.091	0.002	0.143	0.318*	-0.105	0.146	0.152
No. of matured pods per plant	r_g						0.374**	0.584**	0.040	0.027	0.772**	0.471**	0.691**	0.509**	0.767**
	r_p						0.384**	0.552**	0.037	0.024	0.734**	0.464**	0.642**	0.465**	0.734**
No. of immature pods per plant	r_g							0.152	-0.106	-0.024	0.014	-0.104	0.095	0.256	0.018
	r_p							0.155	-0.101	-0.024	0.041	-0.056	0.097	0.234	0.047
Sound mature kernel (%)	r_g								-0.035	-0.223	0.435**	0.367*	0.391**	0.177	0.492**
	r_p								-0.027	-0.211	0.402**	0.330*	0.372**	0.166	0.461**
100-kernel weight (g)	r_g									0.044	0.221	-0.029	0.333*	-0.363*	0.215
	r_p									0.046	0.212	-0.031	0.323*	-0.336*	0.205
Shelling out-turn (%)	r_g										0.162	-0.176	0.034	0.353*	-0.085
	r_p										0.185	-0.160	0.042	0.288*	-0.071
Kernel yield per plant (g)	r_g											0.702**	0.788**	0.401**	0.969**
	r_p											0.702**	0.769**	0.347*	0.966**
Biological yield per plant (g)	r_g												0.189	0.145	0.761**
	r_p												0.167	0.125	0.762**
Harvest index (%)	r_g													0.308*	0.778**
	r_p													0.270	0.762**
Oil content (%)	r_g														0.308*
	r_p														0.270

***, ** Significant at 5 % and 1 % levels, respectively**

correlated at genotypic and phenotypic level both with number of matured pods per plant (E_2, r_g = 0.527, r_p = 0.461) (E_3, r_g = 0.365, r_p = 0.333) (E_4, r_g = 0.433, r_p = 0.386). In case of E_2 significant and positive correlation at genotypic and phenotypic level both was found between number of primary branches per plant and sound mature kernel (E_2, r_g = 0.317, r_p = 0.294). Under E_3 number of primary branches per plant was significantly and positively correlated at genotypic level only with harvest index (E_3, r_g = 0.290). In case of E_4 number of primary branches per plant were significantly and positively correlated at genotypic level only with number of immature pods per plant (E_4, r_g = 0.291), sound mature kernel (E_4, r_g = 0.319), kernel yield per plant (E_4, r_g = 0.311) and harvest index (E_4, r_g = 0.287).

4.3.5 Number of secondary branches per plant

In all four environments number of secondary branches per plant had highly significant positive correlation at both genotypic and phenotypic level with number of matured pods per plant (E_1, r_g = 0.548, r_p = 0.528) (E_2, r_g = 0.485, r_p = 0.452) (E_3, r_g = 0.526, r_p = 0.500) (E_4, r_g = 0.598, r_p = 0.553), kernel yield per plant (E_1, r_g = 0.556, r_p = 0.523) (E_2, r_g = 0.567, r_p = 0.526) (E_3, r_g = 0.428, r_p = 0.396) (E_4, r_g = 0.655, r_p = 0.602) and harvest index (E_1, r_g = 0.580, r_p = 0.543) (E_2, r_g = 0.488, r_p = 0.458) (E_3, r_g = 0.487, r_p = 0.450) (E_4, r_g = 0.455, r_p = 0.433).

In case of E_1 number of secondary branches per plant was significantly and positively correlated at genotypic level with sound mature kernel (E_1, r_g = 0.286). Under E_2 number of secondary branches per plant exhibited highly significant and positive correlation at genotypic and phenotypic level with number of immature pods per plant (E_2, r_g = 0.405, r_p = 0.384) and sound mature kernel (E_2, r_g = 0.527, r_p = 0.499). Number of secondary branches per plant had significant and positive correlation at genotypic and phenotypic level with 100-kernel weight (E_3, r_g = 0.306, r_p = 0.293) in case of E_3. In case of E_4 number of secondary branches per plant exhibited significant and positive correlation at genotypic and phenotypic level with plant height (E_4, r_g = 0.390, r_p = 0.321), number of immature pods per plant (E_4, r_g = 0.338, r_p = 0.318), sound mature kernel (E_4, r_g = 0.335, r_p = 0.317) and biological yield per plant (E_4, r_g = 0.444, r_p = 0.388).

4.3.6 Plant height

In case of E_2, E_3 and E_4 correlation of plant height with biological yield per plant at genotypic and phenotypic level was significant and positive in case of E_4 (E_4, r_g = 0.353, r_p = 0.318) only, while it was non-significant and positive in case of E_2 (E_2, r_g =

0.187, r_p = 0.147) and E_3 (E_3, r_g = 0.222, r_p = 0.174). Under E_1 plant height had non-significant and negative correlation at genotypic and phenotypic level with number of matured pods per plant (E_1, r_g = -0.192, r_p = -0.176), sound mature kernel (E_1, r_g = -0.227, r_p = -0.2093) and oil content (E_1, r_g = -0.135, r_p = -0.118), while it had non-significant and positive correlation at genotypic and phenotypic level with shelling out-turn (E_1, r_g = 0.111, r_p = 0.121). In case of E_2 plant height exhibited non-significant and positive correlation at genotypic and phenotypic level with number of immature pods per plant (E_2, r_g = 0.191, r_p = 0.174), shelling out-turn (E_2, r_g = 0.249, r_p = 0.230) and kernel yield per plant (E_2, r_g = 0.141, r_p = 0.110).

4.3.7 Number of matured pods per plant

In all four environments number of matured pods per plant had highly significant positive correlation at both genotypic and phenotypic level with sound mature kernel (E_1, r_g = 0.568, r_p = 0.540) (E_2, r_g = 0.572, r_p = 0.535) (E_3, r_g = 0.517, r_p = 0.483) (E_4, r_g = 0.584, r_p = 0.552), kernel yield per plant (E_1, r_g = 0.923, r_p = 0.861) (E_2, r_g = 0.637, r_p = 0.587) (E_3, r_g = 0.539, r_p = 0.508) (E_4, r_g = 0.772, r_p = 0.734), harvest index (E_1, r_g = 0.673, r_p = 0.625) (E_2, r_g = 0.513, r_p = 0.471) (E_3, r_g = 0.546, r_p = 0.497 (E_4, r_g = 0.691, r_p = 0.642) and oil content (E_1, r_g = 0.369, r_p = 0.348) (E_2, r_g = 0.399, r_p = 0.371) (E_3, r_g = 0.518, r_p = 0.490) (E_4, r_g = 0.509, r_p = 0.465).

Correlation of number of matured pods per plant with biological yield per plant was highly significant and positive at both genotypic and phenotypic level in case of E_1 (E_1, r_g = 0.687, r_p = 0.651), significant and positive at genotypic and phenotypic level in case of E_2 (E_2, r_g = 0.327, r_p = 0.302), significant and positive at genotypic level only in case of E_3 (E_3, r_g = 0.287), while it was highly significant and positive at genotypic and phenotypic level in case of E_4 (E_4, r_g = 0.471, r_p = 0.464).

In case of E_3 and E_4 number of matured pods per plant had highly significant and positive correlation at both genotypic and phenotypic level with number of immature pods per plant (E_3, r_g = 0.536, r_p = 0.520) (E_4, r_g = 0.374, r_p = 0.384).

4.3.8 Number of immature pods per plant

In all four environments number of immature pods per plant had non-significant and positive correlation at both genotypic and phenotypic level with sound mature kernel (E_1, r_g = 0.191, r_p = 0.188) (E_2, r_g = 0.143, r_p = 0.140) (E_3, r_g = 0.182, r_p = 0.179) (E_4, r_g = 0.152, r_p = 0.155) and oil content (E_1, r_g = 0.179, r_p = 0.172) (E_2, r_g = 0.277, r_p = 0.263) (E_3, r_g = 0.089, r_p = 0.087) (E_4, r_g = 0.256, r_p = 0.234).

Correlation of number of immature pods per plant with harvest index was non-significant and positive at both genotypic and phenotypic level in case of E_1 (E_1, r_g = 0.148, r_p = 0.151), significant and positive at both genotypic and phenotypic level in case of E_2 (E_2, r_g = 0.320, r_p = 0.310) and non-significant and positive at both genotypic and phenotypic level in case of E_3 (E_3, r_g = 0.161, r_p = 0.142).

4.3.9 Sound mature kernel

In case of E_1, E_2 and E_4 sound mature kernel had significant and positive correlation at both genotypic and phenotypic level with kernel yield per plant (E_1, r_g = 0.462, r_p = 0.437) (E_2, r_g = 0.531, r_p = 0.499) (E_4, r_g = 0.435, r_p = 0.402) and biological yield per plant (E_1, r_g = 0.478, r_p = 0.456) (E_2, r_g = 0.316, r_p = 0.295) (E_4, r_g = 0.367, r_p = 0.330). Under E_1 sound mature kernel was highly significant and positively correlated at both genotypic and phenotypic level with 100-kernel weight (E_1, r_g = 0.403, r_p = 0.390).

Correlation of sound mature kernel with harvest index was significant and positive at genotypic level in case of E_1 (E_1, r_g = 0.285), highly significant and positive at both genotypic and phenotypic level in case of E_2 (E_2, r_g = 0.384, r_p = 0.360), significant and positive at genotypic level in case of E_3 (E_3, r_g = 0.302) and highly significant and positive at both genotypic and phenotypic level in case of E_4 (E_4, r_g = 0.391, r_p = 0.372).

4.3.10 100-kernel weight

In all four environments 100-kernel weight had significant and positive correlation at both genotypic and phenotypic level with harvest index (E_1, r_g = 0.322, r_p = 0.300) (E_2, r_g = 0.431, r_p = 0.408) (E_3, r_g = 0.359, r_p = 0.337) (E_4, r_g = 0.333, r_p = 0.323). Under E_1 and E_2 100-kernel weight had significant and positive correlation at both genotypic and phenotypic level with kernel yield per plant (E_1, r_g = 0.347, r_p = 0.322) (E_2, r_g = 0.369, r_p = 0.342).

Correlation of 100-kernel weight with oil content was significant and negative in case of E_1 (E_1, r_g = -0.382, r_p = -0.369), E_2 (E_2, r_g = -0.353, r_p = -0.339) and E_4 (E_4, r_g = -0.363, r_p = -0.336).

4.3.11 Shelling out-turn

Correlation of shelling out-turn with kernel yield per plant was highly significant and positive at genotypic and phenotypic level in case of E_1 (E_1, r_g = 0.393, r_p = 0.386), while it was non-significant and positive at genotypic and phenotypic level in case of E_2 (E_2, r_g = 0.284, r_p = 0.283), E_3 (E_2, r_g = 0.243, r_p = 0.251) and E_4 (E_2, r_g =

0.162, r_p = 0.185). In case of E_1, E_3 and E_4 shelling out-turn had significant and positive correlation at genotypic and phenotypic level with oil content (E_1, r_g = 0.454, r_p = 0.425) (E_3, r_g = 0.367, r_p = 0.309) (E_4, r_g = 0.353, r_p = 0.288).

4.3.12 Kernel yield per plant

In all four environments kernel yield per plant had highly significant and positive correlation at genotypic and phenotypic level with biological yield per plant (E_1, r_g = 0.723, r_p = 0.722) (E_2, r_g = 0.638, r_p = 0.647) (E_3, r_g = 0.817, r_p = 0.810) (E_4, r_g = 0.702, r_p = 0.702) and harvest index (E_1, r_g = 0.691, r_p = 0.701) (E_2, r_g = 0.602, r_p = 0.585) (E_3, r_g = 0.698, r_p = 0.667) (E_4, r_g = 0.788, r_p = 0.769). Correlation of kernel yield per plant with oil content was significant and positive at genotypic level only in case of E_1 (E_1, r_g = 0.306), while it was significant and positive at genotypic and phenotypic level both in case of E_3 (E_3, r_g = 0.506, r_p = 0.474) and E_4 (E_4, r_g = 0.401, r_p = 0.347).

4.3.13 Biological yield per plant

In case of E_3 and E_4 biological yield per plant had non- significant and positive correlation at genotypic and phenotypic level with harvest index (E_3, r_g = 0.182, r_p = 0.139) (E_4, r_g = 0.189, r_p = 0.167). Correlation of biological yield per plant with oil content was significant and positive at genotypic level only in case of E_3 (E_3, r_g = 0.293), while it was non-significant and positive at genotypic and phenotypic level both in case of E_4 (E_4, r_g = 0.145, r_p = 0.125).

4.3.14 Harvest index

Correlation of harvest index with oil content was non-significant and positive at genotypic and phenotypic level in case of E_1 (E_1, r_g = 0.169, r_p = 0.152) and E_2 (E_2, r_g = 0.173, r_p = 0.155), while it was highly significant and positive at genotypic and phenotypic level in case of E_3 (E_3, r_g = 0.406, r_p = 0.380) and significant and positive at genotypic only in case of E_4 (E_4, r_g = 0.308).

4.4 PATH COEFFICIENT ANALYSIS

The phenotypic correlation coefficients calculated for different pairs of character were subjected to path coefficient analysis for partitioning these values into the direct and indirect effects. The results obtained for direct and indirect effects of various characters on pod yield per plant are presented environment wise from Table 4.13 to 4.16. Results are discussed largely on direct and indirect values of phenotypic path coefficient.

4.4.1 Path coefficient analysis under E_1 (Junagadh, *Kharif*-2019)

Under E_1 days to 50 % flowering showed negative and moderate indirect effect on pod yield per plant *via* kernel yield per plant (-0.2110). Number of primary branches per plant showed positive and low indirect effect on pod yield per plant *via* kernel yield per plant (0.1246). Number of secondary branches per plant showed positive and high indirect effect on pod yield per plant *via* kernel yield per plant (0.4321). Character number of matured pods per plant exhibited positive and high indirect effect on pod yield per plant *via* kernel yield per plant (0.7116) and *via* biological yield per plant (0.1064) indirect effect was positive and low on pod yield per plant. Sound mature kernel showed positive and high indirect effect on pod yield per plant *via* kernel yield per plant (0.3611). Positive and moderate indirect effect was showed by 100-kernel weight on pod yield per plant *via* kernel yield per plant (0.2665).

Shelling out-turn (-0.1611) exhibited negative and low direct effect on pod yield per plant, while it showed positive and high indirect effect on pod yield per plant *via* kernel yield per plant (0.3192). Kernel yield per plant (0.8265) showed positive and highest direct effect on pod yield per plant and also showed positive low indirect effect on pod yield per plant *via* biological yield per plant (0.1180). Biological yield per plant (0.1635) showed positive and low direct effect on pod yield per plant and also exhibited positive and high indirect effect on pod yield per plant *via* kernel yield per plant (0.5966). Harvest index (0.1309) showed positive and low direct effect on pod yield per plant, while its indirect effect on pod yield per plant was positive and high *via* kernel yield per plant (0.5790). Oil content showed positive and moderate indirect effect on pod yield per plant *via* kernel yield per plant (0.2334). Residual effect for this environment was 3.57 %.

4.4.2 Path coefficient analysis under E_2 (Junagadh, *Kharif*-2020)

Under E_2 number of primary branches per plant showed positive and low indirect effect on pod yield per plant *via* kernel yield per plant (0.1676). Number of secondary branches per plant showed positive and high indirect effect on pod yield per plant *via* kernel yield per plant (0.4049). Character number of matured pods per plant exhibited positive and high indirect effect on pod yield per plant *via* kernel yield per plant (0.4524). Sound mature kernel showed positive and high indirect effect on pod yield per plant *via* kernel yield per plant (0.3847), while positive and moderate indirect effect was showed by 100-kernel weight on pod yield per plant *via* kernel yield per plant (0.2632). Shelling out-turn (-0.2171) exhibited negative and moderate direct effect on pod yield per plant, while it showed positive and moderate indirect effect on pod yield per plant *via* kernel yield per plant (0.2183).

Highest and positive direct effect on pod yield per plant was exhibited by kernel yield per plant (0.7705), while its indirect effect on pod yield per plant was positive and low *via* biological yield per plant (0.1370) and harvest index (0.1029). Biological yield per plant (0.2116) showed positive and moderate direct effect on pod yield per plant and also exhibited positive and high indirect effect on pod yield per plant *via* kernel yield per plant (0.4986). Harvest index (0.1760) showed positive and low direct effect on pod yield per plant, while its indirect effect on pod yield per plant was positive and high *via* kernel yield per plant (0.4507). Oil content showed positive and low indirect effect on pod yield per plant *via* kernel yield per plant (0.1592). Residual effect for this environment was 4.10 %.

4.4.3 Path coefficient analysis under E_3 (Manavadar, *Kharif*-2019)

Under E_3 days to maturity showed negative and low indirect effect on pod yield per plant *via* kernel yield per plant (-0.1276). Number of primary branches per plant showed positive and low indirect effect on pod yield per plant *via* kernel yield per plant (0.1701). Number of secondary branches per plant showed positive and high indirect effect on pod yield per plant *via* kernel yield per plant (0.3577). Character number of matured pods per plant exhibited positive and high indirect effect on pod yield per plant *via* kernel yield per plant (0.4580). Number of immature pods per plant exhibited positive and low indirect effect on pod yield per plant *via* kernel yield per plant (0.1271). Sound mature kernel showed positive and low indirect effect on pod yield per plant *via* kernel yield per plant (0.1185).

Positive and low indirect effect on pod yield per plant *via* kernel yield per plant (0.1185) was exhibited by 100-kernel weight. Shelling out-turn (-0.1527) exhibited negative and low direct effect on pod yield per plant, while it showed positive and moderate indirect effect on pod yield per plant *via* kernel yield per plant (0.2268). Highest and positive direct effect on pod yield per plant was exhibited by kernel yield per plant (0.9022). Biological yield per plant exhibited positive and high indirect effect on pod yield per plant *via* kernel yield per plant (0.7309). Harvest index showed positive and high indirect effect on pod yield per plant *via* kernel yield per plant (0.6021). Oil content showed positive and high indirect effect on pod yield per plant *via* kernel yield per plant (0.6021). Residual effect for this environment was 3.95 %.

Table 4.13: Phenotypic path coefficient analysis showing direct (diagonal and bold) and indirect effects of different characters on pod yield per plant in 50 genotypes of groundnut at Junagadh during *Kharif*-2019 (E_1)

Characters	Days to 50 % flowering	Days to maturity	No. of primary branches per plant	No. of secondary branches per plant	Plant height (cm)	No. of matured pods per plant	No. of immature pods per plant	Sound mature kernel (%)	100-kernel weight (g)	Shelling out-turn (%)	Kernel yield per plant (g)	Biological yield per plant (g)	Harvest index (%)	Oil content (%)	Phenotypic correlation with pod yield/plant (g)
Days to 50 % flowering	**0.005**	0.000	0.000	0.000	0.003	0.001	-0.001	-0.003	0.002	-0.003	-0.211	-0.047	-0.014	-0.001	-0.270
Days to maturity	0.002	**0.000**	0.000	0.000	0.001	0.000	0.000	-0.002	0.001	0.011	-0.094	-0.004	-0.019	0.000	-0.104
No. of primary branches per plant	0.000	0.000	**0.000**	0.004	-0.001	0.000	0.000	0.002	0.000	-0.031	0.125	0.004	0.017	0.000	0.119
No. of secondary branches per plant	0.000	0.000	0.000	**0.010**	-0.003	-0.001	-0.001	0.005	-0.001	-0.015	0.432	0.038	0.071	0.001	0.535**
Plant height (cm)	0.001	0.000	0.000	-0.003	**0.011**	0.000	0.001	-0.004	0.000	-0.020	-0.087	-0.010	-0.014	0.000	-0.123
No. of matured pods per plant	-0.001	0.000	0.000	0.005	-0.002	**-0.002**	-0.001	0.009	-0.001	-0.042	0.712	0.106	0.082	0.001	0.866**
No. of immature pods per plant	0.001	0.000	0.000	0.001	-0.001	0.000	**-0.006**	0.003	0.002	-0.029	0.089	-0.005	0.020	0.001	0.075
Sound mature kernel (%)	-0.001	0.000	0.000	0.003	-0.002	-0.001	-0.001	**0.017**	-0.003	-0.004	0.361	0.075	0.035	0.000	0.478**
100-kernel weight (g)	-0.001	0.000	0.000	0.001	0.000	0.000	0.001	0.007	**-0.008**	0.015	0.267	0.037	0.039	-0.001	0.356*
Shelling out-turn (%)	0.000	0.000	0.000	0.001	0.001	-0.001	-0.001	0.000	0.001	**-0.161**	0.319	0.018	0.022	0.001	0.201
Kernel yield per plant (g)	-0.001	0.000	0.000	0.005	-0.001	-0.002	-0.001	0.007	-0.003	-0.062	**0.827**	0.118	0.092	0.001	0.979**
Biological yield per plant (g)	-0.001	0.000	0.000	0.002	-0.001	-0.001	0.000	0.008	-0.002	-0.018	0.597	**0.164**	0.009	0.001	0.756**
Harvest index (%)	-0.001	0.000	0.000	0.005	-0.001	-0.001	-0.001	0.005	-0.002	-0.027	0.579	0.012	**0.131**	0.000	0.698**
Oil content (%)	-0.001	0.000	0.000	0.002	-0.001	-0.001	-0.001	0.002	0.003	-0.068	0.233	0.027	0.020	**0.003**	0.217

***, ** Significant at 5 % and 1 % levels, respectively**
Residual effect, R = 0.0357

Table 4.14: Phenotypic path coefficient analysis showing direct (diagonal and bold) and indirect effects of different characters on pod yield per plant in 50 genotypes of groundnut at Junagadh during *Kharif*-2020 (E_2)

Characters	Days to 50 % flowering	Days to maturity	No. of primary branches per plant	No. of secondary branches per plant	Plant height (cm)	No. of matured pods per plant	No. of immature pods per plant	Sound mature kernel (%)	100-kernel weight (g)	Shelling out-turn (%)	Kernel yield per plant (g)	Biological yield per plant (g)	Harvest index (%)	Oil content (%)	Phenotypic correlation with pod yield/plant (g)
Days to 50 % flowering	**0.020**	-0.009	0.000	0.000	0.001	0.000	0.001	0.001	0.001	0.020	-0.073	0.001	-0.016	0.000	-0.053
Days to maturity	0.008	**-0.023**	0.000	-0.002	0.002	0.000	0.001	0.000	0.001	0.014	-0.095	0.033	-0.060	0.000	-0.122
No. of primary branches per plant	0.002	0.002	**0.003**	0.004	0.000	0.001	-0.001	0.004	0.000	-0.020	0.168	0.032	0.027	0.000	0.221
No. of secondary branches per plant	-0.001	0.004	0.001	**0.009**	0.000	0.001	-0.003	0.006	-0.001	-0.027	0.405	0.047	0.081	0.000	0.520**
Plant height (cm)	-0.001	0.006	0.000	0.000	**-0.008**	0.000	-0.001	0.000	0.001	-0.050	0.085	0.031	-0.013	0.000	0.049
No. of matured pods per plant	-0.002	0.004	0.001	0.004	0.001	**0.002**	-0.001	0.006	0.000	-0.025	0.452	0.064	0.083	0.000	0.588**
No. of immature pods per plant	-0.003	0.005	0.000	0.003	-0.001	0.000	**-0.006**	0.002	0.000	-0.049	0.097	-0.036	0.055	0.000	0.066
Sound mature kernel (%)	0.002	0.000	0.001	0.004	0.000	0.001	-0.001	**0.012**	0.000	-0.036	0.385	0.062	0.063	0.000	0.493**
100-kernel weight (g)	-0.004	0.003	0.000	0.001	0.001	0.000	0.000	0.000	**-0.006**	-0.007	0.263	0.015	0.072	0.000	0.339*
Shelling out-turn (%)	-0.002	0.002	0.000	0.001	-0.002	0.000	-0.001	0.002	0.000	**-0.217**	0.218	-0.023	0.026	0.000	0.004
Kernel yield per plant (g)	-0.002	0.003	0.001	0.005	-0.001	0.001	-0.001	0.006	-0.002	-0.062	**0.771**	0.137	0.103	0.000	0.958**
Biological yield per plant (g)	0.000	-0.004	0.001	0.002	-0.001	0.001	0.001	0.004	0.000	0.023	0.499	**0.212**	-0.030	0.000	0.706**
Harvest index (%)	-0.002	0.008	0.001	0.004	0.001	0.001	-0.002	0.004	-0.002	-0.032	0.451	-0.036	**0.176**	0.000	0.570**
Oil content (%)	-0.004	0.006	0.000	0.002	-0.001	0.001	-0.002	0.003	0.002	-0.050	0.159	0.006	0.027	**-0.001**	0.148

***, ** Significant at 5 % and 1 % levels, respectively**
Residual effect, R = 0.0410

Table 4.15: Phenotypic path coefficient analysis showing direct (diagonal and bold) and indirect effects of different characters on pod yield per plant in 50 genotypes of groundnut at Manavadar during *Kharif*-2019 (E_3)

Characters	Days to 50 % flowering	Days to maturity	No. of primary branches per plant	No. of secondary branches per plant	Plant height (cm)	No. of matured pods per plant	No. of immature pods per plant	Sound mature kernel (%)	100-kernel weight (g)	Shelling out-turn (%)	Kernel yield per plant (g)	Biological yield per plant (g)	Harvest index (%)	Oil content (%)	Phenotypic correlation with pod yield/plant (g)
Days to 50 % flowering	**0.007**	0.002	0.000	0.000	0.001	-0.001	0.000	0.000	0.001	-0.015	0.001	0.010	-0.008	0.001	-0.004
Days to maturity	0.002	**0.006**	0.000	0.001	0.000	-0.002	0.001	0.000	0.000	0.016	-0.128	-0.004	-0.010	0.000	-0.118
No. of primary branches per plant	0.000	-0.001	**0.001**	-0.001	0.001	0.003	-0.002	0.000	0.001	-0.024	0.170	0.003	0.019	0.000	0.169
No. of secondary branches per plant	0.000	-0.002	0.000	**-0.003**	0.001	0.004	-0.001	0.000	0.002	-0.031	0.358	0.013	0.033	0.000	0.372**
Plant height (cm)	0.001	0.000	0.000	0.000	**0.005**	0.000	0.000	0.000	-0.001	0.001	0.031	0.015	-0.011	0.000	0.042
No. of matured pods per plant	-0.001	-0.001	0.000	-0.001	0.000	**0.008**	-0.004	0.000	0.000	-0.020	0.458	0.024	0.036	-0.001	0.496**
No. of immature pods per plant	0.000	-0.001	0.000	0.000	0.000	0.004	**-0.008**	0.000	-0.001	-0.023	0.127	0.003	0.010	0.000	0.112
Sound mature kernel (%)	-0.001	-0.001	0.000	-0.001	0.000	0.004	-0.001	**-0.001**	-0.001	0.014	0.119	-0.001	0.019	-0.001	0.150
100-kernel weight (g)	-0.001	0.000	0.000	-0.001	0.000	-0.001	0.001	0.000	**0.006**	0.004	0.198	0.005	0.024	0.001	0.236
Shelling out-turn (%)	0.001	-0.001	0.000	-0.001	0.000	0.001	-0.001	0.000	0.000	**-0.153**	0.227	0.005	0.009	-0.001	0.086
Kernel yield per plant (g)	0.000	-0.001	0.000	-0.001	0.000	0.004	-0.001	0.000	0.001	-0.038	**0.902**	0.072	0.048	-0.001	0.985**
Biological yield per plant (g)	0.001	0.000	0.000	0.000	0.001	0.002	0.000	0.000	0.000	-0.008	0.731	**0.088**	0.010	-0.001	0.823**
Harvest index (%)	-0.001	-0.001	0.000	-0.001	-0.001	0.004	-0.001	0.000	0.002	-0.018	0.602	0.012	**0.072**	-0.001	0.668**
Oil content (%)	-0.002	0.000	0.000	0.000	0.001	0.004	-0.001	0.000	-0.001	-0.047	0.428	0.024	0.027	**-0.003**	0.428**

***, ** Significant at 5 % and 1 % levels, respectively**
Residual effect, R = 0.0395

Table 4.16: Phenotypic path coefficient analysis showing direct (diagonal and bold) and indirect effects of different characters on pod yield per plant in 50 genotypes of groundnut at Manavadar during *Kharif*-2020 (E_4)

Characters	Days to 50 % flowering	Days to maturity	No. of primary branches per plant	No. of secondary branches per plant	Plant height (cm)	No. of matured pods per plant	No. of immature pods per plant	Sound mature kernel (%)	100-kernel weight (g)	Shelling out-turn (%)	Kernel yield per plant (g)	Biological yield per plant (g)	Harvest index (%)	Oil content (%)	Phenotypic correlation with pod yield/plant (g)
Days to 50 % flowering	**0.007**	-0.002	0.000	0.000	0.000	0.001	-0.001	0.000	0.000	-0.027	0.002	0.007	-0.006	0.000	-0.019
Days to maturity	0.002	**-0.008**	-0.001	0.000	0.000	0.001	-0.001	0.000	-0.001	0.024	-0.095	0.012	-0.013	0.000	-0.077
No. of primary branches per plant	0.000	0.001	**0.010**	-0.001	0.000	-0.003	0.001	-0.001	0.000	-0.047	0.252	0.007	0.011	0.000	0.230
No. of secondary branches per plant	0.001	0.001	0.006	**-0.002**	0.000	-0.005	0.002	-0.001	0.001	-0.060	0.561	0.026	0.019	0.000	0.550**
Plant height (cm)	0.000	0.002	0.002	-0.001	**0.001**	-0.001	0.000	0.000	0.001	-0.001	0.133	0.021	-0.005	0.000	0.152
No. of matured pods per plant	0.000	0.001	0.004	-0.001	0.000	**-0.009**	0.002	-0.001	0.000	-0.006	0.684	0.031	0.028	0.000	0.734**
No. of immature pods per plant	-0.001	0.001	0.003	-0.001	0.000	-0.003	**0.006**	0.000	-0.001	0.006	0.038	-0.004	0.004	0.000	0.047
Sound mature kernel (%)	0.000	0.001	0.003	-0.001	0.000	-0.005	0.001	**-0.002**	0.000	0.050	0.375	0.022	0.016	0.000	0.460**
100-kernel weight (g)	0.000	0.001	0.000	0.000	0.000	0.000	-0.001	0.000	**0.006**	-0.011	0.198	-0.002	0.014	0.000	0.205
Shelling out-turn (%)	0.001	0.001	0.002	-0.001	0.000	0.000	0.000	0.000	0.000	**-0.238**	0.172	-0.011	0.002	0.000	-0.071
Kernel yield per plant (g)	0.000	0.001	0.003	-0.001	0.000	-0.007	0.000	-0.001	0.001	-0.044	**0.933**	0.047	0.034	0.000	0.966**
Biological yield per plant (g)	0.001	-0.001	0.001	-0.001	0.000	-0.004	0.000	-0.001	0.000	0.038	0.655	**0.067**	0.007	0.000	0.761**
Harvest index (%)	-0.001	0.002	0.002	-0.001	0.000	-0.006	0.001	-0.001	0.002	-0.010	0.717	0.011	**0.044**	0.000	0.761**
Oil content (%)	-0.002	0.002	0.001	0.000	0.000	-0.004	0.001	0.000	-0.002	-0.069	0.323	0.000	0.012	**-0.001**	0.270

***, ** Significant at 5 % and 1 % levels, respectively**

Residual effect, R = 0.0363

4.4.4 Path coefficient analysis under E_4 (Manavadar, *Kharif*-2020)

Under E_4 number of primary branches per plant showed positive and moderate indirect effect on pod yield per plant *via* kernel yield per plant (0.2523). Number of secondary branches per plant showed positive and high indirect effect on pod yield per plant *via* kernel yield per plant (0.5614), while positive and low indirect effect on pod yield per plant from plant height was exhibited *via* kernel yield per plant (0.1333). Character number of matured pods per plant exhibited positive and high indirect effect on pod yield per plant *via* kernel yield per plant (0.6844). Sound mature kernel showed positive and high indirect effect on pod yield per plant *via* kernel yield per plant (0.3751).

Positive and low indirect effect on pod yield per plant *via* kernel yield per plant (0.1975) was exhibited by 100-kernel weight. Shelling out-turn (-0.2378) exhibited negative and moderate direct effect on pod yield per plant, while it showed positive and low indirect effect on pod yield per plant *via* kernel yield per plant (0.1722). Kernel yield per plant (0.9325) showed highest and positive direct effect on pod yield per plant. Biological yield per plant exhibited positive and high indirect effect on pod yield per plant *via* kernel yield per plant (0.6547). Harvest index showed positive and high indirect effect on pod yield per plant *via* kernel yield per plant (0.7172). Oil content showed positive and high indirect effect on pod yield per plant *via* kernel yield per plant (0.3233). Residual effect for this environment was 3.63 %.

4.5 G X E INTERACTION AND STABILITY PARAMETERS

Results for joint regression analysis and stability parameters for different characters are presented in forth-coming paragraph.

4.5.1 Analysis of variance for phenotypic stability

Analysis of variance for phenotypic stability as per Eberhart and Russel (1966) revealed that the mean squares due to genotypes (G) were found highly significant for all the characters studied, when tested against pooled error and pooled deviation (Table 4.17). The mean squares due to environments (E) when tested against pooled error were found significant for all the characters except number of primary branches per plant and harvest index, while mean squares due to environments (E) when tested against pooled deviation were found significant for days to 50 % flowering, days to maturity, plant height, number of matured pods per plant, sound mature kernel, 100-kernel weight and shelling out-turn.

Table 4.17: Analysis of variance for stability over four environments in groundnut as per Eberhart and Russel (1966) model

Source of variation	d. f.	Days to 50 % flowering	Days to maturity	No. of primary branches per plant	No. of secondary branches per plant	Plant height (cm)	No. of matured pods per plant	No. of immature pods per plant	Sound mature kernel (%)
Environments (E)	3	102.10**++	13.24**++	0.07	0.83**	405.99**++	88.78**++	3.85**	252.04**++
Genotypes	49	21.95**++	7.73**++	1.36**++	2.85**++	25.08**++	56.60**++	2.92**+	100.91**++
G x E	147	1.17**	2.13**++	0.12**	0.46**	12.03**+	3.24**	1.63**	27.15**
Environment + (G x E)	150	3.19**++	2.36**++	0.13**	0.47**	19.91**++	4.95**+	1.68**	31.65**
Environment (linear)	1	306.30**++	39.73**++	0.24*	2.50**+	1217.99**++	266.37**++	11.57**+	756.12**++
G x E (linear)	49	1.52**+	3.70**++	0.09**	0.53**	18.03**++	2.81**	1.46**	26.22**
Pooled deviation	100	0.98**	1.33	0.14**	0.42**	8.85**	3.39**	1.70**	27.07**
Pooled error	392	0.63	1.45	0.05	0.04	2.59	1.15	0.06	2.49

***, ** Significant at 5 and 1 levels, respectively when tested against pooled error**

+, ++ Significant at 5 and 1 levels, respectively when tested against pooled deviation

Table 4.17: *Contd…*

Source of variation	d. f.	100-kernel weight (g)	Shelling out-turn (%)	Pod yield per plant (g)	Kernel yield per plant (g)	Biological yield per plant (g)	Harvest index (%)	Oil content (%)
Environments (E)	3	57.30**++	14.70**+	7.24**	3.93**	54.17**	4.67	0.62*
Genotypes	49	185.89**++	70.89**++	41.65**++	21.66**++	158.95**++	126.89**++	12.23**++
G x E	147	8.06**	3.79**	6.35**	3.12**	35.75**	5.86**	0.63**
Environment + (G x E)	150	9.05**+	4.01**	6.37**	3.14**	36.12**	5.84**	0.64**
Environment (linear)	1	171.91**++	44.10**++	21.74**	11.81**	162.53**+	14.02*	1.87**
G x E (linear)	49	11.92**++	2.99	5.88**	2.49**	31.33**	6.99**	0.78**
Pooled deviation	100	6.02**	4.11**	6.46**	3.38**	37.20**	5.19**	0.55**
Pooled error	392	1.10	2.67	1.22	0.65	6.27	3.36	0.20

***, ** Significant at 5 and 1 levels, respectively when tested against pooled error**

+, ++ Significant at 5 and 1 levels, respectively when tested against pooled deviation

G x E interactions were found significant for all the characters when tested against error mean square. However, G x E interaction was found significant for days to maturity and plant height when tested against pooled deviation. The variance due to E + (G x E) was further partitioned into linear [(Environment (linear) and G x E (linear)] and non-linear (pooled deviations) components. Mean square due to E + (G x E) component was significant for all the traits when tested against pooled error, while against pooled deviation trait days to 50 % flowering, days to maturity, plant height, number of matured pods per plant and 100-kernel weight were found significant. G x E (linear) component was significant for all the traits except shelling out-turn when tested against pooled error, while the same variance *i.e.* G x E (linear) was significant for days to 50% flowering, days to maturity, plant height and 100-kernel weight when tested against pooled deviation. The mean squares due to environments (linear) were significant for all the characters against pooled error, while mean squares due to environments (linear) were found significant for days to 50 % flowering, days to maturity, number of secondary branches per plant, plant height, number of matured pods per plant, number of immature pods per plant, sound mature kernel and 100-kernel weight when tested against pooled deviation. Mean squares due to pooled deviation were significant for all the characters except days to maturity (Table 4.17).

4.5.2 Environmental index

The estimates of environmental index worked-out for different traits are presented in Table 4.18. E_1 was observed to be favorable for number of primary branches per plant (0.0465), number of secondary branches per plant (0.1560), plant height (2.7039), sound mature kernel (2.8359), 100-kernel weight (1.5930) and oil content (0.1575). For characters like days to 50 % flowering (-0.9833), days to maturity (-0.4816), number of matured pods per plant (1.1410), pod yield per plant (0.4411), kernel yield per plant (0.3282), biological yield per plant (1.3030) and harvest index (0.2132) E_2 was favorable. E_3 was observed to be favorable for shelling out-turn (0.5996), while E_4 was observed to be favorable for number of immature pods per plant (-0.3296).

Table 4.18: Estimates of environmental index for various characters under different environments in groundnut

Sr. No.	Characters	Environmental Index			
		Junagadh		Manavadar	
		***Kharif*-2019**	***Kharif*-2020**	***Kharif*-2019**	***Kharif*-2020**
		E_1	**E_2**	**E_3**	**E_4**
1.	Days to 50 % flowering	-0.5900	-0.9833	2.1233	-0.5500
2.	Days to maturity	-0.0216	-0.4816	0.7183	-0.2150
3.	No. of primary branches per plant	0.0465	0.0049	-0.0004	-0.0510
4.	No. of secondary branches per plant	0.1560	0.0013	-0.1600	0.0026
5.	Plant height (cm)	2.7039	2.2143	-2.6181	-2.3001
6.	No. of matured pods per plant	1.0730	1.1410	-0.6470	-1.5670
7.	No. of immature pods per plant	0.2543	0.2036	-0.1283	-0.3296
8.	Sound mature kernel (%)	2.8359	0.7031	-1.3673	-2.1717
9.	100-kernel weight (g)	1.5930	-0.3416	-0.6075	-0.6438
10.	Shelling out-turn (%)	-0.1868	0.2422	0.5996	-0.6549
11.	Pod yield per plant (g)	0.1878	0.4411	-0.3734	-0.2556
12.	Kernel yield per plant (g)	0.1277	0.3282	-0.1642	-0.2917
13.	Biological yield per plant (g)	0.2064	1.3030	-1.1852	-0.3242
14.	Harvest index (%)	0.1597	0.2132	0.0780	-0.4510
15.	Oil content (%)	0.1575	-0.0884	-0.0691	0.0000

4.5.3 Stability parameters

The stability of performance is one of the most desired characteristics of a genotype for wider adaptation**.** In present study linear regression is regarded as measure of responsiveness and deviation from regression as measure of stability of a particular genotype. The genotypes with higher *per se* performance with non-significant S^2d_i were classified on the basis of regression coefficient (b_i). The genotypes with $b_i < 1$ (significantly less than 1) were identified for poor environmental conditions and considered as above average stable, $b_i > 1$ (significantly higher than 1) for good environmental conditions and considered as below average stable and $b_i= 1$ for average environmental conditions and considered as stable in all environments. A genotype is considered to be stable in performance if it has high mean performance, unit regression coefficient ($b_i= 1$) and least deviation from regression ($S^2d_i = 0$).

Stability parameters *viz.*, mean performance (X_i), regression coefficient (b_i) and deviation from linear regression (S^2d_i) for fifty genotypes of groundnut were estimated for fifteen characters to assess the relative phenotypic stability of performance over environments and the results are presented in Table 4.19 to Table 4.33. The results are discussed considering testing of significance of b_i value on the basis of S.Em. calculated for individual genotype *i.e.* $1-b_i/SE(b_i)$. The character-wise results on phenotypic stability are presented here as follows.

4.5.3.1 Days to 50 % flowering

Days to 50 % flowering ranged from 24.583 days (JVB-2494) to 34.917 days (JVB-LS-2507). Stability parameters for this trait revealed that 35 genotypes expressed non-significant deviation from regression indicating their predictable behaviour.

Out of above 35 genotypes, 21 genotypes had mean values below population mean (29.95) so flower earlier. Genotypes *viz.* JVB-2494, JVB-LS-2502, JVB-2508, JVB-2511, JVB-2513, JVB-2515, JVB-2517, JVB-2529, JVB-2530, JVB-2532, JVB-2534 and ICGV-86564 were average stable as having bi value significantly near unity (b_i=1). JVB-2483, JVB-2531 and JVB-2533 also exhibited lower mean than population mean but these were below average stable as bi significantly higher than unity, while genotype *viz.* JSSP-59, JVB-LS-2373, JVB-2518, JVB-2524, GG-20 and GJG-22 were above average stable having bi significantly lower than unity.

Table 4.19: Mean over the environment ($\bar{X}$), regression coefficient (b_i), and deviation from regression (S^2di) for days to 50 % flowering

Sr. No.	Genotypes	Mean	bi		±SEbi	S^2di
1	JSSP-59	28.667	0.46**++	±	0.206	-0.504
2	JSSP-60	30.167	0.479	±	0.510	0.162
3	JSSP-62	31.833	1.198**	±	0.264	-0.42
4	JSSP-63	33.750	0.952	±	0.817	1.409*
5	JVB-2453	31.417	1.421**	±	0.414	-0.108
6	JVB-2483	29.500	1.998**++	±	0.352	-0.255
7	JVB-2486	27.917	0.43	±	0.720	0.952*
8	JVB-2489	29.083	0.685	±	0.672	0.749*
9	JVB-2494	24.583	0.33	±	0.517	0.186
10	JSSP-LS-61	30.250	1.187**	±	0.555	0.311
11	JVB-LS-2436	32.083	0.683	±	0.556	0.314
12	JVB-LS-2373	29.917	0.37**++	±	0.147	-0.568
13	JVB-LS-2501	30.167	0.952*	±	0.646	0.644*
14	JVB-LS-2502	29.500	1.029**	±	0.217	-0.489

Sr. No.	Genotypes	Mean	bi		$\underline{+}SE_{bi}$	S^2di
15	JVB-LS-2505	31.500	1.098**	±	0.580	0.397
16	JVB-LS-2506	33.667	0.71	±	0.542	0.265
17	JVB-LS-2507	34.917	0.875**	±	0.393	-0.161
18	JVB-2508	29.000	0.422	±	0.542	0.266
19	JVB-2509	32.000	0.715	±	0.658	0.69*
20	JVB-2510	29.917	0.747	±	0.762	1.144*
21	JVB-2511	29.000	1.136**	±	0.352	-0.255
22	JVB-2512	32.583	1.258*	±	0.888	1.781**
23	JVB-2513	29.583	1.359**	±	0.521	0.198
24	JVB-2514	30.917	1.528**	±	0.603	0.481
25	JVB-2515	27.167	0.798*	±	0.570	0.359
26	JVB-2516	30.000	1.155*	±	0.665	0.722*
27	JVB-2517	28.250	0.837*	±	0.470	0.041
28	JVB-2518	25.500	0.233++	±	0.190	-0.523
29	JVB-2519	33.500	0.291	±	0.812	1.384*
30	JVB-2520	32.917	1.044**	±	0.479	0.068
31	JVB-2521	30.833	1.386**	±	0.646	0.645*
32	JVB-2522	31.667	1.305**	±	0.428	-0.074
33	JVB-2523	31.500	2.065**	±	0.830	1.474*
34	JVB-2524	27.250	0.37**++	±	0.147	-0.568
35	JVB-2525	31.417	1.271*	±	0.910	1.905**
36	JVB-2526	26.000	0.693	±	0.846	1.561**
37	JVB-2527	30.500	1.558**	±	0.591	0.434
38	JVB-2528	34.333	1.744**++	±	0.340	-0.281
39	JVB-2529	27.083	0.683	±	0.556	0.314
40	JVB-2530	28.833	1.389**	±	0.516	0.182
41	JVB-2531	28.417	1.737**++	±	0.389	-0.172
42	JVB-2532	28.667	1.121**	±	0.480	0.07
43	JVB-2533	27.833	1.851**+	±	0.469	0.041
44	JVB-2534	27.000	1.26**	±	0.210	-0.499
45	Kaushal	32.250	1.744*	±	1.070	2.874**
46	GG-20	27.417	0.118++	±	0.190	-0.524
47	GJG-22	28.250	0.201**++	±	0.097	-0.605
48	GG-HPS-2	30.833	1.491**++	±	0.208	-0.502
49	ICGV-86564	27.167	0.798*	±	0.570	0.359
50	BAU-13	31.000	0.836	±	0.802	1.334*
	G.M.	29.95	1.00		-	-
	S.Em ±	0.23	-		-	-

***, ** significant at 5 and 1 levels, respectively when deviate from "0"**

+, ++ significant at 5 and 1 levels, respectively when deviate from "1"

4.5.3.2 Days to maturity

Days to maturity ranged from 117.167 days (GG-20) to 123.000 days (JSSP-63). Stability parameters for this trait revealed that 42 genotypes expressed non-significant deviation from regression indicating their predictable behaviour.

Out of above 42 genotypes, 20 genotypes had mean values below population mean (120.29). Genotypes *viz.* JVB-2486, JVB-LS-2373, JVB-2508, JVB-2509, JVB-2510, JVB-2514, JVB-2516, JVB-2518, JVB-2524, JVB-2525, JVB-2529, JVB-2531, JVB-2532, JVB-2533 and GJG-22 were average stable as having bi value significantly near unity (b_i=1). JVB-2494, JVB-LS-2505 and JVB-2526 also exhibited lower mean than population mean but these were below average stable as bi significantly higher than unity, while genotype *viz.* JVB-LS-2436 and GG-20 were above average stable having bi significantly lower than unity.

Table 4.20: Mean over the environment ($\bar{X}$), regression coefficient (b_i), and deviation from regression (S^2di) for days to maturity

Sr. No.	Genotypes	Mean	bi		$\pm SE_{bi}$	S^2di
1	JSSP-59	121.167	0.522	±	0.654	-1.282
2	JSSP-60	120.750	4.739**++	±	1.677	-0.334
3	JSSP-62	121.167	-0.759	±	1.536	-0.514
4	JSSP-63	123.000	0.775	±	3.031	2.198*
5	JVB-2453	121.333	-0.66	±	1.789	-0.181
6	JVB-2483	121.250	-0.489	±	1.544	-0.505
7	JVB-2486	120.167	4.221*	±	2.524	1.079
8	JVB-2489	121.167	1.304*	±	0.822	-1.184
9	JVB-2494	119.167	4.294**++	±	0.399	-1.389
10	JSSP-LS-61	121.250	2.464**+	±	1.011	-1.046
11	JVB-LS-2436	119.833	-1.025*++	±	0.698	-1.258
12	JVB-LS-2373	120.167	0.832	±	1.061	-1.005
13	JVB-LS-2501	121.000	-0.386+	±	0.985	-1.067
14	JVB-LS-2502	122.000	-0.503**++	±	0.162	-1.442
15	JVB-LS-2505	118.417	2.787**++	±	0.407	-1.386
16	JVB-LS-2506	122.167	-1.344	±	1.982	0.108
17	JVB-LS-2507	120.667	5.098*	±	3.220	2.667*
18	JVB-2508	118.167	0.832	±	1.061	-1.005
19	JVB-2509	119.833	2.468**	±	1.149	-0.927
20	JVB-2510	119.583	-0.153	±	1.326	-0.753

Sr. No.	Genotypes	Mean	bi		±SE_{bi}	S^2di
21	JVB-2511	120.917	-0.768+	±	1.213	-0.867
22	JVB-2512	120.333	3.344*	±	1.832	-0.119
23	JVB-2513	120.083	4.778	±	3.948	4.74**
24	JVB-2514	118.833	1.106**	±	0.188	-1.438
25	JVB-2515	121.500	-1.847+	±	2.000	0.137
26	JVB-2516	120.083	-1.838	±	2.323	0.692
27	JVB-2517	121.500	-1.623	±	2.185	0.445
28	JVB-2518	118.750	0.058	±	1.618	-0.412
29	JVB-2519	122.250	-0.103+	±	0.611	-1.303
30	JVB-2520	120.417	4.306	±	3.471	3.335*
31	JVB-2521	119.833	-2.512	±	2.893	1.873*
32	JVB-2522	121.417	-0.949	±	1.510	-0.546
33	JVB-2523	122.417	0.693*	±	0.429	-1.379
34	JVB-2524	118.917	0.238	±	1.203	-0.877
35	JVB-2525	119.500	1.914**	±	0.975	-1.074
36	JVB-2526	118.917	2.296**+	±	0.839	-1.173
37	JVB-2527	120.500	2.935	±	2.463	0.959
38	JVB-2528	122.333	-0.503**++	±	0.162	-1.442
39	JVB-2529	118.167	-1.436	±	2.057	0.229
40	JVB-2530	119.583	4.908*	±	3.269	2.795*
41	JVB-2531	118.167	1.268*	±	0.877	-1.147
42	JVB-2532	120.250	3.628*	±	2.384	0.805
43	JVB-2533	117.500	2.549*	±	1.610	-0.422
44	JVB-2534	119.500	4.302*	±	3.006	2.138*
45	Kaushal	119.417	-2.702	±	2.909	1.911*
46	GG-20	117.167	-0.292++	±	0.233	-1.43
47	GJG-22	119.000	0.148	±	1.391	-0.683
48	GG-HPS-2	121.250	0.395	±	0.713	-1.25
49	ICGV-86564	121.167	-0.572+	±	0.965	-1.082
50	BAU-13	122.833	1.263	±	1.569	-0.474
	G.M.	120.29	1.00		-	-
	S.Em ±	0.35	-		-	-

***, ** significant at 5 and 1 levels, respectively when deviate from "0"**

+, ++ significant at 5 and 1 levels, respectively when deviate from "1"

4.5.3.3 Number of primary branches per plant

Number of primary branches per plan**t** ranged from 3.450 (BAU-13) to 6.017 (JVB-2532). Stability parameters for this trait revealed that 31 genotypes expressed non-significant deviation from regression indicating their predictable behaviour.

Out of above 31 genotypes, 19 genotypes had mean values above population mean (4.79). Genotypes *viz.* JVB-2453, JVB-2494, JVB-LS-2505, JVB-LS-2506, JVB-2510, JVB-2516, JVB-2522, JVB-2523, JVB-2525, JVB-2528, JVB-2530, JVB-2531, JVB-2532, JVB-2534, GJG-22 and GG-HPS-2 were average stable as having bi value significantly near unity (b_i=1). JVB-2526 and GG-20 also exhibited higher mean than population mean but these were below average stable as bi significantly higher than unity, while genotype Kuashal was above average stable having bi significantly lower than unity.

Table 4.21: Mean over the environment ($\bar{X}$), regression coefficient (b_i), and deviation from regression (S^2di) for number of primary branches per plant

Sr. No.	Genotypes	Mean	bi		$\pm SE_{bi}$	S^2di
1	JSSP-59	4.200	0.808	±	5.878	0.029
2	JSSP-60	3.683	6.22**++	±	2.545	-0.038
3	JSSP-62	4.717	-0.409	±	15.417	0.517**
4	JSSP-63	4.800	8.545	±	10.149	0.194**
5	JVB-2453	5.167	0.789	±	2.002	-0.044
6	JVB-2483	4.600	-10.235	±	13.089	0.358**
7	JVB-2486	4.600	-5.499	±	9.098	0.145**
8	JVB-2489	4.100	-1.59	±	10.643	0.218**
9	JVB-2494	5.233	1.516	±	4.142	-0.012
10	JSSP-LS-61	4.333	1.334	±	3.345	-0.027
11	JVB-LS-2436	5.050	11.433*+	±	6.643	0.052*
12	JVB-LS-2373	4.867	0.823	±	6.756	0.056*
13	JVB-LS-2501	4.233	2.753	±	3.947	-0.016
14	JVB-LS-2502	4.533	-2.964	±	12.494	0.321**
15	JVB-LS-2505	5.000	-1.882	±	3.070	-0.031
16	JVB-LS-2506	5.300	1.367	±	1.662	-0.047
17	JVB-LS-2507	4.153	1.532	±	3.066	-0.031
18	JVB-2508	3.717	1.258	±	5.533	0.02
19	JVB-2509	5.850	11.485	±	8.410	0.116*

Sr. No.	Genotypes	Mean	bi		±SE_{bi}	S^2di
20	JVB-2510	5.083	2.329	±	3.456	-0.025
21	JVB-2511	4.800	14.14**++	±	6.817	0.058*
22	JVB-2512	4.967	-1.931	±	10.586	0.215**
23	JVB-2513	4.517	2.414	±	6.700	0.054*
24	JVB-2514	4.917	8.625	±	8.949	0.139**
25	JVB-2515	3.550	1.173	±	3.506	-0.024
26	JVB-2516	5.750	-0.561	±	2.791	-0.035
27	JVB-2517	4.550	-7.009	±	9.896	0.181**
28	JVB-2518	4.717	3.326	±	4.794	0.002
29	JVB-2519	4.933	-0.422	±	23.375	1.257**
30	JVB-2520	4.167	-2.094	±	3.882	-0.017
31	JVB-2521	4.650	-2.284	±	15.906	0.553**
32	JVB-2522	4.867	-1.334	±	3.345	-0.027
33	JVB-2523	5.050	-1.373	±	2.494	-0.039
34	JVB-2524	4.800	3.491**++	±	0.886	-0.052
35	JVB-2525	5.167	1.471	±	3.143	-0.03
36	JVB-2526	5.100	2.071**++	±	0.584	-0.053
37	JVB-2527	4.300	-0.522	±	10.748	0.224**
38	JVB-2528	5.933	-1.208	±	2.794	-0.035
39	JVB-2529	4.533	0.437	±	12.906	0.346**
40	JVB-2530	4.950	-0.761	±	2.743	-0.035
41	JVB-2531	4.950	0.447	±	2.812	-0.034
42	JVB-2532	6.017	1.477	±	2.434	-0.039
43	JVB-2533	4.850	-1.617	±	12.019	0.293**
44	JVB-2534	5.967	-2.501	±	3.081	-0.031
45	Kaushal	5.033	-1.367+	±	1.662	-0.047
46	GG-20	5.300	2.071**++	±	0.584	-0.053
47	GJG-22	5.300	0.567	±	2.076	-0.043
48	GG-HPS-2	4.950	2.507	±	2.717	-0.036
49	ICGV-86564	4.433	-0.886	±	6.396	0.045
50	BAU-13	3.450	2.044	±	3.632	-0.022
	G.M.	4.79	1.00		-	-
	S.Em ±	0.07	-		-	-

***, ** significant at 5 and 1 levels, respectively when deviate from "0"**

+, ++ significant at 5 and 1 levels, respectively when deviate from "1"

4.5.3.4 Number of secondary branches per plant

Number of secondary branches per plan**t** ranged from 8.517 (JVB-2515) to 11.967 (JVB-2528). Stability parameters for this trait revealed that 13 genotypes expressed non-significant deviation from regression indicating their predictable behaviour.

Out of above 13 genotypes, 6 genotypes had mean values above population mean (9.71). Genotypes *viz.* JVB-2528 and GG-20 were average stable as having bi value significantly near unity (b_i=1). JVB-2509, JVB-2516 and JVB-2534 also exhibited higher mean than population mean but these were below average stable as bi significantly higher than unity, while genotype *viz.* JVB-LS-2373 was above average stable having bi significantly lower than unity.

Table 4.22: Mean over the environment ($\bar{X}$), regression coefficient (b_i), and deviation from regression (S^2di) for number of secondary branches per plant

Sr. No.	Genotypes	Mean	bi		$\underline{+}SE_{bi}$	S^2di
1	JSSP-59	9.267	-1.114	±	3.268	0.219**
2	JSSP-60	8.783	-2.159	±	2.707	0.136**
3	JSSP-62	9.233	3.186	±	5.394	0.679**
4	JSSP-63	9.333	1.942	±	2.856	0.156**
5	JVB-2453	9.633	-6.277	±	5.740	0.775**
6	JVB-2483	9.817	5.665	±	7.085	1.206**
7	JVB-2486	10.350	4.236	±	4.436	0.444**
8	JVB-2489	9.033	6.06*	±	4.137	0.38**
9	JVB-2494	8.917	-0.804	±	3.952	0.342**
10	JSSP-LS-61	9.417	-0.835	±	1.489	0.008
11	JVB-LS-2436	9.517	-5.914**++	±	1.255	-0.008
12	JVB-LS-2373	10.650	-2.347*++	±	1.656	0.021
13	JVB-LS-2501	8.717	-2.362+	±	2.234	0.077*
14	JVB-LS-2502	9.600	-0.931	±	7.826	1.482**
15	JVB-LS-2505	9.367	-2.766**++	±	1.302	-0.005
16	JVB-LS-2506	9.017	0.436	±	2.744	0.14**
17	JVB-LS-2507	9.083	-0.304	±	5.077	0.596**
18	JVB-2508	11.667	2.716	±	2.516	0.11*
19	JVB-2509	11.733	3.371**++	±	0.860	-0.029
20	JVB-2510	10.367	0.573	±	5.511	0.711**
21	JVB-2511	9.517	1.739	±	6.291	0.941**

Sr. No.	Genotypes	Mean	bi		±SE$_{bi}$	S^2di
22	JVB-2512	10.067	7.16*	±	5.114	0.606**
23	JVB-2513	9.567	6.754	±	5.135	0.611**
24	JVB-2514	9.633	2.216	±	7.720	1.441**
25	JVB-2515	8.517	2.506*	±	1.405	0.002
26	JVB-2516	10.483	6.959**++	±	0.479	-0.042
27	JVB-2517	9.150	-2.061	±	3.690	0.292**
28	JVB-2518	8.683	-2.511*++	±	1.684	0.023
29	JVB-2519	9.600	-0.39	±	2.803	0.149**
30	JVB-2520	8.767	0.477	±	3.163	0.202**
31	JVB-2521	10.333	4.341	±	5.953	0.837**
32	JVB-2522	9.467	0.941	±	5.597	0.735**
33	JVB-2523	9.650	-0.114	±	5.358	0.669**
34	JVB-2524	8.717	-1.013	±	2.587	0.12**
35	JVB-2525	9.650	-2.823	±	4.497	0.457**
36	JVB-2526	10.017	4.198*	±	2.809	0.149**
37	JVB-2527	9.000	3.768**	±	2.034	0.056*
38	JVB-2528	11.967	1.712	±	1.523	0.01
39	JVB-2529	9.650	-3.077	±	8.247	1.651**
40	JVB-2530	9.567	6.537**++	±	2.811	0.15**
41	JVB-2531	9.767	0.869	±	2.282	0.082*
42	JVB-2532	11.167	5.014	±	4.203	0.394**
43	JVB-2533	10.183	-2.178	±	3.743	0.302**
44	JVB-2534	11.217	3.59**++	±	0.941	-0.025
45	Kaushal	9.417	-0.434	±	1.141	-0.015
46	GG-20	11.217	1.465*	±	0.877	-0.028
47	GJG-22	10.200	-1.999	±	5.637	0.746**
48	GG-HPS-2	9.317	3.437	±	3.890	0.33**
49	ICGV-86564	9.083	-0.055	±	3.023	0.181**
50	BAU-13	8.600	0.603	±	1.631	0.019
	G.M.	9.71	1.00		-	-
	S.Em ±	0.06	-		-	-

***, ** significant at 5 and 1 levels, respectively when deviate from "0"**

+, ++ significant at 5 and 1 levels, respectively when deviate from "1"

4.5.3.5 Plant height (cm)

Plant height ranged from 24.704 cm (JVB-2515) to 37.556 cm (JVB-2514). Stability parameters for this trait revealed that 26 genotypes expressed non-significant deviation from regression indicating their predictable behaviour.

Out of above 26 genotypes, 7 genotypes had mean values above population mean (31.53). Genotypes *viz.* JVB-2453 and JVB-LS-2505 were average stable as having bi value significantly near unity (b_i=1). JVB-LS-2506 and JVB-2533 also exhibited higher mean than population mean but these were below average stable as bi significantly higher than unity, while genotype *viz.* JVB-2509, JVB-2526 and ICGV-86564 were above average stable having bi significantly lower than unity.

Table 4.23: Mean over the environment ($\bar{X}$), regression coefficient (b_i), and deviation from regression (S^2di) for plant height (cm)

Sr. No.	Genotypes	Mean	bi		±SE_{bi}	S^2di
1	JSSP-59	29.960	1.039**	±	0.202	-2.096
2	JSSP-60	28.374	1.185**	±	0.404	-0.607
3	JSSP-62	29.072	1.515**	±	0.806	5.312*
4	JSSP-63	28.512	1.486*	±	0.814	5.482*
5	JVB-2453	32.383	1.214**	±	0.379	-0.846
6	JVB-2483	34.048	0.62	±	0.671	2.895*
7	JVB-2486	31.488	1.682**++	±	0.085	-2.507
8	JVB-2489	33.425	2.368*	±	1.293	17.756**
9	JVB-2494	35.010	1.618	±	1.977	45.002**
10	JSSP-LS-61	36.904	-0.053	±	1.666	31.221**
11	JVB-LS-2436	35.302	1.7	±	1.790	36.409**
12	JVB-LS-2373	32.113	0.734	±	0.660	2.717*
13	JVB-LS-2501	29.031	1.375**	±	0.531	0.835
14	JVB-LS-2502	29.293	1.865**++	±	0.468	0.078
15	JVB-LS-2505	32.613	1.614**	±	0.559	1.214
16	JVB-LS-2506	36.475	2.125**++	±	0.531	0.841
17	JVB-LS-2507	32.783	1.891**	±	0.725	3.811*
18	JVB-2508	30.413	0.663	±	0.914	7.57**
19	JVB-2509	33.553	-1.141**++	±	0.398	-0.666
20	JVB-2510	28.436	0.753**	±	0.224	-1.985
21	JVB-2511	30.359	1.487**	±	0.458	-0.038
22	JVB-2512	32.162	0.472	±	0.944	8.251**

Sr. No.	Genotypes	Mean	bi		±SEbi	S^2di
23	JVB-2513	36.885	-1.02*++	±	0.660	2.709*
24	JVB-2514	37.556	0.834	±	0.763	4.502*
25	JVB-2515	24.704	0.38*++	±	0.255	-1.804
26	JVB-2516	32.010	0.82	±	0.742	4.108*
27	JVB-2517	29.847	2.762*	±	1.553	26.784**
28	JVB-2518	30.079	1.085**	±	0.450	-0.126
29	JVB-2519	29.388	0.113++	±	0.429	-0.356
30	JVB-2520	30.923	1.594**	±	0.622	2.111
31	JVB-2521	34.817	1.866**	±	0.792	5.049*
32	JVB-2522	28.283	0.834*	±	0.545	1.024
33	JVB-2523	30.473	2.566**++	±	0.402	-0.63
34	JVB-2524	28.808	1.537**	±	0.578	1.474
35	JVB-2525	31.559	2.136**+	±	0.747	4.203*
36	JVB-2526	31.613	0.025++	±	0.213	-2.041
37	JVB-2527	31.483	0.065+	±	0.541	0.976
38	JVB-2528	30.328	0.358	±	0.747	4.2*
39	JVB-2529	32.103	0.477	±	1.726	33.675**
40	JVB-2530	31.006	1.667	±	1.775	35.77**
41	JVB-2531	31.044	1.18	±	1.123	12.774**
42	JVB-2532	30.041	-0.256++	±	0.546	1.033
43	JVB-2533	31.837	1.486**+	±	0.345	-1.143
44	JVB-2534	30.206	0.899	±	0.726	3.821*
45	Kaushal	31.662	0.482	±	0.795	5.113*
46	GG-20	31.462	1.187**	±	0.486	0.277
47	GJG-22	31.735	0.43	±	0.788	4.975*
48	GG-HPS-2	31.292	-0.425++	±	0.634	2.303
49	ICGV-86564	32.075	-0.222++	±	0.569	1.344
50	BAU-13	31.741	0.933**	±	0.472	0.114
	G.M.	31.53	1.00		-	-
	S.Em ±	0.46	-		-	-

***, ** significant at 5 and 1 levels, respectively when deviate from "0"**

+, ++ significant at 5 and 1 levels, respectively when deviate from "1"

4.5.3.6 Number of matured pods per plant

Number of matured pods per plant ranged from 9.300 (JVB-2515) to 23.233 (JVB-2516). Stability parameters for this trait revealed that 25 genotypes expressed non-significant deviation from regression indicating their predictable behaviour.

Out of above 25 genotypes, 11 genotypes had mean values above population mean (15.04). Genotypes *viz.* JVB-2509, JVB-2516, JVB-2518, JVB-2528, JVB-2532 and GJG-22 were average stable as having bi value significantly near unity (b_i=1). JVB-2510, JVB-2531 and JVB-2534 also exhibited higher mean than population mean but these were below average stable as bi significantly higher than unity, while genotype *viz.* JVB-2508 and GG-20 were above average stable having bi significantly lower than unity.

Table 4.24: Mean over the environment ($\bar{X}$), regression coefficient (b_i), and deviation from regression (S^2di) for number of matured pods per plant

Sr. No.	Genotypes	Mean	bi		$\pm SE_{bi}$	S^2di
1	JSSP-59	9.983	-0.16	±	0.939	1.192*
2	JSSP-60	14.050	1.047**	±	0.353	-0.823
3	JSSP-62	11.817	0.649	±	0.545	-0.363
4	JSSP-63	10.650	0.413	±	0.798	0.541
5	JVB-2453	9.967	0.044	±	1.429	4.287**
6	JVB-2483	17.483	2.076	±	1.752	7.026**
7	JVB-2486	16.500	1.382	±	1.587	5.559**
8	JVB-2489	15.267	1.824	±	1.432	4.307**
9	JVB-2494	12.433	0.96	±	0.878	0.9
10	JSSP-LS-61	14.533	0.344	±	1.235	2.908**
11	JVB-LS-2436	10.650	-0.582+	±	1.061	1.842*
12	JVB-LS-2373	14.917	0.901**	±	0.454	-0.606
13	JVB-LS-2501	10.617	1.211	±	1.264	3.104**
14	JVB-LS-2502	10.867	0.915	±	2.216	11.925**
15	JVB-LS-2505	9.567	0.547*	±	0.368	-0.794
16	JVB-LS-2506	13.800	1.75	±	1.272	3.158**
17	JVB-LS-2507	12.783	1.336*	±	0.811	0.598
18	JVB-2508	20.833	-0.437**++	±	0.101	-1.127
19	JVB-2509	21.400	1.333**	±	0.580	-0.257
20	JVB-2510	21.183	1.799**+	±	0.552	-0.342
21	JVB-2511	16.400	1.313	±	1.430	4.296**

Sr. No.	Genotypes	Mean	bi		±SEbi	S^2di
22	JVB-2512	16.933	0.336	±	2.500	15.493**
23	JVB-2513	11.417	1.223	±	2.040	9.929**
24	JVB-2514	12.067	0.192	±	1.368	3.828**
25	JVB-2515	9.300	0.265	±	0.797	0.537
26	JVB-2516	23.233	0.702	±	0.650	-0.03
27	JVB-2517	18.683	1.277	±	1.603	5.692**
28	JVB-2518	19.783	1.61**	±	0.638	-0.07
29	JVB-2519	16.900	2.154*	±	1.181	2.562*
30	JVB-2520	13.867	1.827*	±	1.192	2.632*
31	JVB-2521	14.133	1.003**	±	0.431	-0.658
32	JVB-2522	16.567	2.208*	±	1.435	4.328**
33	JVB-2523	12.117	1.05	±	0.801	0.555
34	JVB-2524	16.833	0.894	±	0.990	1.457*
35	JVB-2525	17.083	1.747*	±	1.053	1.798*
36	JVB-2526	13.150	0.849	±	0.944	1.217*
37	JVB-2527	13.050	0.459	±	1.767	7.162**
38	JVB-2528	22.283	0.727	±	0.705	0.17
39	JVB-2529	14.850	1.626**	±	0.755	0.366
40	JVB-2530	13.533	1.21**	±	0.635	-0.078
41	JVB-2531	17.483	2.107**++	±	0.382	-0.766
42	JVB-2532	22.767	0.754	±	0.659	0.003
43	JVB-2533	14.650	0.426	±	1.132	2.262*
44	JVB-2534	21.633	2.339**++	±	0.551	-0.345
45	Kaushal	11.600	0.959**	±	0.450	-0.615
46	GG-20	17.167	0.638**++	±	0.189	-1.058
47	GJG-22	15.333	0.289	±	0.524	-0.421
48	GG-HPS-2	11.067	1.504	±	1.530	5.081**
49	ICGV-86564	14.283	1.575**	±	0.777	0.454
50	BAU-13	14.817	-0.615	±	1.259	3.066**
	G.M.	15.04	1.00		-	-
	S.Em ±	0.31	-		-	-

***, ** significant at 5 and 1 levels, respectively when deviate from "0"**

+, ++ significant at 5 and 1 levels, respectively when deviate from "1"

4.5.3.7 Number of immature pods per plant

Number of immature pods per plant ranged from 2.933 (JVB-LS-2505) to 6.117 (JVB-2486). Stability parameters for this trait revealed that only two genotypes expressed non-significant deviation from regression indicating their predictable behaviour.

These two genotypes had mean values below population mean (4.25). Genotype JSSP-60 and JSSP-62 were average stable as having bi value significantly near unity.

Table 4.25: Mean over the environment ($\bar{X}$), regression coefficient (b_i), and deviation from regression (S^2di) for number of immature pods per plant

Sr. No.	Genotypes	Mean	bi		$\pm SE_{bi}$	S^2di
1	JSSP-59	4.383	3.989	±	4.233	2.002**
2	JSSP-60	3.550	-0.052	±	1.024	0.052
3	JSSP-62	4.033	0.88	±	0.716	-0.01
4	JSSP-63	3.450	1.633	±	1.255	0.112*
5	JVB-2453	5.017	4.464	±	3.326	1.209**
6	JVB-2483	4.950	-2.135	±	3.360	1.236**
7	JVB-2486	6.117	3.569	±	4.263	2.032**
8	JVB-2489	4.017	-0.703	±	3.804	1.604**
9	JVB-2494	3.617	-0.009	±	2.160	0.47**
10	JSSP-LS-61	4.600	-0.947	±	5.854	3.893**
11	JVB-LS-2436	3.517	0.644	±	2.692	0.768**
12	JVB-LS-2373	4.450	-2.507	±	2.998	0.97**
13	JVB-LS-2501	3.150	0.332	±	4.039	1.817**
14	JVB-LS-2502	3.050	0.238	±	1.385	0.152*
15	JVB-LS-2505	2.933	-0.349	±	1.206	0.098*
16	JVB-LS-2506	3.233	1.998	±	2.845	0.866**
17	JVB-LS-2507	3.283	1.16	±	1.757	0.287**
18	JVB-2508	5.367	5.627**++	±	2.469	0.635**
19	JVB-2509	4.950	3.786*	±	2.159	0.47**
20	JVB-2510	4.250	0.233	±	3.068	1.019**
21	JVB-2511	3.517	3.419	±	2.668	0.754**
22	JVB-2512	3.067	1.548	±	3.353	1.231**
23	JVB-2513	3.150	-1.215	±	2.659	0.748**
24	JVB-2514	4.400	2.655*	±	1.875	0.337**

Sr. No.	Genotypes	Mean	bi		±SE_{bi}	S^2di
25	JVB-2515	3.100	1.706	±	3.220	1.129**
26	JVB-2516	4.850	-3.444	±	7.339	6.16**
27	JVB-2517	5.033	2.168	±	4.215	1.985**
28	JVB-2518	3.700	-2.359	±	5.054	2.885**
29	JVB-2519	4.783	5.665	±	5.587	3.54**
30	JVB-2520	5.150	2.264	±	6.830	5.326**
31	JVB-2521	4.650	4.784	±	4.382	2.151**
32	JVB-2522	4.533	1.536	±	3.591	1.422**
33	JVB-2523	4.417	-1.694	±	2.784	0.827**
34	JVB-2524	5.683	-3.813	±	3.959	1.744**
35	JVB-2525	4.800	-1.046	±	2.421	0.608**
36	JVB-2526	4.067	-1.212	±	4.106	1.88**
37	JVB-2527	4.550	1.046	±	2.502	0.654**
38	JVB-2528	5.350	-2.974	±	7.201	5.927**
39	JVB-2529	5.700	0.924	±	6.859	5.371**
40	JVB-2530	3.983	0.895	±	3.206	1.119**
41	JVB-2531	5.283	-0.259	±	2.707	0.778**
42	JVB-2532	5.633	-0.49	±	4.952	2.767**
43	JVB-2533	4.867	4.483**+	±	2.027	0.406**
44	JVB-2534	5.250	6.074	±	6.951	5.518**
45	Kaushal	3.850	4.613**++	±	1.659	0.249**
46	GG-20	3.333	0.253	±	3.595	1.425**
47	GJG-22	3.467	1.272	±	2.311	0.548**
48	GG-HPS-2	3.650	1.28	±	2.805	0.84**
49	ICGV-86564	3.083	3.103	±	3.565	1.4**
50	BAU-13	3.933	-3.036	±	4.145	1.917**
	G.M.	4.25	1.00		-	-
	S.Em ±	0.08	-		-	-

***, ** significant at 5 and 1 levels, respectively when deviate from "0"**

+, ++ significant at 5 and 1 levels, respectively when deviate from "1"

4.5.3.8 Sound mature kernel (SMK) %

Sound mature kernel ranged from 64.962 % (JSSP-59) to 88.789 % (JVB-2528). Stability parameters for this trait revealed that 15 genotypes expressed non-significant deviation from regression indicating their predictable behaviour.

Out of above 15 genotypes, 8 genotypes had mean values above population mean (77.83 %). Genotypes *viz.* JVB-LS-2506, JVB-2508 and JVB-2528 were average stable as having bi value significantly near unity (b_i=1). JVB-2486 also exhibited higher mean than population mean but these was below average stable as bi significantly higher than unity, while genotype *viz.* JVB-2510, JVB-2516, JVB-2534 and GG-20 were above average stable having bi significantly lower than unity.

Table 4.26: Mean over the environment ($\bar{X}$), regression coefficient (b_i), and deviation from regression (S^2di) for sound mature kernel (SMK) %

Sr. No.	Genotypes	Mean	bi		$\pm SE_{bi}$	S^2di
1	JSSP-59	64.962	-0.45++	±	0.356	-1.536
2	JSSP-60	77.823	1.52	±	1.578	16.336**
3	JSSP-62	74.595	0.997	±	2.438	42.436**
4	JSSP-63	77.150	-0.23	±	2.758	55.037**
5	JVB-2453	77.002	-0.107+	±	0.750	1.759
6	JVB-2483	81.738	3.179	±	2.732	53.931**
7	JVB-2486	84.091	2.645**++	±	0.145	-2.333
8	JVB-2489	70.746	0.158	±	1.720	19.865**
9	JVB-2494	80.726	1.413	±	1.076	6.27**
10	JSSP-LS-61	75.359	0.085	±	0.779	2.093
11	JVB-LS-2436	75.307	1.126	±	2.907	61.385**
12	JVB-LS-2373	75.950	0.041+	±	0.617	0.382
13	JVB-LS-2501	70.590	3.929**++	±	0.758	1.853
14	JVB-LS-2502	70.234	1.3	±	3.117	70.988**
15	JVB-LS-2505	70.688	2.221	±	4.139	127.03**
16	JVB-LS-2506	80.317	1.194**	±	0.219	-2.13
17	JVB-LS-2507	80.010	2.39	±	2.832	58.171**
18	JVB-2508	87.730	0.751	±	0.587	0.115
19	JVB-2509	85.331	2.434	±	2.070	29.909**
20	JVB-2510	82.656	-0.418++	±	0.626	0.47
21	JVB-2511	73.857	-0.066	±	1.231	8.97**
22	JVB-2512	81.880	1.963**	±	1.034	5.598*

Sr. No.	Genotypes	Mean	bi		±SEbi	S^2di
23	JVB-2513	69.384	-1.001	±	1.871	23.987**
24	JVB-2514	68.899	0.022	±	2.229	35.072**
25	JVB-2515	72.412	-0.898	±	1.912	25.141**
26	JVB-2516	86.867	0.07+	±	0.572	-0.018
27	JVB-2517	78.931	0.398	±	2.841	58.555**
28	JVB-2518	79.133	2.811**+	±	1.016	5.316*
29	JVB-2519	75.060	2.713**+	±	0.966	4.57*
30	JVB-2520	77.111	1.997	±	1.483	14.132**
31	JVB-2521	76.665	-0.643	±	2.505	44.962**
32	JVB-2522	77.544	0.53	±	0.642	0.627
33	JVB-2523	72.703	0.377	±	2.250	35.78**
34	JVB-2524	82.266	2.122	±	1.839	23.079**
35	JVB-2525	81.694	2.065*	±	1.264	9.592**
36	JVB-2526	77.614	3.525	±	3.133	71.708**
37	JVB-2527	75.574	2.64	±	2.281	36.859**
38	JVB-2528	88.789	0.568	±	0.528	-0.384
39	JVB-2529	81.069	2.053	±	1.953	26.358**
40	JVB-2530	79.816	0.204	±	1.327	10.828**
41	JVB-2531	75.950	3.006	±	3.111	70.681**
42	JVB-2532	78.772	-0.429+	±	0.993	4.959*
43	JVB-2533	76.689	0.705	±	2.049	29.262**
44	JVB-2534	83.109	-0.203++	±	0.399	-1.286
45	Kaushal	77.154	-1.654+	±	1.723	19.961**
46	GG-20	82.637	0.099++	±	0.402	-1.269
47	GJG-22	77.766	1.766**++	±	0.410	-1.219
48	GG-HPS-2	78.289	0.216	±	0.819	2.581*
49	ICGV-86564	81.076	0.887	±	2.924	62.149**
50	BAU-13	80.079	-0.025	±	2.883	60.375**
	G.M.	77.83	1.00		-	-
	S.Em ±	0.46	-		-	-

***, ** significant at 5 and 1 levels, respectively when deviate from "0"**

+, ++ significant at 5 and 1 levels, respectively when deviate from "1"

4.5.3.9 100-kernel weight (g)

100-kernel weight ranged from 25.698 g (JVB-2519) to 56.217 g (JVB-LS-2505). Stability parameters for this trait revealed that 14 genotypes expressed non-significant deviation from regression indicating their predictable behaviour.

Out of above 14 genotypes, 10 genotypes had mean values above population mean (39.70 g). Genotypes *viz.* JVB-2483 and JVB-2515 were average stable as having bi value significantly near unity (b_i=1). JVB-LS-2373, JVB-2529 and GG-HPS-2 also exhibited higher mean than population mean but these were below average stable as bi significantly higher than unity, while genotype *viz.* JSSP-60, JVB-2509, JVB-2528, GG-20 and GJG-22 were above average stable having bi significantly lower than unity.

Table 4.27: Mean over the environment ($\bar{X}$), regression coefficient (b_i), and deviation from regression (S^2di) for 100-kernel weight (g)

Sr. No.	Genotypes	Mean	bi		$\pm SE_{bi}$	S^2di
1	JSSP-59	32.119	-2.484	±	2.812	12.487**
2	JSSP-60	44.343	-0.02++	±	0.040	-1.104
3	JSSP-62	31.463	-2.412**++	±	1.129	1.085*
4	JSSP-63	31.413	-2.556*++	±	1.684	3.767**
5	JVB-2453	36.093	-0.485	±	2.310	8.07**
6	JVB-2483	41.687	1.9**	±	1.021	0.686
7	JVB-2486	39.376	-0.345	±	3.009	14.453**
8	JVB-2489	45.051	1.716*	±	1.196	1.351*
9	JVB-2494	39.999	3.93**+	±	2.050	6.117**
10	JSSP-LS-61	40.326	3.971*	±	2.389	8.706**
11	JVB-LS-2436	37.727	-0.092	±	1.874	4.931**
12	JVB-LS-2373	42.928	3.689**++	±	1.098	0.968
13	JVB-LS-2501	55.772	1.167	±	2.958	13.937**
14	JVB-LS-2502	39.056	-2.469	±	2.538	9.97**
15	JVB-LS-2505	56.217	2.135	±	1.967	5.543**
16	JVB-LS-2506	44.993	2.028*	±	1.406	2.29*
17	JVB-LS-2507	45.675	2.172	±	1.647	3.557**
18	JVB-2508	45.033	3.033	±	3.305	17.666**
19	JVB-2509	45.377	-0.023++	±	0.117	-1.083
20	JVB-2510	36.963	2.395**+	±	0.912	0.322
21	JVB-2511	34.028	2.13	±	1.973	5.588**
22	JVB-2512	35.902	4.181**++	±	0.741	-0.162

Sr. No.	Genotypes	Mean	bi		±SE$_{bi}$	S^{2}di
23	JVB-2513	29.433	-1.521+	±	1.723	3.999**
24	JVB-2514	38.453	-0.711	±	2.356	8.439**
25	JVB-2515	44.451	0.77	±	1.058	0.818
26	JVB-2516	29.213	-1.299+	±	1.444	2.478*
27	JVB-2517	39.144	1.967	±	2.342	8.321**
28	JVB-2518	40.202	1.708	±	3.832	24.13**
29	JVB-2519	25.698	-1.451+	±	1.371	2.123*
30	JVB-2520	32.198	0.665	±	2.460	9.296**
31	JVB-2521	34.992	-0.159	±	2.770	12.088**
32	JVB-2522	43.601	1.304	±	1.697	3.843**
33	JVB-2523	37.881	-1.445+	±	1.356	2.054*
34	JVB-2524	30.188	2.785**++	±	0.805	0.007
35	JVB-2525	34.212	1.238	±	2.932	13.667**
36	JVB-2526	40.736	4.511**+	±	2.272	7.765**
37	JVB-2527	40.134	0.457	±	1.510	2.812**
38	JVB-2528	47.709	0.036++	±	0.062	-1.1
39	JVB-2529	42.193	2.597**+	±	1.077	0.889
40	JVB-2530	32.632	2.487**++	±	0.492	-0.691
41	JVB-2531	43.218	1.392	±	1.559	3.074**
42	JVB-2532	45.761	0.472	±	1.554	3.042**
43	JVB-2533	36.703	0.306	±	1.994	5.727**
44	JVB-2534	44.783	0.379	±	1.400	2.264*
45	Kaushal	29.573	0.543	±	2.172	7.003**
46	GG-20	49.361	0.053*++	±	0.036	-1.105
47	GJG-22	49.086	0.212+	±	0.487	-0.7
48	GG-HPS-2	47.246	3.362**++	±	0.972	0.517
49	ICGV-86564	43.856	2.936**+	±	1.167	1.234*
50	BAU-13	31.105	2.845*	±	1.834	4.677**
	G.M.	39.70	1.00		-	-
	S.Em ±	0.30	-		-	-

***, ** significant at 5 and 1 levels, respectively when deviate from "0"**

+, ++ significant at 5 and 1 levels, respectively when deviate from "1"

4.5.3.10 Shelling out-turn (%)

Shelling out-turn ranged from 55.143 % (JVB-2515) to 74.095 % (JVB-2522). Stability parameters for this trait revealed that 36 genotypes expressed non-significant deviation from regression indicating their predictable behaviour.

Out of above 36 genotypes, 23 genotypes had mean values above population mean (68.43 %). Genotypes *viz.* JSSP-63, JVB-2453, JVB-2489, JVB-LS-2501, JVB-2510, JVB-2511, JVB-2512, JVB-2513, JVB-2517, JVB-2519, JVB-2521, JVB-2522, JVB-2525, JVB-2527, JVB-2531, JVB-2532, Kaushal and GJG-22 were average stable as having bi value significantly near unity (b_i=1). JVB-2486 also exhibited higher mean than population mean but these was below average stable as having bi significantly higher than unity, while genotype *viz.* JVB-2508, JVB-2520, JVB-2529 and GG-20 were above average stable having bi significantly lower than unity.

Table 4.28: Mean over the environment ($\bar{X}$), regression coefficient (b_i), and deviation from regression (S^2di) for shelling out-turn (%)

Sr. No.	Genotypes	Mean	bi		$\pm SE_{bi}$	S^2di
1	JSSP-59	62.045	-1.344	±	2.896	1.02
2	JSSP-60	65.150	-2.148	±	2.342	-0.26
3	JSSP-62	65.959	0.551	±	3.527	2.806*
4	JSSP-63	70.408	2.805*	±	1.772	-1.295
5	JVB-2453	73.622	3.137	±	2.583	0.263
6	JVB-2483	69.388	0.52	±	4.101	4.737*
7	JVB-2486	71.360	3.381**++	±	0.504	-2.568
8	JVB-2489	72.159	2.419	±	2.171	-0.601
9	JVB-2494	70.118	-1.368	±	5.273	9.583**
10	JSSP-LS-61	65.081	-0.108	±	3.163	1.731
11	JVB-LS-2436	69.690	1.335	±	4.042	4.527*
12	JVB-LS-2373	68.135	-3.135*++	±	2.198	-0.549
13	JVB-LS-2501	72.614	2.758	±	3.015	1.33
14	JVB-LS-2502	71.654	-0.639	±	5.281	9.619**
15	JVB-LS-2505	66.867	-0.882	±	4.863	7.75**
16	JVB-LS-2506	62.409	-0.106	±	3.879	3.957*
17	JVB-LS-2507	67.844	2.821	±	2.821	0.83
18	JVB-2508	69.357	0.136++	±	0.161	-2.668
19	JVB-2509	65.842	2.432	±	2.704	0.544
20	JVB-2510	70.397	2.426	±	2.403	-0.133

Sr. No.	Genotypes	Mean	bi		±SEbi	S^2di
21	JVB-2511	71.633	0.203	±	3.159	1.723
22	JVB-2512	68.610	1.241	±	3.429	2.505
23	JVB-2513	70.899	1.806	±	3.422	2.485
24	JVB-2514	67.131	-2.611*++	±	1.697	-1.41
25	JVB-2515	55.143	1.477	±	2.797	0.772
26	JVB-2516	68.083	2.526	±	1.859	-1.155
27	JVB-2517	70.412	2.471	±	2.269	-0.409
28	JVB-2518	69.099	3.649	±	3.483	2.67*
29	JVB-2519	71.854	0.915	±	2.165	-0.613
30	JVB-2520	74.088	-2.166+	±	2.230	-0.487
31	JVB-2521	73.115	-0.574	±	3.033	1.377
32	JVB-2522	74.095	1.387	±	3.015	1.329
33	JVB-2523	71.939	2.805	±	3.534	2.827*
34	JVB-2524	61.162	3.49	±	3.729	3.454*
35	JVB-2525	69.746	3.148	±	2.492	0.06
36	JVB-2526	70.361	2.878	±	3.645	3.179*
37	JVB-2527	71.046	1.482	±	2.770	0.704
38	JVB-2528	66.468	0.036++	±	0.135	-2.672
39	JVB-2529	71.209	-2.352+	±	2.171	-0.6
40	JVB-2530	59.860	0.251	±	4.912	7.962**
41	JVB-2531	71.658	-1.414	±	2.675	0.476
42	JVB-2532	70.757	2.005	±	2.966	1.2
43	JVB-2533	67.611	3.354*	±	2.048	-0.83
44	JVB-2534	68.915	0.03	±	4.992	8.309**
45	Kaushal	70.217	1.485	±	2.706	0.549
46	GG-20	72.134	-0.291+	±	0.780	-2.411
47	GJG-22	69.698	0.313	±	0.998	-2.24
48	GG-HPS-2	57.871	3.039	±	2.516	0.113
49	ICGV-86564	65.128	2.419	±	1.908	-1.074
50	BAU-13	61.687	2.005	±	3.560	2.909*
	G.M.	68.43	1.00		-	-
	S.Em ±	0.47	-		-	-

***, ** significant at 5 and 1 levels, respectively when deviate from "0"**

+, ++ significant at 5 and 1 levels, respectively when deviate from "1"

4.5.3.11 Pod yield per plant (g)

Pod yield per plant ranged from 10.787 g (JVB-2527) to 22.309 g (JVB-2528). Stability parameters for this trait revealed that 15 genotypes expressed non-significant deviation from regression indicating their predictable behaviour.

Out of above 15 genotypes, 7 genotypes had mean values above population mean (14.87 g). Genotypes *viz.* JVB-2516 and JVB-2529 were average stable as having bi value significantly near unity (b_i=1), while genotypes *viz.* JVB-2508, JVB-2528, JVB-2532, GG-20 and GJG-22 were above average stable having bi significantly lower than unity.

Table 4.29: Mean over the environment ($\bar{X}$), regression coefficient (b_i), and deviation from regression (S^2di) for pod yield per plant (g)

Sr. No.	Genotypes	Mean	bi		$\pm SE_{bi}$	S^2di
1	JSSP-59	11.372	-4.2*++	±	2.507	0.137
2	JSSP-60	19.067	-0.999	±	6.089	6.83**
3	JSSP-62	12.653	-0.011	±	5.400	5.11**
4	JSSP-63	12.938	-1.762	±	4.816	3.813**
5	JVB-2453	12.297	-1.228	±	5.186	4.616**
6	JVB-2483	17.175	6.807	±	7.527	11.085**
7	JVB-2486	14.251	-1.829	±	9.286	17.512**
8	JVB-2489	15.401	8.361	±	8.501	14.479**
9	JVB-2494	10.943	9.246**++	±	1.363	-0.825
10	JSSP-LS-61	14.738	1.51	±	4.304	2.798*
11	JVB-LS-2436	12.472	-1.772	±	5.536	5.433**
12	JVB-LS-2373	11.984	6.706*	±	4.200	2.605*
13	JVB-LS-2501	11.158	-1.777	±	4.105	2.435*
14	JVB-LS-2502	14.842	-4.26	±	12.986	35.428**
15	JVB-LS-2505	12.355	3.735	±	4.190	2.587*
16	JVB-LS-2506	14.688	2.277	±	3.813	1.932*
17	JVB-LS-2507	13.983	6.566**++	±	2.162	-0.213
18	JVB-2508	20.658	0.074+	±	0.631	-1.142
19	JVB-2509	21.190	0.681	±	5.301	4.88**
20	JVB-2510	12.643	4.176	±	5.944	6.45**
21	JVB-2511	14.835	-2.57	±	5.650	5.711**
22	JVB-2512	18.047	-0.684	±	15.486	50.899**
23	JVB-2513	11.304	-5.011**++	±	2.547	0.181

Sr. No.	Genotypes	Mean	bi		±SE_{bi}	S^2di
24	JVB-2514	13.368	-4.08+	±	3.220	1.024
25	JVB-2515	11.630	0.74	±	4.321	2.83*
26	JVB-2516	20.685	-0.698	±	1.460	-0.765
27	JVB-2517	15.383	5.346	±	4.002	2.252*
28	JVB-2518	19.363	-4.617+	±	3.598	1.584*
29	JVB-2519	13.960	-4.938	±	7.015	9.466**
30	JVB-2520	11.930	2.482	±	5.181	4.605**
31	JVB-2521	16.389	-0.368	±	6.241	7.236**
32	JVB-2522	16.121	6.555	±	7.552	11.167**
33	JVB-2523	12.444	0.918	±	4.584	3.339**
34	JVB-2524	13.327	3.719	±	2.693	0.347
35	JVB-2525	11.413	0.95	±	4.078	2.386*
36	JVB-2526	11.914	5.989**++	±	1.835	-0.497
37	JVB-2527	10.787	1.903	±	3.759	1.842*
38	JVB-2528	22.309	-0.086++	±	0.403	-1.194
39	JVB-2529	15.018	1.501	±	2.697	0.352
40	JVB-2530	14.182	2.112	±	5.522	5.399**
41	JVB-2531	16.626	3.365	±	7.771	11.898**
42	JVB-2532	21.473	-0.562+	±	0.919	-1.045
43	JVB-2533	14.648	6.591	±	5.268	4.804**
44	JVB-2534	20.478	-0.16	±	5.486	5.312**
45	Kaushal	11.868	-1.755	±	2.957	0.672
46	GG-20	19.510	-0.323++	±	0.407	-1.193
47	GJG-22	17.352	-0.079++	±	0.523	-1.169
48	GG-HPS-2	12.677	-4.541+	±	3.910	2.094*
49	ICGV-86564	15.216	3.22	±	3.561	1.527*
50	BAU-13	12.441	2.781	±	5.150	4.536**
	G.M.	14.87	1.00		-	-
	S.Em ±	0.32	-		-	-

***, ** significant at 5 and 1 levels, respectively when deviate from "0"**

+, ++ significant at 5 and 1 levels, respectively when deviate from "1"

4.5.3.12 Kernel yield per plant (g)

Kernel yield per plant ranged from 6.391 g (JVB-2515) to 15.218 g (JVB-2532). Stability parameters for this trait revealed that 18 genotypes expressed non-significant deviation from regression indicating their predictable behaviour.

Out of above 18 genotypes, 7 genotypes had mean values above population mean (10.18 g). Genotypes *viz.* JVB-2508, JVB-2529 and JVB-2532 were average stable as having bi value significantly near unity (b_i=1), while genotype *viz.* JVB-2516, JVB-2528, GG-20 and GJG-22 were above average stable having bi significantly lower than unity.

Table 4.30: Mean over the environment ($\bar{X}$), regression coefficient (b_i), and deviation from regression (S^2di) for kernel yield per plant (g)

Sr. No.	Genotypes	Mean	bi		$\pm SE_{bi}$	S^2di
1	JSSP-59	7.093	-4.395**++	±	2.114	-0.132
2	JSSP-60	12.393	1.076	±	4.569	1.806**
3	JSSP-62	8.341	0.176	±	5.022	2.319**
4	JSSP-63	9.098	-1.97	±	4.220	1.444*
5	JVB-2453	9.087	0.77	±	6.021	3.622**
6	JVB-2483	11.875	5.517	±	6.356	4.111**
7	JVB-2486	10.141	-0.839	±	9.053	9.02**
8	JVB-2489	11.113	6.726	±	9.405	9.786**
9	JVB-2494	7.742	9.378**++	±	3.296	0.623*
10	JSSP-LS-61	9.580	0.043	±	3.595	0.866*
11	JVB-LS-2436	8.650	-1.832	±	4.284	1.508*
12	JVB-LS-2373	8.162	4.891	±	5.606	3.051**
13	JVB-LS-2501	8.104	-0.072	±	4.584	1.822**
14	JVB-LS-2502	10.663	-1.037	±	13.596	21.17**
15	JVB-LS-2505	8.295	3.94	±	3.986	1.217*
16	JVB-LS-2506	9.131	1.784	±	2.863	0.308
17	JVB-LS-2507	9.462	6.047**++	±	1.658	-0.335
18	JVB-2508	14.350	0.171	±	0.607	-0.616
19	JVB-2509	13.960	-0.837	±	3.434	0.733*
20	JVB-2510	8.916	2.885	±	6.233	3.928**
21	JVB-2511	10.611	-3.912	±	4.388	1.614**
22	JVB-2512	12.345	1.619	±	13.910	22.191**
23	JVB-2513	8.033	-5.612**++	±	1.024	-0.536

Sr. No.	Genotypes	Mean	bi		±SE$_{bi}$	S^2di
24	JVB-2514	8.993	-4.267*+	±	3.026	0.422
25	JVB-2515	6.391	-0.628	±	2.829	0.285
26	JVB-2516	14.084	-1.323**++	±	0.585	-0.619
27	JVB-2517	10.825	4.291	±	4.588	1.827**
28	JVB-2518	13.387	-2.332	±	5.855	3.389**
29	JVB-2519	10.061	-3.088	±	8.283	7.444**
30	JVB-2520	8.867	1.327	±	6.320	4.058**
31	JVB-2521	11.973	1.405	±	6.349	4.1**
32	JVB-2522	11.971	6.642	±	8.230	7.339**
33	JVB-2523	8.964	1.58	±	4.373	1.599**
34	JVB-2524	8.154	3.349*	±	2.208	-0.084
35	JVB-2525	7.937	1.075	±	3.359	0.672*
36	JVB-2526	8.374	5.671**++	±	1.557	-0.373
37	JVB-2527	7.653	2.014	±	3.676	0.936*
38	JVB-2528	14.850	-0.072++	±	0.190	-0.655
39	JVB-2529	10.695	2.101*	±	1.230	-0.481
40	JVB-2530	8.469	1.359	±	4.336	1.56**
41	JVB-2531	11.909	2.498	±	7.989	6.878**
42	JVB-2532	15.218	1.046	±	1.240	-0.478
43	JVB-2533	9.913	6.326	±	5.018	2.314**
44	JVB-2534	14.165	0.238	±	7.326	5.679**
45	Kaushal	8.318	-2.002+	±	1.919	-0.225
46	GG-20	14.076	-0.631**++	±	0.200	-0.655
47	GJG-22	12.088	0.244++	±	0.319	-0.648
48	GG-HPS-2	7.351	-4.288*++	±	2.746	0.231
49	ICGV-86564	9.882	2.188	±	2.674	0.185
50	BAU-13	7.648	0.76	±	4.538	1.772**
	G.M.	10.18	1.00		-	-
	S.Em ±	0.23	-		-	-

***, ** significant at 5 and 1 levels, respectively when deviate from “0”**

+, ++ significant at 5 and 1 levels, respectively when deviate from “1”

4.5.3.13 Biological yield per plant (g)

Biological yield per plant ranged from 30.335 g (JVB-2527) to 56.165 g (JVB-2516). Stability parameters for this trait revealed that 15 genotypes expressed non-significant deviation from regression indicating their predictable behaviour.

Out of above 15 genotypes, 8 genotypes had mean values above population mean (40.63 g). Genotypes JSSP-LS-61 and JVB-2516 were average stable as bi significantly near unity, while genotype *viz.* JSSP-60, JVB-2508, JVB-2518, JVB-2528, JVB-2532 and GG-20 were above average stable having bi significantly lower than unity and having low deviation from regression.

Table 4.31: Mean over the environment ($\overline{X}$), regression coefficient (b_i), and deviation from regression (S^2di) for biological yield per plant (g)

Sr. No.	Genotypes	Mean	bi		$\pm SE_{bi}$	S^2di
1	JSSP-59	34.841	-3.235	±	3.995	19.66**
2	JSSP-60	48.541	-0.57++	±	0.599	-5.694
3	JSSP-62	37.788	1.508	±	6.046	53.135**
4	JSSP-63	34.156	-1.099	±	4.113	21.223**
5	JVB-2453	44.458	0.137	±	4.535	27.143**
6	JVB-2483	50.994	9.041	±	6.906	71.24**
7	JVB-2486	35.286	-2.495	±	6.644	65.466**
8	JVB-2489	36.664	6.095	±	6.760	68.002**
9	JVB-2494	39.810	11.405**++	±	4.830	31.637**
10	JSSP-LS-61	47.344	2.69	±	2.303	2.345
11	JVB-LS-2436	38.645	-1.551	±	5.165	37.085**
12	JVB-LS-2373	33.916	4.952*+	±	2.759	6.097*
13	JVB-LS-2501	31.927	-4.163*++	±	2.555	4.334
14	JVB-LS-2502	44.551	-2.146	±	10.528	173.855**
15	JVB-LS-2505	34.862	0.731	±	2.452	3.492
16	JVB-LS-2506	51.434	3.06	±	3.589	14.664*
17	JVB-LS-2507	32.463	3.43**++	±	1.087	-4.356
18	JVB-2508	45.080	0.007++	±	0.149	-6.24
19	JVB-2509	52.626	2.033	±	4.297	23.73**
20	JVB-2510	35.300	2.683	±	6.690	66.467**
21	JVB-2511	40.791	-0.948	±	3.122	9.563*
22	JVB-2512	52.975	-0.378	±	15.133	365.927**
23	JVB-2513	37.169	-4.255	±	5.462	42.214**

Sr. No.	Genotypes	Mean	bi		±SE$_{bi}$	S^2di
24	JVB-2514	39.503	-0.697	±	4.101	21.051**
25	JVB-2515	36.711	4.329*	±	3.043	8.774*
26	JVB-2516	56.165	2.361	±	2.640	5.047
27	JVB-2517	36.810	3.245	±	2.860	7.014*
28	JVB-2518	49.451	-1.929++	±	1.484	-2.698
29	JVB-2519	47.026	-3.811	±	6.385	59.981**
30	JVB-2520	35.953	1.964	±	4.276	23.441**
31	JVB-2521	41.129	0.955	±	3.743	16.495**
32	JVB-2522	46.889	3.42	±	6.246	57.133**
33	JVB-2523	36.779	0.644	±	3.741	16.475**
34	JVB-2524	35.447	1.374	±	2.780	6.284*
35	JVB-2525	32.252	-0.768	±	2.315	2.433
36	JVB-2526	41.449	5.214*	±	3.314	11.571*
37	JVB-2527	30.335	0.343	±	2.227	1.781
38	JVB-2528	46.985	-0.237++	±	0.483	-5.897
39	JVB-2529	40.541	1.003	±	1.305	-3.51
40	JVB-2530	37.718	2.383	±	5.017	34.636**
41	JVB-2531	40.689	1.949	±	5.480	42.525**
42	JVB-2532	41.564	-0.102+	±	0.666	-5.556
43	JVB-2533	34.946	3.603	±	3.683	15.767**
44	JVB-2534	40.298	-1.612	±	3.995	19.664**
45	Kaushal	31.853	-1.484	±	2.365	2.815
46	GG-20	42.079	-0.16++	±	0.328	-6.102
47	GJG-22	44.840	0.668	±	2.809	6.549*
48	GG-HPS-2	36.872	-2.891	±	4.552	27.404**
49	ICGV-86564	43.018	0.711	±	4.557	27.481**
50	BAU-13	43.027	2.592	±	6.602	64.566**
	G.M.	40.63	1.00		-	-
	S.Em ±	0.72	-		-	-

***, ** significant at 5 and 1 levels, respectively when deviate from “0”**

+, ++ significant at 5 and 1 levels, respectively when deviate from “1”

4.5.3.14 Harvest index (%)

Harvest index ranged from 27.433 % (JVB-2453) to 51.783 % (JVB-2532). Stability parameters for this trait revealed that 33 genotypes expressed non-significant deviation from regression indicating their predictable behaviour.

Out of above 33 genotypes, 13 genotypes had mean values above population mean (36.55 %). Genotypes *viz.* JVB-2489, JVB-2508, JVB-2517, JVB-2524, JVB-2528, JVB-2529, JVB-2532 and JVB-2534 were average stable as having bi value significantly near unity (b_i=1). JVB-LS-2507 and JVB-2533 were also exhibited higher mean than population mean but these were below average stable as bi significantly higher than unity, while genotype *viz.* JVB-2509, GG-20 and GJG-22 were above average stable having bi significantly lower than unity.

Table 4.32: Mean over the environment ($\overline{X}$), regression coefficient (b_i), and deviation from regression (S^2di) for harvest index (%)

Sr. No.	Genotypes	Mean	bi		$\pm SE_{bi}$	S^2di
1	JSSP-59	32.551	-3.952+	±	3.257	-1.877
2	JSSP-60	39.325	9.888	±	9.705	9.844**
3	JSSP-62	33.529	2.014	±	5.296	0.569
4	JSSP-63	37.888	-0.167	±	7.017	3.541*
5	JVB-2453	27.433	1.628	±	6.717	2.964
6	JVB-2483	33.956	2.146	±	9.761	9.998**
7	JVB-2486	40.134	4.864	±	7.743	5.045*
8	JVB-2489	41.733	5.592	±	5.229	0.47
9	JVB-2494	27.451	0.07++	±	0.216	-3.358
10	JSSP-LS-61	31.210	-8.206	±	7.784	5.133*
11	JVB-LS-2436	32.182	-3.921	±	5.512	0.896
12	JVB-LS-2373	35.048	7.263	±	8.158	5.969*
13	JVB-LS-2501	34.914	6.215**++	±	2.759	-2.297
14	JVB-LS-2502	32.688	-2.057	±	13.672	22.85**
15	JVB-LS-2505	35.228	11.882*+	±	6.688	2.91
16	JVB-LS-2506	28.446	1.995	±	3.760	-1.382
17	JVB-LS-2507	42.752	10.544**++	±	3.243	-1.89
18	JVB-2508	45.879	1.178	±	1.846	-2.886
19	JVB-2509	40.371	-0.117++	±	0.395	-3.342
20	JVB-2510	35.734	1.421	±	4.076	-1.035
21	JVB-2511	36.221	-8.925**++	±	3.523	-1.623

Sr. No.	Genotypes	Mean	bi		$\underline{+}SE_{bi}$	S^2di
22	JVB-2512	33.777	-3.623	±	6.944	3.398*
23	JVB-2513	30.360	-0.934	±	7.827	5.227*
24	JVB-2514	33.847	-6.839+	±	5.186	0.408
25	JVB-2515	31.869	-8.552*++	±	5.076	0.249
26	JVB-2516	37.011	0.044	±	6.889	3.292*
27	JVB-2517	41.669	5.602	±	5.133	0.331
28	JVB-2518	39.168	-3.717	±	8.678	7.197*
29	JVB-2519	29.416	-2.945	±	7.538	4.605*
30	JVB-2520	33.061	-3.749	±	5.826	1.395
31	JVB-2521	39.747	-0.136	±	7.795	5.157*
32	JVB-2522	34.129	6.687	±	6.336	2.266
33	JVB-2523	33.679	2.714	±	3.678	-1.467
34	JVB-2524	37.553	3.465	±	5.446	0.796
35	JVB-2525	35.329	6.786	±	8.754	7.382*
36	JVB-2526	28.773	3.47	±	4.213	-0.875
37	JVB-2527	35.537	7.25	±	8.795	7.483*
38	JVB-2528	47.468	0.4	±	0.446	-3.336
39	JVB-2529	37.000	3.778	±	3.646	-1.5
40	JVB-2530	37.633	1.397	±	7.185	3.876*
41	JVB-2531	40.787	-3.137	±	6.459	2.487
42	JVB-2532	51.783	-1.502	±	2.694	-2.346
43	JVB-2533	41.754	8.417*+	±	5.244	0.492
44	JVB-2534	50.916	1.623	±	2.721	-2.326
45	Kaushal	37.140	-0.189	±	8.019	5.653*
46	GG-20	46.389	-0.293++	±	0.309	-3.351
47	GJG-22	38.867	-7.849**++	±	0.657	-3.304
48	GG-HPS-2	34.200	-2.189	±	4.474	-0.557
49	ICGV-86564	35.427	5.281	±	4.609	-0.385
50	BAU-13	28.896	-0.611	±	3.874	-1.259
	G.M.	36.56	1.00		-	-
	S.Em ±	0.53	-		-	-

***, ** significant at 5 and 1 levels, respectively when deviate from "0"**

+, ++ significant at 5 and 1 levels, respectively when deviate from "1"

4.5.3.15 Oil content (%)

Oil content ranged from 46.26 % (GG-HPS-2) to 54.20 % (JVB-2513). Stability parameters for this trait revealed that 29 genotypes expressed non-significant deviation from regression indicating their predictable behaviour.

Out of above 29 genotypes, 11 genotypes had mean values above population mean (50.54 %). Genotypes JVB-2489, JVB-2513, JVB-2517, JVB-2521, JVB-2525, JVB-2527 and ICGV-86564 were average stable as having bi value significantly near unity (b_i=1). JVB-2494 and JVB-2511 exhibited higher mean than population mean and these were below average stable as having bi significantly higher than unity, while genotype *viz.* GG-20 and BAU-13 were above average stable having bi significantly lower than unity.

Table 4.33: Mean over the environment ($\bar{X}$), regression coefficient (b_i), and deviation from regression (S^2di) for oil content (%)

Sr. No.	Genotypes	Mean	bi		$\pm SE_{bi}$	S^2di
1	JSSP-59	50.20	-0.41	±	7.678	0.895**
2	JSSP-60	49.34	0.916	±	7.362	0.806**
3	JSSP-62	50.25	1.162	±	6.355	0.548**
4	JSSP-63	50.12	6.491*	±	4.039	0.097
5	JVB-2453	49.30	6.078*	±	4.193	0.121
6	JVB-2483	49.51	-4.435+	±	3.795	0.062
7	JVB-2486	51.25	0.572	±	7.178	0.756**
8	JVB-2489	51.30	6.378*	±	3.945	0.083
9	JVB-2494	52.25	6.533*+	±	3.846	0.069
10	JSSP-LS-61	49.24	6.02*	±	4.323	0.142
11	JVB-LS-2436	48.65	-1.868	±	3.003	-0.039
12	JVB-LS-2373	48.35	-6.632*++	±	4.134	0.112
13	JVB-LS-2501	47.28	-4.312+	±	3.542	0.027
14	JVB-LS-2502	49.30	0.606	±	6.858	0.672**
15	JVB-LS-2505	47.31	-6.445*+	±	4.390	0.153
16	JVB-LS-2506	47.30	-5.951*+	±	3.793	0.061
17	JVB-LS-2507	50.20	6.292*+	±	3.768	0.058
18	JVB-2508	53.31	-1.051	±	6.473	0.576**
19	JVB-2509	51.28	0.741	±	7.472	0.837**
20	JVB-2510	50.18	-0.022	±	6.973	0.702**
21	JVB-2511	52.21	6.254**+	±	3.106	-0.027

Sr. No.	Genotypes	Mean	bi		$\pm SE_{bi}$	S^2di
22	JVB-2512	52.26	-0.802	±	7.345	0.802**
23	JVB-2513	54.20	5.86*	±	3.884	0.074
24	JVB-2514	51.30	0.711	±	7.254	0.777**
25	JVB-2515	48.34	-6.089**++	±	3.241	-0.011
26	JVB-2516	52.24	0.841	±	6.597	0.606**
27	JVB-2517	52.30	5.487*	±	3.284	-0.006
28	JVB-2518	52.23	-0.607	±	6.968	0.701**
29	JVB-2519	53.21	0.069	±	7.043	0.72**
30	JVB-2520	50.18	5.546*	±	3.349	0.002
31	JVB-2521	52.18	5.63*	±	3.550	0.028
32	JVB-2522	49.34	-0.017	±	7.401	0.817**
33	JVB-2523	49.23	0.868	±	7.573	0.865**
34	JVB-2524	51.33	-0.829	±	7.624	0.88**
35	JVB-2525	51.25	5.679	±	4.348	0.146
36	JVB-2526	52.34	0.944	±	6.859	0.672**
37	JVB-2527	52.23	5.671	±	4.164	0.116
38	JVB-2528	51.27	0.58	±	7.190	0.759**
39	JVB-2529	52.33	-0.644	±	6.306	0.536**
40	JVB-2530	49.28	6.094*	±	3.974	0.088
41	JVB-2531	50.14	6.498*+	±	3.942	0.083
42	JVB-2532	50.36	-5.482+	±	4.053	0.099
43	JVB-2533	49.30	-6.2*+	±	4.165	0.117
44	JVB-2534	53.31	0.464	±	6.954	0.697**
45	Kaushal	49.22	6.113*	±	3.902	0.077
46	GG-20	51.25	-5.659*+	±	3.638	0.04
47	GJG-22	50.19	6.034*+	±	3.518	0.024
48	GG-HPS-2	46.26	-0.376	±	6.842	0.668**
49	ICGV-86564	51.27	6.519*	±	4.346	0.145
50	BAU-13	50.78	-9.821**++	±	3.042	-0.035
	G.M.	50.54	1.00		-	-
	S.Em ±	0.13	-		-	-

***, ** significant at 5 and 1 levels, respectively when deviate from "0"**

+, ++ significant at 5 and 1 levels, respectively when deviate from "1"

CHAPTER – V

DISCUSSION

Groundnut (*Arachis hypogaea* L.) is grown over a vast area in the country as well as world and a little increase in its yield potential would make a tremendous impact on the total production. The improvement of pod yield largely depends on magnitude of genetic variability present and the extent to which pod yield determining characters are heritable. It is also important to understand the association of important characters with pod yield for effective selection in the segregating population.

The amount of variability present in a collected germplasm in respect of various quantitative characters is a basic pre-requisite for a plant breeder to commence with any crop improvement programme. Heritability and genetic advance would help in deciding the appropriate selection intensity, whereas the genetic advance predicts the gain that is likely to be achieved through selection.

Pod yield, being a complex and polygenic character, is influenced by various components. The effectiveness of selection for high yielding genotypes depends upon magnitude and its direction of correlation between pod yield and yield contributing characters as well as association among various plant characters. The measures of direct and indirect effects of traits influencing pod yield exhibits their relative significance in selection and breeding programme can be done by path coefficient analysis. Direct selection on the basis of yield is not beneficial because many morphological traits affect it.

Low productivity of groundnut in the country is attributed to several constraints and one among those is poor adaption of improved varieties and their inconsistent performance over range of environments, as the crop is largely cultivated as rainfed crop (Gadgil *et al.*, 1995). Therefore, it has become necessary to develop varieties with attributes such as wide adaptability.

The consistent performance of a genotype over a range of environments is essential for a wide stability of a variety. Stability of genotypes depends upon maintaining expression of certain morphological and physiological attributes and allowing others to vary, resulting in G x E interactions. G x E interaction has a masking effect on the performance of a genotype and hence the relative ranking of the genotype do not remain the same over number of environments. G x E is a phenomenon that is very important and is of significance to plant breeders, agronomist and farmers all over the world. Breeding materials can be selected and assessed on the basis of their different responses to the environments. Studying of G x E interaction is very important to plant breeders because this interaction it can limit the progress in the selection process and since it is a basic cause of differences between genotypes for yield stability. It is generally agreed that the more stable genotypes adjust their phenotypic responses to provide some measure of uniformity in spite of environmental fluctuations. Therefore, an attempt has been made in present study to evaluate different groundnut genotypes across the different environment to know the role of G x E interactions and also to analyze the stability of genotypes for different traits.

The present investigation was conducted by keeping objective like estimation of variability for different quantitative characters, character association and path analysis and to know the stability of genotypes across the environments. The experiment was conducted at two different locations Junagadh (E_1: *Kharif*-2019, E_2: *Kharif*-2020) and Manavadar (E_3: *Kharif*-2019, E_4: *Kharif*-2020) creating four different environments. The results obtained from individual environments are discussed in to the following sub heads:

5.1 ANALYSIS OF VARIANCE

The analysis of variance revealed that mean squares due to fifty genotypes of groundnut had highly significant differences for all the characters studied in both the years and locations indicating presence of high genetic variability among the genetic material tested in the experiment. Availability of sufficient variability in the material handled by the plant breeders is of immense importance for the success of any breeding programme.

5.2 GENETIC VARIABILITY

Genetic variability is basic tool for crop improvement due to its wider scope for selection. Therefore, the effectiveness of selection depends upon the nature and magnitude of genetic variability present in the experimental material and the extent of its heritability. The present experimental material showed wide range of phenotypic variation in all environments for number of matured pods per plant, 100-kernel weight, pod yield per plant, kernel yield per plant, biological yield per plant and harvest index as revealed by high values of coefficient of range. Characters which showed wide range of variation had more scope of improvement while making selection of genotypes from segregating material. Selection must be practiced on characters having wide range of variation under the respective sowing condition.

5.2.1 Phenotypic and genotypic coefficient of variation

The estimate of genotypic and phenotypic coefficient of variability in all four environments indicated that the values of phenotypic coefficient of variation were higher than genotypic coefficient of variation for all environments, in most of the cases, indicating more influence of environmental factors. Similar results were also reported by Kumar & Rajamani (2004), Kumar *et al.* (2014) and Om & Nadaf (2017). These findings suggested that selection can be effective on the basis of phenotype along with equal probability of genotypic values.

Estimates of variability parameters are generally more or less same for all the environments. For all the environments generally high estimates of genotypic coefficient of variation and phenotypic coefficient of variation were observed for number of matured pods per plant, number of immature pods per plant, pod yield per plant and kernel yield per plant. Only in E_3 biological yield per plant had high values of genotypic and phenotypic coefficient of variation. The high genotypic coefficient of variation indicated the presence of wide variation for the characters under study to allow selection for individual traits.

High estimates of phenotypic and genotypic coefficient of variation in groundnut have been reported for number of matured pods per plant by Nath and Alam (2002), Mothilal *et al.* (2004), Wani *et al.* (2004), Vekariya *et al.* (2011), Zaman *et al.* (2011), Babariya (2012) and Sanjeevakumar *et al.* **(**2015); for number of immature pods per plant by Zaman *et al.* (2011), Babariya (2012) and Sanjeevakumar *et al.* **(**2015); for pod yield per plant by Venkataramana (2001), Nath and Alam (2002), Kumar and Rajamani (2004), Mothilal *et al.* (2004), Kadam *et al.* (2007) and Sanjeevakumar *et al.* **(**2015); for kernel yield per plant by Venkataramana (2001), Kadam *et al.* (2007) and Vekariya *et al.* (2011); for biological yield per plant by Vekariya *et al.* (2011) and Babariya (2012).

In all environments moderate values for phenotypic and genotypic coefficient of variation were found for number of primary branches per plant, number of secondary branches per plant (except in E_3 and $E_{4,}$ values were low in this two environment for these trait), plant height, 100-kernel weight, biological yield per plant (except in $E_{3,}$ value was high for this environment) and harvest index. While, low estimates for phenotypic and genotypic coefficient of variation were found for days to 50% flowering, days to maturity, sound mature kernel, shelling out-turn and oil content.

Moderate values of phenotypic and genotypic coefficient of variation in groundnut have been reported for number of primary branches per plant by Prasad *et al.* (2002) and Kumar *et al.* (2014); for number of secondary branches per plant by Sushree *et al*. (2017); for plant height by Prasad *et al.* (2002), Mothilal *et al.* (2004) and Babariya (2012); for 100-kernel weight by Prasad *et al.* (2002), Mothilal *et al.* (2004), Babariya (2012) and Gupta *et al.* (2015a); for biological yield per plant by Gupta *et al.* (2015a) and Namrata *et al.* (2016); for harvest index by Gupta *et al.* (2015a) and Gouranga *et al.* (2017). Low values of phenotypic and genotypic coefficient of variation in groundnut have been reported for days to 50% flowering by Kumar and Rajamani (2004), Vekariya *et al.* (2011), Zaman *et al.* (2011), Babariya (2012), Kumar *et al.* (2014) and Gupta *et al.* (2015a); for days to maturity by Vekariya *et al.* (2011), Zaman *et al.* (2011), Babariya (2012) and Gupta *et al.* (2015a); for sound mature kernel by Parameshwarappa *et al*. (2004) and Gupta *et al.* (2015a); for shelling out-turn by Gupta *et al.* (2015a) and Sanjeevakumar *et al.* **(**2015); for oil content by Parameshwarappa *et al*. (2004), Zaman *et al.* (2011), Babariya (2012) and Gupta *et al.* (2015a).

5.2.2 Heritability

With the help of genotypic coefficient of variation alone, it is not possible to determine the extent of variation which is heritable. Thus, the knowledge of heritability of a character helps the plant breeder in predicting the genetic advance for any quantitative characters and aids in exercising necessary selection procedure. Burton (1952) suggested that genotypic coefficient of variation together with heritability estimate would give the best picture expected for selection.

In all the environments heritability estimates were high for days to 50% flowering, number of primary branches per plant, number of secondary branches per plant, plant height, number of matured pods per plant, number of immature pods per plant, sound mature kernel, 100-kernel weight, shelling out-turn, pod yield per plant, kernel yield per plant, biological yield per plant, harvest index and oil content. Days to maturity have moderate heritability estimates under E_1, E_3 and E_4, while it have high heritability under E_2. High heritability for the characters which is controlled by polygenes might be useful to plant breeders for making effective selection.

The high magnitude of heritability in groundnut has also been earlier reported by Khote *et al.* (2009) and Kumar *et al.* (2014) for days to 50% flowering; by Singh and Chaubey (2003) for number of primary branches per plant; by Korat *et al.* (2009) and Babariya (2012) for number of secondary branches per plant; by Singh and Chaubey (2003), John *et al.* (2013) and Kumar *et al.* (2014) for plant height; by Prasad *et al.* (2002), Singh and Chaubey (2003), Mahalakshmi *et al.* (2005) and Vekariya *et al.* (2011) for number of matured pods per plant; by Mahalakshmi *et al.* (2005) for number of immature pods per plant; by Venkataramana (2001), Parameshwarappa *et al*. (2004) and Babariya (2012) for sound mature kernel; by Venkataramana (2001), Singh and Chaubey (2003), Parameshwarappa *et al*. (2004) and Wani *et al.* (2004) for 100-kernel weight; by Nath and Alam (2002), Wani *et al.* (2004) and Mahalakshmi *et al.* (2005) for shelling out-turn; by Prasad *et al.* (2002), Kadam *et al.* (2007) and Vekariya *et al.* (2011) for pod yield per plant; by Parameshwarappa *et al*. (2004), Kadam *et al.* (2007) and Vekariya *et al.* (2011) for kernel yield per plant; by Khote *et al.* (2009) and Babariya (2012) for biological yield per plant; by Prasad *et al.* (2002), Babariya (2012) and John *et al.* (2012) for harvest index; by Venkataramana (2001) and John *et al.* (2012) for oil content.

5.2.3 Genetic advance as per cent of mean

The high value of genetic advance as percent of mean for all environments were recorded for number of primary branches per plant, number of matured pods per plant, number of immature pods per plant, 100-kernel weight, pod yield per plant, kernel yield per plant, biological yield per plant and harvest index. Days to 50% flowering and sound mature kernel exhibited moderate values for genetic advance as percent of mean under all environments, while low values of genetic advance as percent of mean were exhibited by days to maturity and oil content. Number of secondary branches per plant recorded high values of genetic advance as percent of mean under E_1 and E_2, while low values under E_3 and E_4. Plant height recorded high values of genetic advance as percent of mean for all environments except E_3, in which it have moderate value of genetic advance as percent of mean. Shelling out-turn recorded moderate values of genetic advance as percent of mean for all environments except E_3, in which it have low value of genetic advance as percent of mean.

Johnson *et al.*, (1955) suggested that the heritability estimate along with genetic advance is more useful than the heritability alone in predicting the resultant effect of selection. In the present study, the estimates of high heritability coupled with high genetic advance as percent of mean were observed for number of primary branches per plant, number of matured pods per plant, number of immature pods per plant, 100-

kernel weight, pod yield per plant, kernel yield per plant, biological yield per plant and harvest index, which may be contributed to the preponderance of additive gene action and selection pressure could profitably be applied on these characters for improving the pod yield.

High heritability coupled with high genetic advance as percent of mean in groundnut have been reported for number of matured pods per plant by Mahalakshmi *et al.* (2005), Vekariya *et al.* (2011) and Babariya (2012); for number of immature pods per plant by Mahalakshmi *et al.* (2005); for 100-kernel weight by Venkataramana (2001), Parameshwarappa *et al*. (2004) and Wani *et al.* (2004); for pod yield per plant by Prasad *et al.* (2002), Kadam *et al.* (2007) and Vekariya *et al.* (2011); for kernel yield per plant by Parameshwarappa *et al*. (2004), Kadam *et al.* (2007) and Vekariya *et al.* (2011); for biological yield per plant by Babariya (2012) and Gupta *et al.* (2015a); for harvest index by Prasad *et al.* (2002), Babariya (2012) and John *et al.* (2012).

For the remaining characters like days to 50% flowering, days to maturity, sound mature kernel, shelling out-turn and oil content, major variation was environmental leading to low genetic advance as percent of mean and hence, little gain is expected through selection. Characters which had high heritability with low genetic advance may conditioned by non-additive gene action and presence of high genotype x environment interaction. The high heritability is being exhibited due to favourable influence of environment rather than genotype and simple selection would not be rewarding. As such, progeny or family testing is to be practiced for improvement of these traits. However, these characters can be improved by development of hybrid varieties or utilization of transgrassive segregants in heterosis breeding programme.

High heritability with low genetic advance as percent of mean in groundnut have been reported for days to 50% flowering by Singh and Chaubey (2003) & Zaman *et al.* (2011); for shelling out-turn by Singh and Chaubey (2003); for oil content by John *et al.* (2012) and Zaman *et al.* (2011).

5.3 CORRELATION COEFFICIENTS

In plant breeding programmes several yield attributing characters are often to be handled together by a breeder as most of the characters especially of fitness are correlated. Thus, the different components of yield very often exhibit considerable degree of association among themselves and with seed yield. Yield is a complex character and the multiplicative end product of many quantitative traits (Whitehouse *et* *al.*, 1958). Therefore, selection for yield *per se* will not be desirable. Searle (1965) suggested that the average merit of a character in a population could be changed by means of selection programme based on phenotype of the main trait concerned. However, such an improvement would be more reliable if indirect selection based on another trait correlated with it is made. Thus, for rational improvement of yield and its components, the understanding of correlation has been observed very useful.

Correlation among traits may result from pleiotropy, linkage or physiological associations among characters. The linkage is a cause of transit correlations particularly in a population derived from crosses between divergent strains. The correlation is the overall or net effect of the segregating genes. Some of the genes may increase both the characters causing the positive correlation, while the others may increase the one and decrease the other causing the negative correlation (Falconer, 1981). Thus, to accumulate optimum combination of yield contributing characters in a single genotype, it is essential to know the implication of the interrelationship among various plant characters.

In the present investigation, for both sowing conditions most of the character pairs had higher values of genotypic correlations than their corresponding phenotypic correlations. Such high amount of genotypic correlations could result due to masking or modifying effect of environmental on the association of characters. This indicates that though there was high degree of association between two variables at genotypic level, its phenotypic expression was deflated by the influence of environment. It was also indicated that there was inherent relationship between the characters studied which is in agreement with the findings of Venkataravana *et al*. (2000a), Nagda & Joshi (2004) and Sonone & Thaware (2009).

The study of genotypic correlation coefficient indicates the extent of relationship between different variables. This relationship among yield contributing characters as well as their association with yield provides information for exercising selection pressure for bringing genetic improvement in pod yield. In the present study, for all environments pod yield per plant was found to be highly significant and positively correlated with number of secondary branches per plant, number of matured pods per plant, kernel yield per plant, biological yield per plant and harvest index at both the genotypic and phenotypic levels. Pod yield per plant also exhibited highly significant and positive correlation both at genotypic and phenotypic level with sound mature kernel under E_1, E_2 and E_4. In case of E_1 and E_2 pod yield per plant exhibited significant and positive correlation at genotypic and phenotypic level with 100-kernel weight. Correlation with oil content of pod yield per plant was highly significant and positive both at genotypic and phenotypic level under E_3, while it was significant and positive at genotypic level only under E_4. This indicates that these attributes were more influencing the pod yield in groundnut and therefore, were important for bringing improvement in pod yield. Johnson *et al.*, (1955) emphasized that these correlated yield attributes can serve as indicator characters for improving pod yield. They have further emphasized that such improvement depends not only on genotypic correlations but phenotypic correlations also play an important role.

Such positive interrelationships in groundnut with pod yield per plant have also been reported for number of secondary branches per plant by Venkataravana *et al*. (2000a) and Kadam *et al.* (2009); for number of matured pods per plant by Venkataravana *et al*. (2000a), Jayalakshmi and Lakshmikantha (2003) and Kadam *et al.* (2009); for kernel yield per plant by Venkataravana *et al*. (2000a), Giri *et al.* (2009) and Sonone and Thaware (2009); for biological yield per plant by Golakia *et al.* (2004) and Vekariya *et al.* (2010); for harvest index by Venkataravana *et al*. (2000a), Jayalakshmi and Lakshmikantha (2003) and Golakia *et al.* (2004); for sound mature kernel by Venkataravana *et al*. (2000a), Mane *et al.* (2008) and Channayya *et al.* (2011); for 100-kernel weight by Venkataravana *et al*. (2000a), Golakia *et al.* (2004) and Kadam *et al.* (2009); for oil content by Venkataravana *et al*. (2000a), Golakia *et al.* (2004) and Siddiquey *et al.* (2006).

In all four environments number of secondary branches per plant had highly significant and positive correlation with number of matured pods per plant, number of matured pods per plant had highly significant and positive correlation with sound mature kernel, 100-kernel weight had significant and positive correlation with harvest index, kernel yield per plant had highly significant and positive correlation with biological yield per plant. In case of E_1, E_2 and E_4 sound mature kernel had significant and positive correlation with kernel yield per plant. This indicates there is inter correlation of characters which are correlated with pod yield per plant. This relationship indicated that the improvement in one will bring the improvement in another which, in turn, automatically lead to increase in pod yield. Such an inter correlation was also been reported by Golakia *et al.* (2004), Kadam *et al.* (2009) and Nirmala & Jayalakshmi (2015).

Thus, the results revealed that the number of secondary branches per plant, number of matured pods per plant, sound mature kernel, 100-kernel weight, kernel yield per plant, biological yield per plant, harvest index and oil content were the most important attributes which contributed towards higher yield. Therefore, more emphasis should be given to these components during selection for higher yield.

5.4 PATH COEFFICIENT ANALYSIS

A complex situation before a plant breeder is to select high yielding cultivars, which is a polygenic trait influenced by various components directly or indirectly. Consequently, path coefficient analysis could provide the more realistic picture of the interrelationship as it considers direct as well as indirect effects of the variables by partitioning the correlation coefficient.

In all environments positive and highest direct effect on pod yield per plant was found by kernel yield per plant, while biological yield per plant and harvest index have moderate to low direct effect on pod yield per plant. These characters also have high and positive phenotypic correlation with pod yield per plant. Shelling out-turn had negative and low to moderate direct effect on pod yield per plant, while its correlation with pod yield per plant was positive and low, which was nullified by high and positive indirect effect via kernel yield per plant. Positive direct effect on pod yield per plant were also reported by Methews *et al.* (2001), Nagda and Joshi (2004), Awatade *et al.* (2009) and Vekariya *et al.* (2010) for kernel yield per plant; by Suneetha *et al.* (2004), Khanpara *et al.* (2010), Vaithiyalingan *et al*. (2010) and Vekariya *et al.* (2010) for biological yield per plant; by Nagda and Joshi (2004), Suneetha *et al.* (2004) Vekariya *et al.* (2010) for harvest index.

Character like number of secondary branches per plant, number of matured pods per plant, sound mature kernel, 100-kernel weight, biological yield per plant and harvest index had positive and high correlation with pod yield per plant, which have low to moderate positive direct effect but it have high and positive and indirect effect on pod yield per plant via kernel yield per plant. High indirect effect via kernel yield per plant by these positively correlated characters with pod yield per plant were also reported by Giri *et al.* (2009), Namrata *et al.* (2016) and Sushree *et al*. (2017).

For all environments the residual effect was of low magnitude suggesting that the majority of the yield attributing characters have been included in the path analysis. It was apparent from the path analysis that higher direct effects were exerted by kernel yield per plant, biological yield per plant and harvest index. These all characters also exhibited significant and positive association with pod yield per plant and hence, these may be considered as most important yield contributing characters and due emphasis should be placed on these components while breeding for high yield in groundnut.

It can also be concluded that the characters which are most important for correlation studies are also important for path analysis. Thus, it can be suggested that correlation and path analysis study should be consider together for rapid gain for final improvement in yield.

5.5 G X E INTERACTION AND STABILITY:

Crop variety developed should show stable performance under different environments, especially in India where wide range of environment is prevailing. It is a need to develop genotype with high degree of adaptability levels over a wide range of eco geographical conditions for successful exploitation of its inherent potential. A variety is said to be stable which can adjust its phenotypic and genotypic status in response to changing environment. The genotype x environment interaction studies is as an important as crop improvement.

Genotype x environment interaction is supposed to be one of the genetic parameter responsible for phenotypic stability and adaptation. There are many investigations done in the past and continued till today with a view to identify a stable and adaptable genotype for different yield contributing characters.

Phenotypically stable varieties are usually sought for commercial production of crop plants. In any breeding programme it is necessary to screen and identify phenotypically stable genotypes, which could perform more or less uniformly under different environmental conditions. Considering this fact in mind, the present investigation was carried out to collect information on fifty genotypes which may be of great use in launching a dynamic and efficient breeding programme.

The pooled analyses of variance revealed that the mean squares due to genotypes (G) were found highly significant for all the characters studied, when tested against pooled error and pooled deviation. The mean squares due to environments (E) when tested against pooled error were found significant for all the characters except number of primary branches per plant and harvest index, while mean squares due to environments (E) when tested against pooled deviation were found significant for days to 50% flowering, days to maturity, plant height, number of matured pods per plant, sound mature kernel, 100-kernel weight and shelling out-turn. G x E interactions were found significant for all the characters when tested against error mean square. However, G x E interaction was found significant for days to maturity and plant height when tested against pooled deviation. This indicating the presence of variability among the genotypes and environments. The variance due to E + (G x E) was further partitioned into linear [(Environment (linear) and G x E (linear)] and non-linear (pooled deviations) components. Mean square due to E + (G x E) component was significant for all the traits when tested against pooled error, while against pooled deviation trait days to 50% flowering, days to maturity, plant height, number of matured pods per plant and 100-kernel weight were found significant. G x E (linear) component was significant for all the traits except shelling out-turn when tested against pooled error, while the same variance *i.e.* G x E (linear) was significant for days to 50% flowering, days to maturity, plant height and 100-kernel weight when tested against pooled deviation. The mean squares due to environments (linear) were significant for all the characters against pooled error, while mean squares due to environments (linear) were found significant for days to 50% flowering, days to maturity, number of secondary branches per plant, plant height, number of matured pods per plant, number of immature pods per plant, sound mature kernel and 100-kernel weight when tested against pooled deviation. Mean squares due to pooled deviation were significant for all the characters except days to maturity. These results are in agreement with those reported by Mahto and Mahto (2000), Minimol *et al.* (2000), Mekontchou *et al*. (2006), Reddy *et al*. (2016) and Minde *et al*. (2017).

Existence of genotype x environment interactions necessitated the study of different stability parameters. Knowledge of stability performance is important for the development of potential genotypes with consistent higher productivity over a range of environments.

Different measures of stability have been used by various workers. Finlay and Wilkinson (1963) considered linear regression slope as measure of stability. Eberhart and Russell (1966) realized the need of considering both linear (b_i) and non-linear (S^2di) components of genotype x environment interaction in judging the phenotypic stability of a genotype. Comstock and Moll (1963), Allard and Bradshaw (1964), Eberhart and Russell (1966) and Perkins and Jinks (1968) have emphasized the importance of evaluating genotypes under different agro-climatic conditions to obtain reliable information on stability parameters of breeding material. Later, Breese (1969) and Paroda and Hayes (1971) advocated that linear regression could simply be regarded as a measure of responsiveness for a particular genotype, whereas, deviations around regression lines (S^2di) were considered as a better measure of stability. They concluded that genotypes with the lowest standard deviation were the most stable and *vice-versa*.

Genotypes were considered as stable having high mean performance ($\overline{X}$), regression coefficient close to unity (b_i=l.00) deviation from regression approaching to zero (S^2di=0). The genotypes having high mean, $b_i > 1$ and non-significant S^2di were suitable for favourable environment and considered as below average stable, while the genotypes with high mean, $b_i < 1$ and non-significant S^2di were treated as good for poor environment and considered as above average stable (Eberhart and Russell, 1966). The genotypes having significant S^2di were treated as unstable. In view of above, the present material was analysed for stability parameters. Results based on mean performance, regression coefficient and deviation from regression are discussed below:

In present study for pod yield per plant, genotypes JVB-2516 and JVB-2529 were average stable as having high pod yield per plant, near unit regression coefficient and non-significant deviation from regression indicated that these genotype were highly stable across all the environments. Genotype JVB-2516 had also possessed stability for characters like days to maturity, number of primary branches per plant, number of secondary branches per plant, number of matured pods per plant, sound mature kernel, kernel yield per plant and biological yield per plant. While genotype JVB-2529 had also possessed stability for characters like days to 50% flowering, 100-kernel weight, shelling out-turn, kernel yield per plant and harvest index. Genotypes JVB-2508, JVB-2528, JVB-2532, GG-20 and GJG-22 were exhibited high mean value, less than unit regression coefficients and non-significant deviation from regression, indicates these genotypes were good for poor environment and considered as above average stable. These genotypes also exhibited stability for other yield governing characters also, like genotype JVB-2508 possessed stability for number of matured pods per plant, sound mature kernel, shelling out-turn, kernel yield per plant, biological yield per plant and harvest index; genotype JVB-2516 possessed stability for number of primary branches per plant, kernel yield per plant and biological yield per plant; genotype JVB-2528 possessed stability for number of secondary branches per plant, number of matured pods per plant, sound mature kernel, 100-kernel weight, kernel yield per plant, biological yield per plant and harvest index; genotype JVB-2532 possessed stability for number of secondary branches per plant, number of matured pods per plant, shelling out-turn, kernel yield per plant, biological yield per plant and harvest index; genotype GG-20 possessed stability for number of secondary branches per plant, number of matured pods per plant, sound mature kernel, 100-kernel weight, shelling out-turn, kernel yield per plant, biological yield per plant, harvest index and oil content; genotype GJG-22 possessed stability for number of primary branches per plant, number of matured pods per plant, 100-kernel weight, shelling out-turn, kernel yield per plant and harvest index (Table 5.1).

Out of the above said seven stable genotypes, most promising genotypes were JVB-2528 (22.30 g), JVB-2532 (21.47 g), JVB-2516 (20.68 g), JVB-2508 (20.65 g) and GG-20 (19.51 g) because they produced more yield with stability.

Table 5.1: List of genotypes found stable for various characters in groundnut

1. Days to 50 % flowering	
Above average stable	JSSP-59, JVB-LS-2373, JVB-2518, JVB-2524, GG-20, GJG-22
Average stable	JVB-2494, JVB-LS-2502, JVB-2508, JVB-2511, JVB-2513, JVB-2515, JVB-2517, JVB-2529, JVB-2530, JVB-2532, JVB-2534, ICGV-86564
Below average stable	JVB-2483, JVB-253, JVB-2533
2. Days to maturity	
Above average stable	JVB-LS-2436, GG-20
Average stable	JVB-2486, JVB-LS-2373, JVB-2508, JVB-2509, JVB-2510, JVB-2514, JVB-2516, JVB-2518, JVB-2524, JVB-2525, JVB-2529, JVB-2531, JVB-2532, JVB-2533, GJG-22
Below average stable	JVB-2494, JVB-LS-2505, JVB-2526
3. Number of primary branches per plant	
Above average stable	Kuashal
Average stable	JVB-2453, JVB-2494, JVB-LS-2505, JVB-LS-2506, JVB-2510, JVB-2516, JVB-2522, JVB-2523, JVB-2525, JVB-2528, JVB-2530, JVB-2531, JVB-2532, JVB-2534, GJG-22, GG-HPS-2
Below average stable	JVB-2526, GG-20
4. Number of secondary branches per plant	
Above average stable	JVB-LS-2373

Average stable	JVB-2528, GG-20
Below average stable	JVB-2509, JVB-2516, JVB-2534
5. Plant height (cm)	
Above average stable	JVB-2509, JVB-2526, ICGV-86564
Average stable	JVB-2453, JVB-LS-2505
Below average stable	JVB-LS-2506, JVB-2533
6. Number of matured pods per plant	
Above average stable	JVB-2508, GG-20
Average stable	JVB-2509, JVB-2516, JVB-2518, JVB-2528, JVB-2532, GJG-22
Below average stable	JVB-2510, JVB-2531, JVB-2534
7. Number of immature pods per plant	
Above average stable	-
Average stable	JSSP-60, JSSP-62
Below average stable	-
8. Sound mature kernel (%)	
Above average stable	JVB-2510, JVB-2516, JVB-2534, GG-20
Average stable	JVB-LS-2506, JVB-2508, JVB-2528
Below average stable	JVB-2486
9. 100-kernel weight (g)	
Above average stable	JSSP-60, JVB-2509, JVB-2528, GG-20, GJG-22
Average stable	JVB-2483, JVB-2515
Below average stable	JVB-LS-2373, JVB-2529, GG-HPS-2
10. Shelling out-turn (%)	
Above average stable	JVB-2508, JVB-2520, JVB-2529, GG-20
Average stable	JSSP-63, JVB-2453, JVB-2489, JVB-LS-2501, JVB-2510, JVB-2511, JVB-2512, JVB-2513, JVB-2517, JVB-2519, JVB-2521, JVB-2522, JVB-2525, JVB-2527, JVB-2531, JVB-2532, Kaushal, GJG-22
Below average stable	JVB-2486
11. Pod yield per plant (g)	
Above average stable	JVB-2508, JVB-2528, JVB-2532, GG-20, GJG-22

Average stable	JVB-2516, JVB-2529
Below average stable	-
12. Kernel yield per plant (g)	
Above average stable	JVB-2516, JVB-2528, GG-20, GJG-22
Average stable	JVB-2508, JVB-2529, JVB-2532
Below average stable	-
13. Biological yield per plant (g)	
Above average stable	JSSP-60, JVB-2508, JVB-2518, JVB-2528, JVB-2532, GG-20
Average stable	JSSP-LS-61, JVB-2516
Below average stable	-
14. Harvest index (%)	
Above average stable	JVB-2509, GG-20, GJG-22
Average stable	JVB-2489, JVB-2508, JVB-2517, JVB-2524, JVB-2528, JVB-2529, JVB-2532, JVB-2534
Below average stable	JVB-LS-2507, JVB-2533
15. Oil content (%)	
Above average stable	GG-20, BAU-13
Average stable	JVB-2489, JVB-2513, JVB-2517, JVB-2521, JVB-2525, JVB-2527, ICGV-86564
Below average stable	JVB-2494, JVB-2511

CHAPTER – VI

SUMMARY AND CONCLUSION

The present investigation was carried out in a Randomized Block Design with three replications during *kharif* 2019 and *kharif* 2020 at two locations; Main Oilseeds Research Station, JAU, Junagadh and Oilseeds Research Station, JAU, Manavadar. A set of fifty genotypes of Virginia bunch groundnut were utilized to estimate genetic variability, correlation coefficient, path coefficient analysis and G x E interaction along with stability of pod yield and component traits.

The observations were recorded on five randomly selected plants from each replication except days to maturity and days to 50% flowering where plot means were used. The characters considered under study were days to 50% flowering, days to maturity, number of primary branches per plant, number of secondary branches per plant, plant height, number of matured pods per plant, number of immature pods per plant, sound mature kernel, 100-kernel weight, shelling out-turn, pod yield per plant, kernel yield per plant, biological yield per plant, harvest index and oil content. The silent features of findings are as under:

1. The mean sum of squares due to genotypes was significant for all the characters under each environment indicating thereby sufficient variability in the present material.
2. High coefficient of range in all environments were observed for number of matured pods per plant, number of immature pods per plant, 100-kernel weight, pod yield per plant, kernel yield per plant, biological yield per plant and harvest index.
3. The values of phenotypic coefficient of variation were higher than their corresponding genotypic coefficient of variation under all environments indicating the influence of environmental factors. But the differences between phenotypic and genotypic coefficient of variation were not substantial. Under all environment high estimates of genotypic coefficient of variation were registered for number of matured pods per plant, number of immature pods per plant, pod yield per plant and kernel yield per plant. This indicated the presence of wide genetic variation for these characters.

4. All the characters in present investigation found high heritability values under all the environments, except days to maturity which have moderate estimates for heritability in three environments ($E_{1,}$ E_3 and E_4) and high in one environment (E_2). High heritability coupled with high genetic advance as percent of mean were observed for number of primary branches per plant, number of matured pods per plant, number of immature pods per plant, 100-kernel weight, pod yield per plant, kernel yield per plant, biological yield per plant and harvest index.
5. The estimates of genotypic correlation coefficients were in general higher than their corresponding phenotypic correlation coefficients under all environments. For all environments significant and positive genotypic and phenotypic correlations of pod yield per plant were observed with number of secondary branches per plant, number of matured pods per plant, kernel yield per plant, biological yield per plant and harvest index.
6. The path coefficient analysis revealed high and positive direct effects of kernel yield per plant on pod yield per plant, while biological yield per plant and harvest index have moderate to low direct effect on pod yield per plant under all four environments. Thus, these characters turned-out to be the major components of pod yield.
7. Number of secondary branches per plant, number of matured pods per plant, sound mature kernel, 100-kernel weight, biological yield per plant and harvest index had low to moderate positive direct effect but it have high and positive indirect effect on pod yield per plant via kernel yield per plant.
8. The phenotypic residual effects for all environments were of low magnitude suggesting that the majority of the yield attributes have been included in the study of path analysis.
9. The joint regression analysis revealed that genotype x environment interactions was highly significant for all the characters. Mean square due to E + (G x E) component was significant for all the traits. G x E (linear) component was significant for all the traits except shelling out-turn, while the mean squares due to environments (linear) were significant for all the characters. The non-linear component of interaction (pooled deviation) was significant for all characters except days to maturity.

10. In present study for pod yield per plant, genotype JVB-2516 and JVB-2529 were average stable as having high pod yield per plant, near unit regression coefficient and non-significant deviation from regression indicated that this genotype was highly stable across all the environments. Genotype JVB-2516 had also possessed stability for characters like days to maturity, number of primary branches per plant, number of secondary branches per plant, number of matured pods per plant, sound mature kernel, kernel yield per plant and biological yield per plant. While genotype JVB-2529 had also possessed stability for characters like days to 50% flowering, 100-kernel weight, shelling out-turn, kernel yield per plant and harvest index. Genotype JVB-2508, JVB-2528, JVB-2532, GG-20 and GJG-22 were exhibited high mean value, less than unit regression coefficients and non-significant deviation from regression, indicates these genotypes were good for poor environment and considered as above average stable.

CONCLUSION

It can be concluded from variability parameters that additive gene action were operating for number of primary branches per plant, number of matured pods per plant, number of immature pods per plant, 100-kernel weight, pod yield per plant, kernel yield per plant, biological yield per plant and harvest index. Correlation study revealed that number of secondary branches per plant, number of matured pods per plant, kernel yield per plant, biological yield per plant and harvest index were correlated with pod yield per plant and path coefficient analysis also revealed high direct and indirect effect of these characters, therefore, due weightage should be given to these traits for selection in groundnut. Genotypes JVB-2516 and JVB-2529 were found average stable for pod yield per plant, while genotypes JVB-2508, JVB-2528, JVB-2532, GG-20 and GJG-22 were found above average stable and found good under poor environmental conditions for pod yield per plant.

Where, double arrowed lines indicate phenotypic correlation coefficient and single arrowed lines indicate direct effect

1. Days to 50 % flowering
2. Days to maturity
3. Number of primary branches per plant
4. Number of secondary branches per plant
5. Plant height (cm)
6. Number of matured pods per plant
7. Number of immature pods per plant
8. Sound mature kernel (%)
9. 100-kernel weight (g)
10. Shelling out-turn (%)
11. Pod yield per plant (g)
12. Kernel yield per plant (g)
13. Biological yield per plant (g)
14. Harvest index (%)
15. Oil content (%)

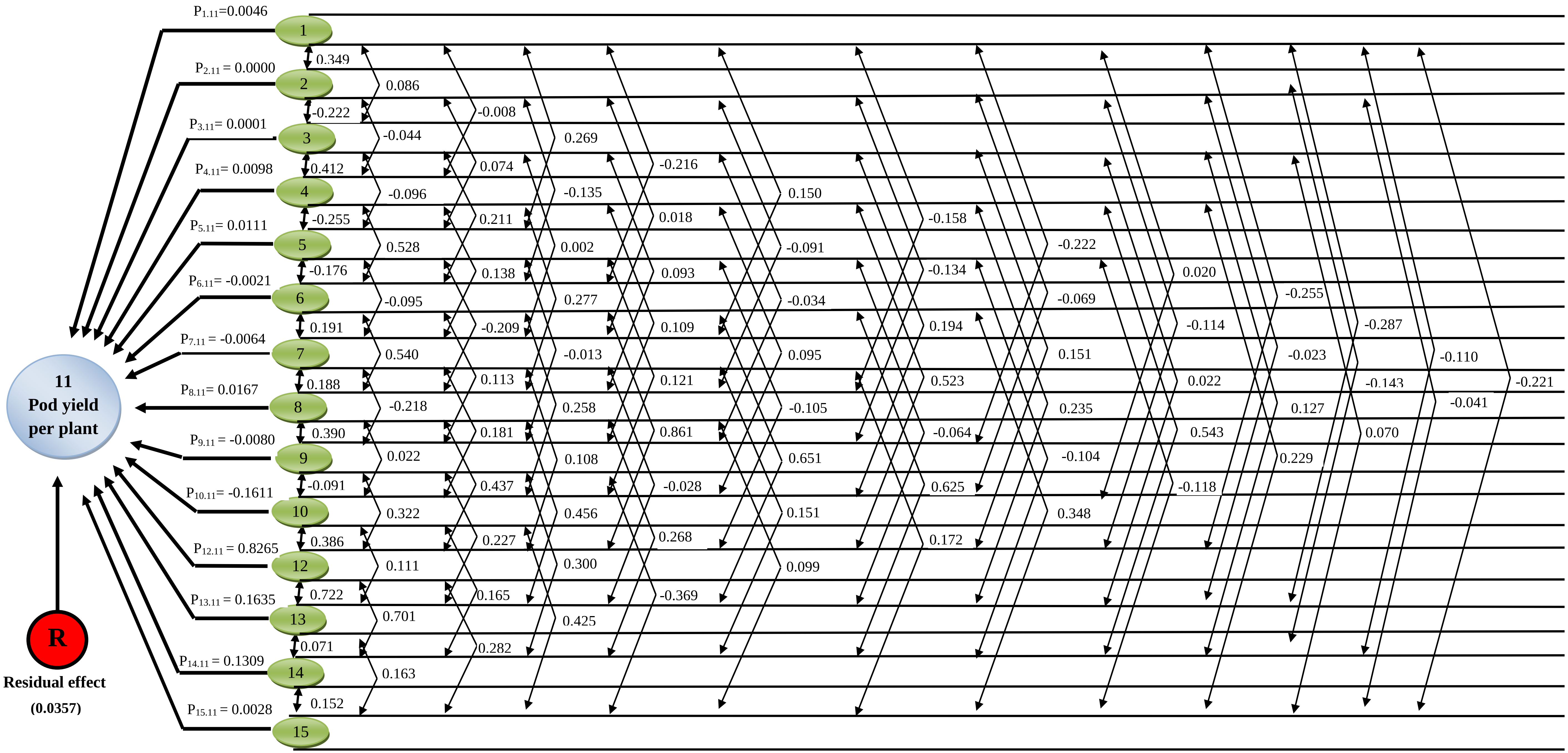

Fig 4.1: Diagrammatic representation of phenotypic path analysis in groundnut at Junagadh during *Kharif*-2019 (E_1)

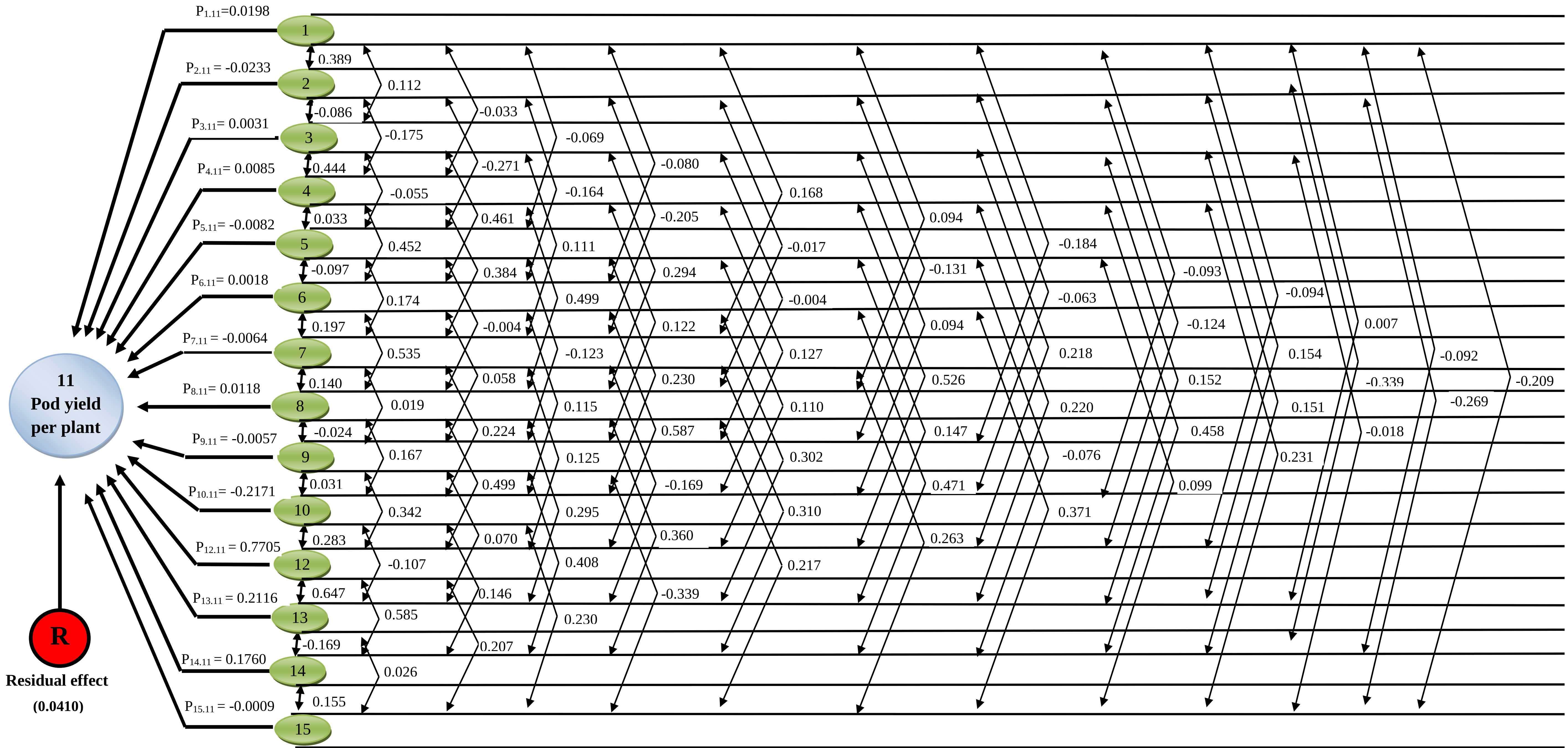

Fig 4.2: Diagrammatic representation of phenotypic path analysis in groundnut at Junagadh during *Kharif*-2020 (E_2)

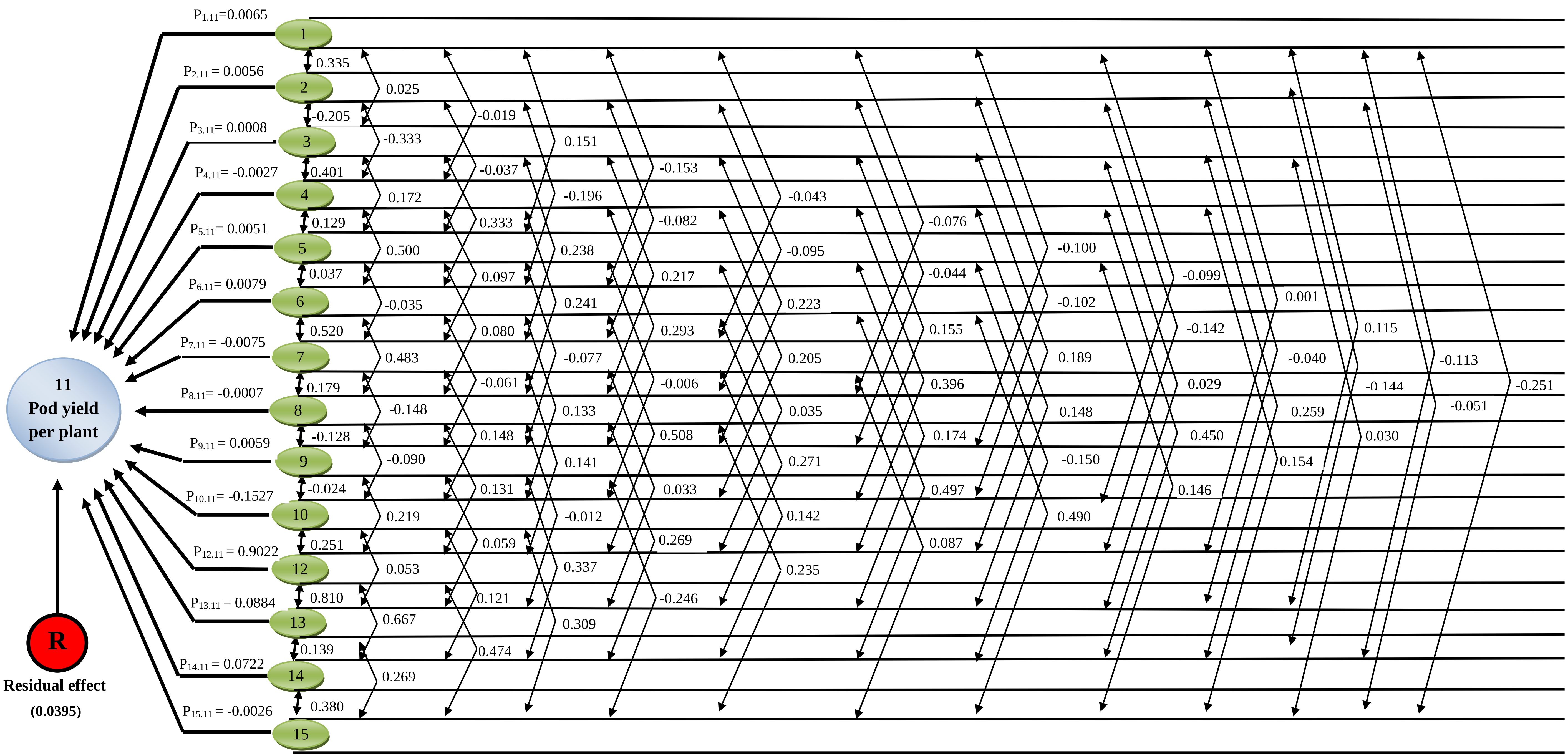

Fig 4.3: Diagrammatic representation of phenotypic path analysis in groundnut at Manavadar during *Kharif*-2019 (E_3)

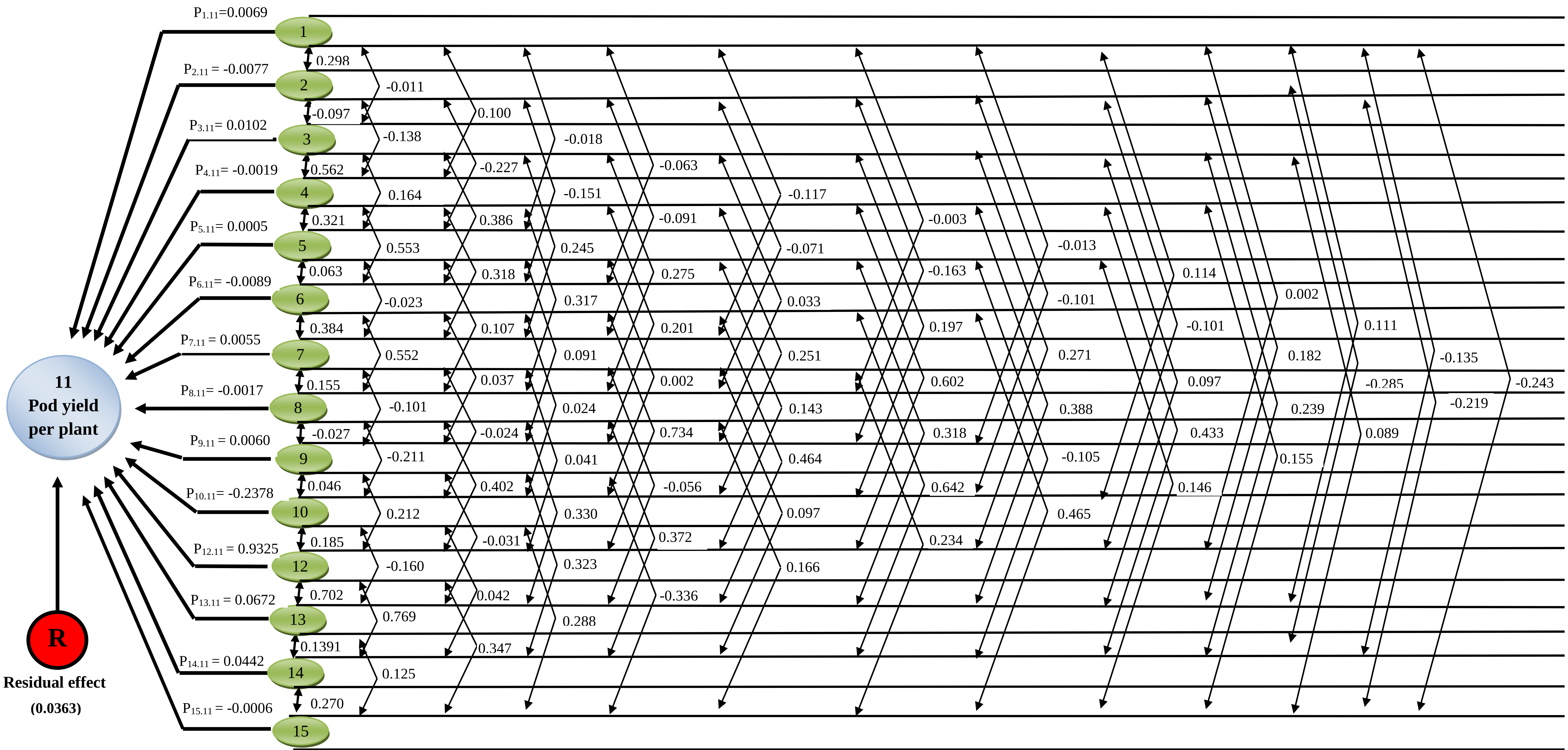

Fig 4.4: Diagrammatic representation of phenotypic path analysis in groundnut at Manavadar during *Kharif*-2020 (E_4)

Plate No. 3.1.: Field view of the experiment

BIBLIOGRAPHY

Ahmad, E.; Tirkey, S. K.; Ansari, A. M.; Sah, A. and Ali, M. N. (2008). Stability analysis for pod yield in the groundnut (*Arachis hypogaea* L.). *Green Farm.*, **12**(1): 22-23.

Al-Jibouri, H. A.; Miller, P. A. and Robinson, H. F. (1958). Genotypic and environmental variances in upland cotton cross of interspecific origin. *Agron. J.*, **50**(10): 633-635.

Allard, R. W. (1960). *Principles of Plant Breeding*, John Willey and Sons, New York.

Allard, R. W. and Bradshaw, A. D. (1964). Implication of genotypes environment interactions in applied plant breeding. *Crop Sci.*, **4**: 503-508.

Anonymous (2020a). FAOSTAT, Area, Production and Productivity of Groundnut. http://www.fao.org/faostat/en/#data/QC, Date: 17/03/2021.

Anonymous (2020b). Final Advance Estimate of Area, Production and Yield of Major *Kharif/Rabi* crops of Gujarat State for the year 2019-20. Agriculture, Farmers Welfare and Co-operation Department, Government of Gujarat, Gandhinagar.

Anusha, H. A. and Savithramma, D. L. (2017). Association and path coefficient studies for traits related to water use efficiency, yield and its components of RILs in groundnut (*Arachis hypogaea* L.). *Int. J. Curr. Microbiol. App. Sci.*, **6**(9): 1266-1271.

Ashutosh, K.; Soma, G. and Sheetal, R. S. (2017). Genetic variability, correlation coefficient and path coefficient analysis for yield and component traits in groundnut. *Indian J. Ecol.*, **44**(1): 85-89.

Awatade, S. M.; Thaware B. L.; Jadhav B. B. and Gaikwad, K. J. (2009). Correlation, path and diversity analysis in groundnut. *J. Maharashtra Agric. Univ.*, **35**: 29-31.

Babariya, C. A. (2012). Analysis of yield component, selection indices and genetic divergence in groundnut (*Arachis hypogaea* L.). M.Sc. (Agri.) thesis submitted to the Junagadh Agricultural University, Junagadh.

Babariya, C. A. and Dobariya, K. L. (2012). Correlation coefficient and path coefficient analysis for yield components in groundnut (*Arachis hypogaea* L.). *Electron. J. Plant Breed.,* **3**(3): 932-938.

Bentur, M. G.; Parameshwarappa, K. G. and Malligawad, L. H. (2004). Stability analysis in large seeded groundnut (*Arachis hypogaea* L.) genotypes for pod yield and its component traits. *J. Oilseeds Res.*, **21**(1): 17–20.

Bhargavi, G.; Satyanarayana Rao, V. R.; Ratnababu, D. and Narasimha Rao, K. L. (2015). Character association and path coefficient analysis of pod yield and yield components in Spanish bunch groundnut (*Arachis hypogaea* L.). *Electron. J. Plant Breed.,* **6**(3): 764-770.

Bhosale, S. D. (2011). Character association, selection indices and genetic divergence in groundnut (*Arachis hypogaea* L.). M.Sc. (Agri.) thesis submitted to the Junagadh Agricultural University, Junagadh.

Breece, E. L. (1969). The measurement and significance of genotype-environment interaction in grasses. *Heredity,* **24**: 27-44.

Breese, E. L. (1969). The measurement and significance of genotype x environment interaction in grasses. *Heredity,* **24**: 27-44.

Burton, G. W. (1952). *Quantitative inheritance in grasses*. Proc. 6th Int. Grassland Cong., **1**: 277-283.

Channayya, H.; Nadaf, H. L.; Ganapathi, M. and Praveenkumar, B. (2011). Induced mutants in groundnut (*Arachis hypogaea* L.). *Karnataka J. Agric. Sci*., **23**(2): 327-329.

Chavadhari, R. M.; Kachhadia, V. H.; Vachhani, J. H. and Virani, M. B. (2017). Genetic variability studies in groundnut (*Arachis hypogaea* L.). *Electron. J. Plant Breed*., **8(**4): 1288-1292.

Chavan, R. D.; Toprore, V. N.; Jagtap, P. K. and Aglave, B. N. (2009). Stability analysis in groundnut for pod yield and its component traits. *Internat. J. Plant Sci.*, **4**(2): 531-534.

Choudhary, M.; Sharma, S. P.; Dashora, A. and Maloo, S. R. (2013). Assessment of genetic variability, correlation and path analysis for yield and its components in groundnut (*Arachis hypogaea* L.*). J. Oilseeds Res.*, **30**(2): 163-166.

Chuni Lal; Radhakrishnan, T.; Mathur, R. K.; Manivel, P.; Samdur, M. Y.; Gor, H. K.; and Chikani, B. M. (2006). Evaluation of groundnut varieties for yield and quality characters. *Legume Res.*, **29**(2): 102-105.

Comstock, R. E. and Moll, R. H. (1963). Genotype-environment interaction, "In: *Statistical Genetics and Plant Breeding*". NAS-NRC Publ. (1982), pp.164-196.

Desai, B. B.; Kotecha, P. M. and Salunkhe, D. K. (1999). *Science and Technology of Groundnut: Biology, Production, Processing and Utilization*. Naya Prokash, Calcutta. pp. 2-4.

Dewangan, H.; Kumar, N. J.; Gabrial, M. and Kumar, P. R. (2015). Study on genetic variability in groundnut (*Arachis hypogaea* L.) germplasm. *Inter. J. Agric. Sci. Res*., **5(**1): 19-22.

Dewey, D. R. and Lu, K. H. (1959). A correlation and path co-efficient analysis of components of crested wheat grass seed production. *J. Agron*., **51**(9): 515-518.

Eberhart, S. A. and Russell, W. A. (1966). Stability parameters for comparing the varieties. *Crop Sci.*, **6**:36-40.

Falconer, D. S. (1981). Introduction to Quantitative Genetics, Ed. 2. Longmans Green, London, New York.

Finlay, K. W. and Wilkinson, G. N. (1963). The analysis of adaptation in a plant breeding programme. *Aus. J. Agric. Res.*, **14**: 742-754.

Fisher, R. A. (1918). The correlations among relatives on the supposition of Menalian inheritance. *Trans. R. Soc. Edinburgh*, **52**: 399-433.

Gadgil, S.; Seshagiri Rao, P. R.; Joshi, N. V. and Sridhar, S. (1995). Forecasting rain for groundnut farmers-How good is good enough? *Current Sci.*, **68**(3): 301-309.

Galton, F. (1889). *Natural Inheritance*. McMillan, London.

Giri, R. R.; Toprope, V. N. and Jagtap, P. K. (2009). Genetic variability, character association and path analysis for yield and its component traits in groundnut. *Internat. J. Plant Sci.*, **4:** 551-555.

Golakia, P. R.; Makne, V. G. and Monpara, B. A. (2004). Character association in Virginia runner groundnut (*Arachis hypogaea* L.). Paper presented in the National Symposium on *"Enhancing productivity of groundnut for sustaining food and nutritional security"* held at NRCG, Junagadh during October 11-12, 2004.

Goudar, I. V.; Roopa, U.; Hiremath, G.; Yenagi, B. S. and Nadaf, H. L. (2017). Genotype × environment interaction for pod yield in groundnut. *Int. J. Curr. Microbiol. App. Sci.*, **11**(6): 1566-1571.

Goulden, C. H. (1962). Problems in plant selection. *In*: Punnet, R. C. (*Ed.*) *"Proceeding of the VII International Congress of Genetics"* Cambridge University Press, Cambridge. pp. 132-135.

Gouranga, S. M.; Arpita, D.; Debika, D.; Bholanath, M. and Bijoy, K. S. (2017). Genetic variability and character association studies in groundnut (*Arachis hypogaea* L.). *Sch. J. Agric. Vet. Sci*., **4**(10): 424-433.

Gregory, W. C.; Krapovickas, A. and Gregory, M. P. (1980). Structures, variation, evaluation and classification in *Arachis*. In: *Advances in Legume Science*, R. J. Summer Field and A. H. Bunting (Eds.) Royal Botanic Gardens, Kew. pp. 469-481.

Gupta, R. P.; Vachhani, J. H.; Kachhadia, V. H.; Vaddoria, M. A. and Papi, R. (2015a). Genetic variability and heritability studies in Virginia groundnut (*Arachis hypogaea* L.). *Elec. J. of Plant Breeding*, **6**(1): 253-256.

Gupta, R. P.; Vachhani, J. H.; Kachhadia, V. H.; Vaddoria, M. A. and Barad, H. R. (2015b). Correlation and path analysis in Virginia groundnut (*Arachis hypogaea* L.). *Elec. J. of Plant Breeding*, **6**(1): 248-252.

Hanson, C. H.; Robinson, H. G. and Comstock, R. E. (1956). Biometrical studies of yield in segregating populations of Korean Lespedeza. *Agron. J*., **48**: 268-272.

Hariprasanna, K.; Lal, C. and Radhakrishnan, T. (2008). Genotype x environment interaction and stability analysis in large seeded genotypes of groundnut (*Arachis hypogaea* L.). *J. Oilseeds Res.,* **25**(2): 126-131.

Jain, S.; Singh, P. B.; and Sharma, P. P. (2016). Correlation and path analysis in groundnut (*Arachis hypogaea* L.). *Int. J. Curr. Res.*, **8**(8): 35811-35813.

Jayalakshmi, V. and G. Lakshmikantha, R. G. (2003). Genetic variability and correlation studies in groundnut hybrids. *Agric. Sci. Digest,* **23**(4): 247-250.

John, K.; Raghava, R. P.; Hariprasad, P. R.; Sudhakar, P. and Eswar Reddy, N. P. (2012). Genetic parameters for morphological, physiological and yield attributes related to moisture stress tolerance in groundnut. *Agri. Review,* **33**(2): 104-113.

John, K.; Vasanthi, R. P.; Sireesha, K. and Giridharakrishna, T. (2013). Genetic variability studies in different advanced breeding genotypes of Spanish bunch groundnut (*Arachis hypogaea* L.). *Int. J. App. Bio. Pharm. Tech*., **4**(2): 185-187.

Johnson, H. W.; Robinson, H. F. and Comstock, R. E. (1955). Genotypic correlation in soybean and their implication in selection. *Agron. J*., **47**: 477-483.

Joshi, H. J.; Vekaria, G. B. and Mehta, D. R. (2003). Stability analysis for morpho-physiological traits in groundnut. *Legume Res.*, **26**(1): 20-23.

Kadam, P. S.; Desai, D. T.; Chinchane, V. N. and Sharma, V. (2009). Correlation and path coefficient analysis in groundnut (*Arachis hypogaea* L.). *J. Oilseeds Res.*, **26**: 63-65.

Kadam, P. S.; Desai, D. T.; Jagdish, A.; Chauhan, D. A. and Shelke, B. L. (2007). Variability, heritability and genetic advance in groundnut. *J. Maharashtra Agric. Univ*., **32**: 71-73.

Kamdi, S. R.; Patil, S. R.; Kadu, P. R.; Bhasme, S. P. and Kothikar, R. B. (2017). Genetic variability, correlation and path analysis in groundnut. *Quarterly J. Life Sci.*, **14**(1): 36-39.

Kasno, A. and Trustinah (2015). Genotype × environment interaction analysis of peanut in indonesia. *SABRAO J. Breed. and Genet.*, **47**(4): 482-492.

Khan, H.; Patted, V. S.; Muralidhara,; Arunkumar, B. and Shankergoud, I. (2018). Stability estimates for pod yield and its component traits in groundnut (*Arachis hypogaea* L.) under farmer's participatory varietal selection. *Int. J. Curr. Microbiol. App. Sci.*, **7**(1): 3171-3179.

Khanpara, M. D.; Shinde, P. P.; Jivani, L. L.; Vachhani, J. H. and Kachhadia, V. H. (2010). Character association and path coefficient analysis in groundnut (*Arachis hypogaea* L.). *Plant Archives,* **10:** 695-698.

Khote, A. C.; Bendale, V. W.; Bhave, S. G. and Patil, P. P. (2009). Genetic variability, heritability and genetic advance in some exotic genotypes of groundnut (*Arachis hypogaea* L.). *Crop Res*., **37(**1/3): 186-191.

Korat, V. P.; Pithia, M. S.; Savaliya, J. J.; Pansuriya, A. G. and Sodavadiya, P. R. (2009). Studies on genetic variability in different genotypes of groundnut (*Arachis hypogaea* L.) *Legume Res.*, **32**(3): 224-226.

Krapovickas, A. (1969). The origin, variability and spread of groundnut (*Arachis hypogaea* L.) in the Domestication and Exploitation of Plants and Animals (P. J. Ucko and G. Dimbley, eds). Duckworth, London, UK. pp. 135-151.

Krapovickas, A. (1973). Evolution of the genus *Arachis*. In : Maov, R. (Ed.), *Agricultural Genetics : Selected Topics*. John Willey & Sons, New York. pp. 135-151.

Kumar, P. R. and Rajamani, S. (2004). Genetic variability and heritability in groundnut (*Arachis hypogaea* L.). *Indian J. agric. Res.*, **16**: 61-64.

Kumar, P. R.; Krishna, K.; Arvind, A. K. (2014). Study on the performance of groundnut (*Arachis hypogea* L.) genotypes for quantitative traits in Allahabad region chaurasia. *Carib. J. Sci. Tech.*, **2**: 564-569.

Kumari, K. and Sasidharan, N. (2020). Studies on Genetic Variability, Correlation and Path Coefficient Analysis for Morphological and Yield Traits in Different *Arachis* spp. *Int. J. Curr. Microbiol. App. Sci.*, **9**(11): 1030-1039.

Lenka, D. and Mishra, B. (1973). Path coefficient analysis of yield in rice varieties. *Indian J. Agric. Sci*., **43**: 376- 379.

Mahalakshmi, P.; Manivannan, N. and Muralidharn, V. (2005). Variability and correlation studies in groundnut (*Arachis hypogaea* L.) *Legume Res.*, **28**: 197.

Mahesh, R. H.; Hasan, K.; Temburne, B. V.; Janila, P. and Amaregouda, A. (2018). Genetic variability, correlation and path analysis studies for yield and yield attributes in groundnut (*Arachis hypogaea* L.). *J. Pharmacogn. Phytochem*., **7**(1): 870-874.

Mahto, R. N. and Mahto, D. (2000). Stability Analysis in groundnut (*Arachis hypogaea* L.). *J. Res*., **12**(2): 171-174.

Malik, S. N.; Nazakat, N.; Muhammad, Y.; Mubashir, A. K.; Muhammad, Y. M.; Akbar, S. M.; Altaf, S. M. and Asif, M. M. (2009). Stability performance for pod yield in groundnut (*Arachis hypogaea* L.). *Pak. J. Agri. Res*., **22**: 3-4.

Mallikarjun, K. and Savithramma, D. L. (2017). Genetic variability, heritability, correlation and regression in F_3 and F_4 segregating generation for traits related to WUE and yield in the Cross NRCG 12274 × ICG 12370 of groundnut (*Arachis hypogaea* L.). *Int. J. Curr. Microbiol. App. Sci.*, **6**(11): 3912-3921.

Mane, P. S.; Lad, D. B. and Jagtap, P. K. (2008). Correlation and path coefficient analysis in summer bunch groundnut. *J. Maharashtra agric. Univ*., **8**(33): 174-176.

Mekontchou, T.; Ngueguim, M. and Fobasso, M. (2006). Stability analysis for yield and yield components of selected peanut breeding lines (*Arachis hypogaea* L.) in the north province of Cameroon. *Tropicultura*, **24**(2): 90-94.

Meta, H. R. and Monpara, B. A. (2010). Genetic variation and trait relationships in summer groundnut (*Arachis hypogaea* L.). *J. Oilseeds Res.,* **27**(1): 8-11.

Methews, C.; Nagada, A. K. and Sharma, U. C. (2001). A study of path analysis in groundnut. *Madras Agric. J.,* **87**: 480-481.

Minde, A. S.; Kamble, M. S. and Pawar, R. M. (2017). Stability analysis for pod yield and its component traits in groundnut (*Arachis hypogaea* L.). *Asian J. Biosci.,* **12**(1): 15-20.

Minimol, J. S.; Datke, S. B.; Deshmukh, S. N. and Satpute, G. N. (2000). Genotype × environment interaction in groundnut (*Arachis hypogaea* L.). *Ann. Pl. Phys.,* **14**(1): 74-79.

Mitra, M.; Gantait, S. and Kundu, R. (2021). Genetic variability, character association and genetic divergence in groundnut (*Arachis hypogaea* L.) accessions. *Legume Res.,* **44**(2): 164-169.

Mothilal, A.; Nallathambi, G. and Sankara Pandian, R. (2004). Genetic variability in confectionary groundnut (*Arachis hypogaea* L.) genotypes. Paper presented in the National Symposium on "Enhancing Productivity of Groundnut for Sustaining Food and Nutritional Security" held at NRCG, Junagadh during October 11-12, 2004.

Mothilal, A.; Vindhiya, V. P. and Manivannan, N. (2010). Stability analysis of foliar disease resistant groundnut genotypes *(Arachis hypogaea* L.*). Electron J. Plant Breed.,* **1**: 1021-1023.

Mukesh, B. and Lal, G. M. (2017). Estimation of genetic variability, correlation and path analysis in groundnut (*Arachis hypogaea* L.) germplasm. *Chem. Sci. Rev. Lett.*, **6**(22): 1107-1112.

Naazar, A.; Nawaz, M. S.; Mirza, M. Y. and Hazara, G. R. (2001). Stability analysis for pod yield in groundnut (*Arachis hypogaea* L.). *Pak. J. Bot.,* **33**(2): 191-196.

Nagda, A. K. and Joshi, V. N. (2004). Correlation and path coefficient analysis in drought tolerant genotypes of groundnut (*Arachis hypogaea* L.). Paper presented in the National Symposium on "Enhancing productivity of groundnut for sustaining food and nutritional security" held at NRCG, Junagadh during October 11-12, 2004.

Namrata, H. S.; Ranwah, B. R. and Prashant, B. (2016). Variability assessment and path coefficient analysis in groundnut (*Arachis hypogaea* L.) genotypes in sub- humid southern plains of Rajasthan**.** *Trends in Biosciences*, **9**(11): 642-646.

Narasimhulu, R.; Kenchanagoudar, P. V. and Gowda, M. V. C. (2012). Study of genetic variability and correlations in selected groundnut genotypes. *Int. J. App. Bio. Pharm. Tech.*, **3**(1): 355-358.

Nath, U. K. and Alam, M. S. (2002). Genetic variability, heritability and genetic advance of yield and related traits of groundnut (*Arachis hypogaea* L.). *Onl. J. Bio. Sci.*, **2**(11): 762-764.

Nirmala, D. and Jayalakshmi, V. (2015). Association studies of drought tolerant attributes in groundnut (*Arachis hypogaea* L.). *Electron. J. Plant Breed.,* **6**(2): 630-638.

Om, P. P. and Nadaf, H. L. (2017). An assessment of genetic variability and traits association among high oleic advanced breeding lines for yield and quality traits in groundnut (*Arachis hypogaea* L.). *Electron. J. Plant Breed.*, **8**(1): 201-205.

Omima, B. H. H.; Ahmed, H. A. A.; Adel, M. F. and Amin, A. S. A. (2018). Variability heritability and genetic advance of some groundnut genotypes (*Arachis hypogaea* L.) under saline sodic soil**.** *Ann. Rev. Res*., **1**(1): 555-554.

Panse, V. G. and Sukhatme, P. V. (1985). *Statistical Methods for Agricultural Workers* (Second edition), I.C.A.R., New Delhi.

Parameshwarappa, K. G.; Kenchanagoudar, P. V.; Bentur, M. G. and Patil, R. K. (2004). Genetic variability and correlation in adapted genotypes of Spanish bunch groundnut. National Symposium: Enhancing Productivity of Groundnut for Sustaining Food and Nutritional Security. NRCG, Junagadh. Oct. 11-12, 2004, pp: 74-75.

Paroda, R. S. and Hayes, J. D. (1971). An investigation of genotype-environment interactions for rate of ear emergence in spring barley. *Heredity,* **26**: 157-175.

Patil, A. S.; Nandanwar, H. R.; Punewar, A. A. and Shah, K. P. (2014). Stability for yield and its component traits in groundnut (*Arachis hypogaea* L.). *Int. J. Bio-resourses and Stress Management,* **5**(2): 240-245.

Patil, A. S.; Punewar, A. A.; Nandanwar, H. R. and Shah, K. P. (2014). Estimation of variability parameters for yield and its component traits in groundnut (*Arachis hypogaea* L.). *Int. Qua. J. Life Sci*., **9**(2): 749-754.

Patil, G. K.; Kenchanagoudar, P. V.; Parameshwarappa, K. G. and Salimath, P. M. (2006). A study of correlation and path analysis in groundnut. *Karnataka J. Agric. Sci.,* **19:** 272-277.

Perkins, J. M. and Jinks, J. L. (1968). Environmental and genotype environmental components of variability III multiple lines and crosses. *Heredity*., **23**: 339-356.

Pradhan, K.; Das, P. K. and Patra, R. K. (2010). Genotype × environment interaction for pod yield and yield components of groundnut varieties in warm sub-humid climate and moderately acidic soil. *Indian J. Genet*., **70**(2): 201-203.

Prasad, Y.; Verma, A. K.; Haider, Z. A. and Mahto, J. (2002). Variability studies in Spanish bunch groundnut. *J. Birsa Agric. Univ.,* **14**: 91-93.

Ramanarnurthy, G. V. (1985). *Advances in oil seeds production technology*. ICAR, New Delhi. pp. l-22.

Reddy, A. L.; Srinivas, T.; Rajesh, A. P. and Umamaheshwari, P. (2016). Genotype x environment interaction studies in rainfed groundnut (*Arachis hypogaea* L.). *J. Plant Breed.,* **7**(4): 953-959.

Sadeghi, S. M. and Seyyed, A. N. N. (2012). Correlation and path coefficient analysis in peanut (*Arachis hypogaea* L.) genotypes under drought stress and irrigated conditions. *Ann. Bio. Res*., **3**(6): 2593-2596.

Sahay, G. and Sarma, B. K. (2005). Yield stability of some groundnut (*Arachis hypogaea* L.) genotypes in Meghalaya. *Indian J. Agric. Res.,* **39**(3): 221-224.

Sandhya, K. M.; Venkataravana, P.; and Pushpa, H. D. (2016). Correlation and path analysis studies in groundnut under different environment. *Legume Res*., **39**(6): 1048-1050.

Sanjeevakumar, P.; Shivanna, S.; Irappa, B. M. and Shweta **(**2015). Genetic variability and character association studies for yield and yield attributing components in groundnut (*Arachis hypogeae* L.). *Internat. J. Recent Sci. Res.*, **6**(6): 4568-4570.

Searle, S. R. C. (1965). The value of indirect selection. I. Mass selection. *Biometrics*, **21**: 682-707.

Senapathi, B. K.; Maity, D. and Sarkar, G. (2004). Stability evaluation of summer groundnut (*Arachis hypogaea* L.) under coastal saline zone of West Bengal. *Ele. J. of Pl. Breed*., **27**(2): 103-106.

Siddiquey, M. N. H.; Haque, M. M.; Ara, M. J. F.; Ahmed, M. R. and Roknuzzaman, M. (2006). Correlation, path and genetic diversity analysis of groundnut. *Intl. J. Sust. Agric. Tech.*, **2**: 6-10.

Singh, P. B.; Bharti, B.; Arun, K.; Ranbir, S.; Narendra, K. and Rathnakumar, A. L. (2017). Genetic characterization, character association for yield and yield component traits in groundnut (*Arachis hypogaea* L). *Electron. J. Plant Breed*., **8**(4): 1229-1235.

Singh, S. B. and Chaubey, A. K. (2003). Variability and association amongst quantitative characters in peanut (*Arachis hypogaea* L.) genotypes. *J. Res. Punjab Agric. Univ*., **38**: 147-152.

Sivasubramanian, S. and Menon, P. (1973). Genotypic and phenotypic variability in rice. *Madras Agric. J*., **60**: 1093-1096.

*Smith, H. F. (1936). A discriminant function for plant selection. *Ann. Eugen*., **7**:240-250.

Solanki, S. M.; Chaudhari, S. B.; Sapovadiya, M. H. and Damor, V. (2019). Genetic Variability, Correlation and Path Analysis for Yield and Its Contributing

Traits in Virginia Groundnut (*Arachis hypogaea* L.). *Inddian J. Pure App. Biosci.*, **7**(6): 226-233.

Sonone, N. G. and Thaware, B. L. (2009). Study on genetic diversity in groundnut. *Ann. Plant Physiol*, **23:** 54-56.

Sreekala, P. and Kumar, M. H. (2009). Phenotypic stability of kernel and protein yield in groundnut (*Arachis hypogaea* L.). *The Asian and Australasian J. Pl. Sci. Biotech.*, **3**(1): 55-60.

Suneetha, K.; Dasarda, C.; Rami Reddy and Ramana, J. V. (2004). Genetic variability and character association in groundnut (*Arachis hypogaea* L.). Paper presented in the National Symposium on "Enhancing Productivity of Groundnut for Sustaining Food and Nutritional Security" held at NRCG, Junagadh during October 11-12, 2004.

Sushree, S. S.; Kedareswar, P. and Bibhu, S. B. (2017). Variation, correlation and path coefficient study in groundnut breeding lines of Odisha. *J. Pharmacogn. Phytochem.*, **6**(5): 1966-1973.

Thakur, S. B.; Ghimire, S. K.; Chaudhary, N. K.; Shrestha, S. M. and Mishra, B. (2013). Determination of relationship and path co-efficient between pod yield and yield component traits of groundnut cultivars. *Nep. J. Sci. Tech*., **14**(2): 1-8.

Thaware, B. L. (2009). Stability analysis for dry pod yield in spanish bunch groundnut. *Agric. Sci. Digest*, **29**(3): 221-223.

Trivikrama, R. A.; Sekhar, R. M.; Vijayabharathi, A.; Lakshmi, P. T.; Lakshmikantha, G. R. and Jayalakshmi, V. (2017). Correlation and path analysis of kernel yield and its components in groundnut (*Arachis hypogaea* L.). *Int. J. Curr. Microbiol. App. Sci.*, **6**(12): 10-16.

Tulsi, R. D.; Hemlata, S.; Ramesh, K. and Ram, K. (2017). Correlation and path analysis for yield and its contributing traits in groundnut (*Arachis hypogaea* L.). *Int. J. Agrc. Sci*., **9**(10): 3997-3999.

Ukiey, K. N.; Kamdi, S. R.; Patil, S. R.; Deotale, R. D.; Lande, N. V. and Jayade, V. S. (2017). Genetic variability studied in local collection of groundnut. *IJRBAT.*, **2**(5): 412-420.

Vaithiyalingan, M.; Manoharan, V. and Ramamoorthi, N. (2010). Association analysis among the yield and yield attributes of early season drought tolerant groundnut (*Arachis hypogaea* L.). *Electron J. Plant Breed.,* **1**(5): 1347-1350.

Vekariya, H. B.; Khanpara, M. D.; Vachhani, J. H.; Jivani, L. L.; Vagadiya, K. J. and Revar, H. J. (2010). Correlation and path analysis in bunch groundnut (*Arachis hypogaea* L.). *Intl. J. Plant Sci.,* **6:** 11-15.

Vekariya, H. B.; Khanpara, M. D.; Vachhani, J. H.; Kachhadia, V. H.; Madariya, R. B. and Jivani, L. L. (2011). Variability and heritability studies in bunch groundnut (*Arachis hypogaea* L.). *Int. J. Agric. Sci.*, **7**(1): 32-34.

Venkataramana, P. (2001). Variability and correlation studies in groundnut. *Crop Res.*, **21**: 81-83.

Venkataravana, P.; Sheriff, R. A.; Kulkarni, R. S.; Shankaranarayana, V. and Fathima, P. S. (2000a). Correlation and path analysis in groundnut (*Arachis hypogaea* L.). *Mysore J. agric. Sci*., **34**: 321-325.

Venkataravana, P.; Sheriff, R. A.; Shankaranarayana, V.; Reddy, V. S. N.; Reddy, M. N. N. and Prasad, V. L. M. (2000b). Stability analysis for pod yield and its components in groundnut (*Arachis hypogaea* L.). *Mysore J. Agric. Sci.,* **34**(3): 233-239.

Viswanathan, P. L.; Manivannan, N.; Murugan, E. and Mohanasundaram, K. (2001). Phenotypic stability analysis in groundnut (*Arachis hypogaea* L.). *Agric. Sci. Digest*, **21**:164-166.

Wadikar, P. B.; Dake, A. D.; Chavan, M. V. and Thorat, G. S. (2018). Character association and variability studies of yield and its attributing characters in groundnut (*Arachis hypogaea* L.). *Int. J .Curr. Microbiol. App. Sci.,* **6**: 924-929.

Wani, S. C.; Deshmukh, S. N. and Satpute, G. N. (2004). Variability in advance generation lines of groundnut (*Arachis hypogaea* L.). Paper presented in the National Symposium on "Enhancing Productivity of Groundnut for Sustaining Food and Nutritional Security" held at NRCG, Junagadh during October 11-12, 2004.

Weiss, E. A. (2000). *Oilseed Crops*. (Second Ed.), Blackwell Science Ltd., London.pp. 53-92.

Whitehouse, R. N. H.; Thompsen, J. B. and Riberino, M. A. H. (1958). Studies on the breeding of self-pollinating cereals II. The use of diallel cross analysis in yield prediction. *Euphytica*, **7**: 147- 169.

Wright, S. (1921). Correlation and causation. *J. Agric. Res.*, **20**: 557-585.

Yadlapalli, S. (2014). Genetic variability and character association studies in groundnut (*Arachis hypogaea* L.). *Inter. J. Plant Ani. Envi. Sci*., **4**(4): 298-300.

Zaman, M. A.; Khatun, M. T.; Ullah, M. Z.; Moniruzzamn, M. and Alam, K. H. (2011). Genetic variability and path analysis of groundnut (*Arachis hypogaea* L.). *Sci. J. Kri. Foun*., **9**(1&2): 29-36.

Appendix I: Meteorological data for the duration of crop season in *Kharif*-2019 at Junagadh (Weekly data)

Months	Standard Week	Temperature (˚C)		Mean relative humidity (%)		Rainfall (mm)
		Max.	**Min.**	**Max.**	**Min.**	
June 2019	24	34.2	26.7	87	71	114.7
	25	34.5	26.7	90	58	17.1
July 2019	26	35.6	27.2	85	59	6.3
	27	35.2	27.5	85	58	2.6
	28	35.6	27.5	80	51	0.5
	29	34.5	26.2	87	58	63.7
	30	31.9	25.5	91	79	114.3
August 2019	31	28.3	24.9	96	95	213.3
	32	28.9	25.5	96	92	180.6
	33	30.6	25.3	96	84	22.9
	34	32.4	24.8	90	73	3.9
September 2019	35	30.9	25.5	96	88	49.6
	36	31.1	25.4	94	86	248.0
	37	29.8	25.3	96	85	180.5
	38	32.6	25.1	89	77	24.6
	39	31.0	24.3	93	84	196.2
October 2019	40	32.5	23.9	87	65	36.8
	41	34.9	23.4	80	49	0.0

Appendix II: Meteorological data for the duration of crop season in *Kharif*-2020 at Junagadh (Weekly data)

Months	Standard Week	Temperature (˚C)		Mean relative humidity (%)		Rainfall (mm)
		Max.	**Min.**	**Max.**	**Min.**	
June 2020	25	34.3	26.6	87	77	78.0
	26	34.7	26.7	84	70	78.0
July 2020	27	31.7	25.5	94	89	267.6
	28	31.3	25.9	95	89	118.7
	29	32.5	26.4	94	80	30.1
	30	33.1	26.3	94	82	37.6
	31	33.2	25.9	86	76	53.8
August 2020	32	31.3	25.5	93	83	203.4
	33	28.6	25.3	96	92	224.4
	34	29.3	24.9	93	87	133.7
	35	30.2	24.5	96	87	250.7
September 2020	36	33.9	25.9	84	59	0.0
	37	32.9	25.4	90	73	112.6
	38	33.2	25.6	89	70	23.5
	39	32.5	24.8	83	56	0.0
October 2020	40	34.0	24.2	84	51	19.1
	41	36.7	25.2	73	35	0.0

Appendix III: Meteorological data for the duration of crop season in *Kharif*-2019 at Manavadar (Weekly data)

Months	Standard Week	Temperature (˚C)		Mean relative humidity (%)		Rainfall (mm)
		Max.	Min.	Max.	Min.	
June 2019	24	34.2	27.1	87	71	58.0
	25	34.3	27.4	90	58	11.0
July 2019	26	36.4	27.5	85	59	23.0
	27	35.8	27.6	85	58	0.0
	28	36.4	27.8	80	51	0.0
	29	35.1	26.4	87	58	17.0
	30	32.0	25.7	91	79	30.0
August 2019	31	28.6	25.1	96	95	120.0
	32	29.8	26.2	96	92	93.0
	33	31.5	25.3	96	57	0.0
	34	32.4	25.6	90	59	0.0
September 2019	35	31.1	26.4	96	94	150.0
	36	31.4	25.5	94	93	165.0
	37	30.2	25.1	96	89	116.0
	38	33.3	25.0	89	77	29.0
	39	31.6	24.7	93	87	168.0
October 2019	40	33.5	24.5	87	61	0.0
	41	35.7	23.6	80	49	0.0

Appendix IV: Meteorological data for the duration of crop season in *Kharif*-2020 at Manavadar (Weekly data)

Months	Standard Week	Temperature (˚C)		Mean relative humidity (%)		Rainfall (mm)
		Max.	**Min.**	**Max.**	**Min.**	
June 2020	25	34.4	27.4	87	77	0.0
	26	35.1	27.1	84	70	35.0
July 2020	27	32.2	26.6	97	92	373.0
	28	31.3	26.5	95	89	5.0
	29	33.8	26.2	94	80	73.0
	30	33.7	26.3	94	82	46.0
August 2020	31	33.4	26.4	88	76	66.0
	32	31.5	25.5	96	88	103.0
	33	29.6	25.2	93	92	99.0
	34	29.9	25.6	91	90	161.0
	35	30.3	25.4	96	93	187.0
September 2020	36	34.2	26.7	84	59	0.0
	37	33.1	25.8	93	86	120.0
	38	33.2	26.9	91	84	93.0
	39	33.6	25.6	83	56	0.0
October 2020	40	34.5	24.3	84	51	0.0
	41	37.2	25.4	73	35	0.0

Appendix V:

Mean performance for days to 50 % flowering and days to maturity

		Days to 50 % flowering					Days to maturity				
Sr. No.	**Genotype**	**E_1**	**E_2**	**E_3**	**E_4**	**Mean**	**E_1**	**E_2**	**E_3**	**E_4**	**Mean**
1	**JSSP-59**	28.67	28.33	29.67	28.00	28.67	120.67	121.00	121.67	121.33	121.17
2	**JSSP-60**	29.33	30.67	31.33	29.33	30.17	121.67	118.67	124.00	118.67	120.75
3	**JSSP-62**	31.67	30.33	34.33	31.00	31.83	120.00	122.00	121.00	121.67	121.17
4	**JSSP-63**	32.00	34.33	36.00	32.67	33.75	120.67	123.67	124.33	123.33	123.00
5	**JVB-2453**	31.33	29.33	34.33	30.67	31.42	120.00	122.33	121.33	121.67	121.33
6	**JVB-2483**	29.00	27.00	33.67	28.33	29.50	120.33	122.33	121.33	121.00	121.25
7	**JVB-2486**	26.33	28.67	29.00	27.67	27.92	122.00	117.67	122.67	118.33	120.17
8	**JVB-2489**	27.33	29.33	30.67	29.00	29.08	120.67	121.00	122.33	120.67	121.17
9	**JVB-2494**	23.33	24.67	25.33	25.00	24.58	119.00	117.33	122.33	118.00	119.17
10	**JSSP-LS-61**	30.67	28.33	32.67	29.33	30.25	121.67	120.33	123.00	120.00	121.25
11	**JVB-LS-2436**	30.67	32.33	33.67	31.67	32.08	120.33	120.33	119.00	119.67	119.83
12	**JVB-LS-2373**	29.67	29.33	30.67	30.00	29.92	119.33	120.00	121.00	120.33	120.17
13	**JVB-LS-2501**	30.33	28.00	32.00	30.33	30.17	120.33	121.67	121.00	121.00	121.00
14	**JVB-LS-2502**	29.33	28.33	31.67	28.67	29.50	122.00	122.33	121.67	122.00	122.00
15	**JVB-LS-2505**	31.67	29.33	33.67	31.33	31.50	118.67	117.00	120.33	117.67	118.42
16	**JVB-LS-2506**	32.67	34.00	35.33	32.67	33.67	120.67	123.33	121.67	123.00	122.17
17	**JVB-LS-2507**	35.00	33.33	36.67	34.67	34.92	123.00	117.67	123.67	118.33	120.67
18	**JVB-2508**	27.67	29.33	30.00	29.00	29.00	117.33	118.00	119.00	118.33	118.17
19	**JVB-2509**	30.33	32.33	33.67	31.67	32.00	120.67	118.33	121.33	119.00	119.83
20	**JVB-2510**	28.00	30.33	31.67	29.67	29.92	118.67	119.67	119.67	120.33	119.58
21	**JVB-2511**	29.00	27.33	31.33	28.33	29.00	120.00	121.67	120.67	121.33	120.92
22	**JVB-2512**	33.00	29.67	35.00	32.67	32.58	121.67	118.33	122.33	119.00	120.33
23	**JVB-2513**	29.67	27.33	32.33	29.00	29.58	123.00	117.00	122.67	117.67	120.08
24	**JVB-2514**	31.00	28.33	34.00	30.33	30.92	118.67	118.33	119.67	118.67	118.83
25	**JVB-2515**	25.67	27.33	29.00	26.67	27.17	120.00	123.00	120.67	122.33	121.50
26	**JVB-2516**	30.67	28.00	32.33	29.00	30.00	118.33	121.67	119.33	121.00	120.08
27	**JVB-2517**	27.00	27.33	30.00	28.67	28.25	120.00	122.33	120.67	123.00	121.50

Contd…

Sr. No.	Genotype	Days to 50 % flowering					Days to maturity				
		E_1	E_2	E_3	E_4	Mean	E_1	E_2	E_3	E_4	Mean
28	**JVB-2518**	25.00	25.33	26.00	25.67	25.50	117.67	118.67	119.00	119.67	118.75
29	**JVB-2519**	32.00	34.67	34.33	33.00	33.50	122.00	122.67	122.33	122.00	122.25
30	**JVB-2520**	33.00	31.00	35.00	32.67	32.92	123.00	117.33	122.67	118.67	120.42
31	**JVB-2521**	31.33	28.67	33.67	29.67	30.83	117.67	121.67	118.67	121.33	119.83
32	**JVB-2522**	31.67	29.67	34.33	31.00	31.67	120.33	122.00	121.00	122.33	121.42
33	**JVB-2523**	31.67	28.00	35.67	30.67	31.50	122.33	122.33	123.00	122.00	122.42
34	**JVB-2524**	27.00	26.67	28.00	27.33	27.25	118.00	119.00	119.33	119.33	118.92
35	**JVB-2525**	29.00	31.67	34.33	30.67	31.42	119.67	118.00	120.67	119.67	119.50
36	**JVB-2526**	24.00	26.67	27.67	25.67	26.00	119.33	117.33	120.33	118.67	118.92
37	**JVB-2527**	30.67	28.00	33.67	29.67	30.50	122.33	118.33	122.00	119.33	120.50
38	**JVB-2528**	34.00	32.33	38.00	33.00	34.33	122.33	122.67	122.00	122.33	122.33
39	**JVB-2529**	25.67	27.33	28.67	26.67	27.08	117.67	118.00	117.00	120.00	118.17
40	**JVB-2530**	29.00	26.67	31.67	28.00	28.83	122.00	116.33	122.33	117.67	119.58
41	**JVB-2531**	28.00	26.00	32.00	27.67	28.42	118.67	117.67	119.00	117.33	118.17
42	**JVB-2532**	27.33	27.33	31.00	29.00	28.67	122.00	118.00	122.33	118.67	120.25
43	**JVB-2533**	27.67	25.33	31.67	26.67	27.83	118.67	116.00	119.00	116.33	117.50
44	**JVB-2534**	26.67	25.67	29.67	26.00	27.00	121.67	117.00	122.00	117.33	119.50
45	**Kaushal**	33.00	30.67	36.00	29.33	32.25	117.33	121.00	118.00	121.33	119.42
46	**GG-20**	27.00	27.33	27.67	27.67	27.42	117.00	117.33	117.00	117.33	117.17
47	**GJG-22**	28.00	28.00	28.67	28.33	28.25	118.00	119.00	119.33	119.67	119.00
48	**GG-HPS-2**	30.33	29.33	34.00	29.67	30.83	121.67	120.67	121.33	121.33	121.25
49	**ICGV-86564**	25.67	27.33	29.00	26.67	27.17	121.00	121.00	120.67	122.00	121.17
50	**BAU-13**	29.33	31.67	33.00	30.00	31.00	124.00	121.67	123.33	122.33	122.83
	G.M.	29.36	28.97	32.07	29.40	29.95	120.27	119.81	121.01	120.08	120.30
	S.Em ±	0.84	0.73	0.86	0.75	0.23	1.14	1.05	1.25	1.35	0.35
	CD at 5 %	2.36	2.04	2.41	2.10	-	3.20	2.96	3.51	3.80	-
	CV %	4.96	4.35	4.64	4.41	-	1.64	1.52	1.79	1.95	-

Mean performance for number of primary branches per plant and number of secondary branches per plant

		Number of primary branches per plant					Number of secondary branches per plant				
Sr. No.	**Genotype**	**E_1**	**E_2**	**E_3**	**E_4**	**Mean**	**E_1**	**E_2**	**E_3**	**E_4**	**Mean**
1	**JSSP-59**	4.07	4.20	4.53	4.00	4.20	9.47	8.93	9.80	8.87	9.27
2	**JSSP-60**	4.00	3.80	3.53	3.40	3.68	8.73	8.67	9.40	8.33	8.78
3	**JSSP-62**	4.93	5.13	3.80	5.00	4.72	9.47	10.27	8.47	8.73	9.23
4	**JSSP-63**	4.87	4.93	5.33	4.07	4.80	9.33	9.80	8.73	9.47	9.33
5	**JVB-2453**	5.20	5.27	5.07	5.13	5.17	8.47	8.93	10.47	10.67	9.63
6	**JVB-2483**	4.13	3.93	5.27	5.07	4.60	11.07	8.47	9.27	10.47	9.82
7	**JVB-2486**	4.00	4.93	4.87	4.60	4.60	10.80	11.20	9.47	9.93	10.35
8	**JVB-2489**	4.33	3.47	4.20	4.40	4.10	10.40	8.33	8.47	8.93	9.03
9	**JVB-2494**	5.33	5.40	5.00	5.20	5.23	8.47	9.67	8.73	8.80	8.92
10	**JSSP-LS-61**	4.33	4.27	4.53	4.20	4.33	9.27	9.20	9.53	9.67	9.42
11	**JVB-LS-2436**	5.33	5.40	5.20	4.27	5.05	8.67	9.27	10.53	9.60	9.52
12	**JVB-LS-2373**	5.00	5.07	4.47	4.93	4.87	10.47	10.40	11.20	10.53	10.65
13	**JVB-LS-2501**	4.27	4.20	4.47	4.00	4.23	8.60	8.53	9.33	8.40	8.72
14	**JVB-LS-2502**	4.87	4.00	4.20	5.07	4.53	8.60	10.80	8.93	10.07	9.60
15	**JVB-LS-2505**	4.80	5.07	5.13	5.00	5.00	9.07	9.33	9.93	9.13	9.37
16	**JVB-LS-2506**	5.40	5.33	5.20	5.27	5.30	9.07	8.60	8.93	9.47	9.02
17	**JVB-LS-2507**	4.15	4.13	4.33	4.00	4.15	9.60	8.73	9.67	8.33	9.08
18	**JVB-2508**	3.93	3.73	3.40	3.80	3.72	12.20	11.93	11.33	11.20	11.67
19	**JVB-2509**	6.07	6.20	6.13	5.00	5.85	12.27	11.87	11.20	11.60	11.73
20	**JVB-2510**	5.07	5.27	5.13	4.87	5.08	10.93	9.33	10.73	10.47	10.37
21	**JVB-2511**	5.20	5.13	5.00	3.87	4.80	9.33	10.73	8.80	9.20	9.52
22	**JVB-2512**	5.07	5.20	4.33	5.27	4.97	11.13	10.93	8.87	9.33	10.07
23	**JVB-2513**	4.87	4.40	4.20	4.60	4.52	10.73	8.67	8.60	10.27	9.57
24	**JVB-2514**	5.00	5.13	5.33	4.20	4.92	9.47	9.13	8.80	11.13	9.63
25	**JVB-2515**	3.73	3.47	3.40	3.60	3.55	9.07	8.40	8.27	8.33	8.52
26	**JVB-2516**	5.73	5.87	5.60	5.80	5.75	11.60	10.40	9.40	10.53	10.48
27	**JVB-2517**	3.87	4.73	5.00	4.60	4.55	8.47	9.80	9.13	9.20	9.15

Contd…

		Number of primary branches per plant					Number of secondary branches per plant				
Sr. No.	**Genotype**	**E_1**	**E_2**	**E_3**	**E_4**	**Mean**	**E_1**	**E_2**	**E_3**	**E_4**	**Mean**
28	**JVB-2518**	4.80	4.60	5.00	4.47	4.72	8.20	8.53	9.00	9.00	8.68
29	**JVB-2519**	5.33	5.47	3.53	5.40	4.93	9.40	9.33	9.53	10.13	9.60
30	**JVB-2520**	4.00	4.07	4.40	4.20	4.17	8.53	8.80	8.40	9.33	8.77
31	**JVB-2521**	5.13	4.20	4.00	5.27	4.65	11.47	10.60	10.07	9.20	10.33
32	**JVB-2522**	4.87	4.93	4.67	5.00	4.87	9.07	9.53	8.80	10.47	9.47
33	**JVB-2523**	4.93	5.00	5.20	5.07	5.05	9.07	9.87	9.13	10.53	9.65
34	**JVB-2524**	4.93	4.87	4.80	4.60	4.80	8.33	8.67	8.67	9.20	8.72
35	**JVB-2525**	5.13	5.20	5.33	5.00	5.17	9.67	9.53	10.53	8.87	9.65
36	**JVB-2526**	5.20	5.13	5.07	5.00	5.10	10.73	10.40	9.40	9.53	10.02
37	**JVB-2527**	4.07	4.93	4.00	4.20	4.30	9.80	8.67	8.60	8.93	9.00
38	**JVB-2528**	5.87	6.07	5.80	6.00	5.93	12.07	12.20	11.53	12.07	11.97
39	**JVB-2529**	4.73	3.80	5.00	4.60	4.53	8.47	11.20	9.47	9.47	9.65
40	**JVB-2530**	5.00	4.93	4.80	5.07	4.95	10.53	10.07	8.47	9.20	9.57
41	**JVB-2531**	5.07	4.80	4.93	5.00	4.95	9.80	9.53	9.53	10.20	9.77
42	**JVB-2532**	6.00	6.07	6.13	5.87	6.02	12.33	10.40	10.73	11.20	11.17
43	**JVB-2533**	5.00	4.13	5.20	5.07	4.85	10.27	9.87	10.93	9.67	10.18
44	**JVB-2534**	5.80	6.13	5.87	6.07	5.97	11.73	11.40	10.60	11.13	11.22
45	**Kaushal**	4.93	5.00	5.13	5.07	5.03	9.40	9.53	9.53	9.20	9.42
46	**GG-20**	5.40	5.33	5.27	5.20	5.30	11.53	11.07	11.07	11.20	11.22
47	**GJG-22**	5.33	5.20	5.40	5.27	5.30	10.53	9.53	11.13	9.60	10.20
48	**GG-HPS-2**	5.13	4.80	5.00	4.87	4.95	9.53	9.20	8.47	10.07	9.32
49	**ICGV-86564**	4.33	4.20	4.80	4.40	4.43	9.40	8.93	9.40	8.60	9.08
50	**BAU-13**	3.47	3.40	3.67	3.27	3.45	8.87	8.53	8.67	8.33	8.60
	G.M.	4.84	4.80	4.79	4.74	4.79	9.87	9.71	9.55	9.72	9.71
	S.Em ±	0.22	0.23	0.24	0.23	0.07	0.20	0.23	0.21	0.23	0.06
	CD at 5 %	0.62	0.66	0.68	0.64	-	0.56	0.64	0.59	0.66	-
	CV %	7.92	8.47	8.72	8.29	-	3.50	4.04	3.80	4.18	-

Mean performance for plant height (cm) and number of matured pods per plant

		Plant height (cm)					Number of matured pods per plant				
Sr. No.	**Genotype**	**E_1**	**E_2**	**E_3**	**E_4**	**Mean**	**E_1**	**E_2**	**E_3**	**E_4**	**Mean**
1	**JSSP-59**	32.62	32.38	26.56	28.28	29.96	8.53	10.60	11.40	9.40	9.98
2	**JSSP-60**	32.26	30.33	26.50	24.41	28.37	15.73	14.67	13.47	12.33	14.05
3	**JSSP-62**	35.70	29.58	24.48	26.53	29.07	13.07	12.33	10.47	11.40	11.82
4	**JSSP-63**	29.94	34.60	23.61	25.89	28.51	12.33	10.20	9.53	10.53	10.65
5	**JVB-2453**	35.28	35.58	30.38	28.29	32.38	8.40	10.80	12.27	8.40	9.97
6	**JVB-2483**	37.85	33.03	31.95	33.36	34.05	22.67	17.20	15.47	14.60	17.48
7	**JVB-2486**	35.92	35.33	26.82	27.89	31.49	20.40	16.33	13.80	15.47	16.50
8	**JVB-2489**	35.98	43.05	28.77	25.90	33.43	19.47	15.67	12.60	13.33	15.27
9	**JVB-2494**	32.95	45.59	28.96	32.53	35.01	12.07	14.60	12.67	10.40	12.43
10	**JSSP-LS-61**	42.22	30.83	38.36	36.20	36.90	13.73	15.33	16.47	12.60	14.53
11	**JVB-LS-2436**	45.78	32.64	32.13	30.66	35.30	8.80	10.60	12.73	10.47	10.65
12	**JVB-LS-2373**	35.54	32.03	28.66	32.23	32.11	16.60	15.20	14.47	13.40	14.92
13	**JVB-LS-2501**	34.40	30.21	24.97	26.54	29.03	9.80	13.80	10.60	8.27	10.62
14	**JVB-LS-2502**	35.46	32.26	25.59	23.86	29.29	8.13	15.40	10.67	9.27	10.87
15	**JVB-LS-2505**	37.09	35.93	26.52	30.91	32.61	10.53	9.67	9.67	8.40	9.57
16	**JVB-LS-2506**	43.67	39.65	32.05	30.52	36.48	14.87	17.27	10.67	12.40	13.80
17	**JVB-LS-2507**	39.41	35.44	29.86	26.42	32.78	15.33	13.60	10.80	11.40	12.78
18	**JVB-2508**	29.45	34.82	27.15	30.22	30.41	20.20	20.47	21.20	21.47	20.83
19	**JVB-2509**	29.80	31.68	35.33	37.41	33.55	23.80	22.00	20.47	19.33	21.40
20	**JVB-2510**	30.11	30.46	25.78	27.40	28.44	24.00	22.33	20.13	18.27	21.18
21	**JVB-2511**	35.43	32.57	27.67	25.76	30.36	19.80	15.60	16.60	13.60	16.40
22	**JVB-2512**	30.72	36.09	29.12	32.72	32.16	13.13	20.80	18.40	15.40	16.93
23	**JVB-2513**	36.08	32.54	40.72	38.20	36.89	10.60	15.73	8.13	11.20	11.42
24	**JVB-2514**	37.33	42.11	34.68	36.11	37.56	10.87	12.87	14.27	10.27	12.07
25	**JVB-2515**	25.49	25.75	22.87	24.71	24.70	10.87	8.60	8.40	9.33	9.30
26	**JVB-2516**	31.93	36.29	28.77	31.05	32.01	25.07	23.13	22.33	22.40	23.23
27	**JVB-2517**	42.31	30.55	24.31	22.22	29.85	21.80	17.80	19.73	15.40	18.68

Contd…

		Plant height (cm)					Number of matured pods per plant				
Sr. No.	**Genotype**	**E_1**	**E_2**	**E_3**	**E_4**	**Mean**	**E_1**	**E_2**	**E_3**	**E_4**	**Mean**
28	**JVB-2518**	33.95	31.54	28.50	26.33	30.08	20.53	22.67	18.47	17.47	19.78
29	**JVB-2519**	28.80	30.55	27.89	30.31	29.39	17.27	21.27	15.47	13.60	16.90
30	**JVB-2520**	34.75	35.13	28.74	25.07	30.92	16.80	15.73	10.53	12.40	13.87
31	**JVB-2521**	38.09	41.04	31.73	28.40	34.82	15.93	14.60	13.40	12.60	14.13
32	**JVB-2522**	32.14	28.30	25.40	27.29	28.28	21.07	17.60	13.40	14.20	16.57
33	**JVB-2523**	37.81	35.81	25.08	23.19	30.47	12.40	14.47	10.47	11.13	12.12
34	**JVB-2524**	34.70	30.24	24.12	26.17	28.81	16.47	18.67	17.67	14.53	16.83
35	**JVB-2525**	35.24	38.69	27.12	25.19	31.56	20.73	17.47	15.60	14.53	17.08
36	**JVB-2526**	31.93	31.34	30.90	32.28	31.61	15.47	13.13	11.47	12.53	13.15
37	**JVB-2527**	32.70	30.38	29.92	32.94	31.48	14.67	11.53	15.53	10.47	13.05
38	**JVB-2528**	33.39	28.91	30.92	28.09	30.33	22.00	24.27	21.47	21.40	22.28
39	**JVB-2529**	27.79	39.25	29.19	32.18	32.10	17.87	15.53	13.60	12.40	14.85
40	**JVB-2530**	29.90	41.00	27.91	25.20	31.01	14.73	15.40	11.60	12.40	13.53
41	**JVB-2531**	30.81	37.54	29.11	26.72	31.04	19.40	20.40	15.60	14.53	17.48
42	**JVB-2532**	28.34	30.48	29.10	32.25	30.04	22.47	24.60	22.60	21.40	22.77
43	**JVB-2533**	36.04	35.01	29.11	27.19	31.84	15.13	14.40	16.47	12.60	14.65
44	**JVB-2534**	35.03	29.54	27.90	28.35	30.21	23.33	25.20	19.80	18.20	21.63
45	**Kaushal**	34.80	30.57	28.65	32.63	31.66	13.07	12.53	10.20	10.60	11.60
46	**GG-20**	33.16	35.71	27.65	29.32	31.46	17.87	18.00	16.40	16.40	17.17
47	**GJG-22**	35.47	29.89	31.30	30.28	31.74	15.40	16.20	14.27	15.47	15.33
48	**GG-HPS-2**	28.27	32.34	31.26	33.29	31.29	10.47	15.27	9.13	9.40	11.07
49	**ICGV-86564**	32.59	30.24	31.22	34.25	32.08	17.13	15.27	12.33	12.40	14.28
50	**BAU-13**	35.45	32.57	30.44	28.50	31.74	15.13	12.53	17.07	14.53	14.82
	G.M.	34.24	33.75	28.92	29.23	31.53	16.12	16.19	14.40	13.48	15.05
	S.Em ±	1.40	1.65	1.78	1.60	0.46	1.09	1.21	1.02	0.97	0.31
	CD at 5 %	3.93	4.62	4.98	4.48	-	3.05	3.39	2.86	2.73	-
	CV %	7.09	8.45	10.64	9.46	-	11.67	12.91	12.26	12.48	-

Mean performance for number of immature pods per plant and sound mature kernel (SMK) %

		Number of immature pods per plant					Sound mature kernel (SMK) %				
Sr. No.	**Genotype**	**E_1**	**E_2**	**E_3**	**E_4**	**Mean**	**E_1**	**E_2**	**E_3**	**E_4**	**Mean**
1	**JSSP-59**	4.13	6.73	3.47	3.20	4.38	63.46	64.76	66.59	65.04	64.96
2	**JSSP-60**	3.20	3.87	3.67	3.47	3.55	80.01	83.52	72.42	75.34	77.82
3	**JSSP-62**	4.07	4.47	3.80	3.80	4.03	76.37	75.10	80.49	66.42	74.60
4	**JSSP-63**	4.27	3.33	3.27	2.93	3.45	72.40	85.53	72.46	78.21	77.15
5	**JVB-2453**	5.13	7.13	4.20	3.60	5.02	75.65	78.35	78.59	75.42	77.00
6	**JVB-2483**	4.00	4.47	6.53	4.80	4.95	89.78	83.38	85.60	68.19	81.74
7	**JVB-2486**	6.07	8.27	4.67	5.47	6.12	91.43	86.33	80.12	78.48	84.09
8	**JVB-2489**	3.00	5.13	3.20	4.73	4.02	73.85	65.43	73.39	70.31	70.75
9	**JVB-2494**	3.40	4.13	2.87	4.07	3.62	85.02	80.30	82.08	75.50	80.73
10	**JSSP-LS-61**	4.87	3.07	6.80	3.67	4.60	76.40	73.46	77.24	74.33	75.36
11	**JVB-LS-2436**	3.73	3.20	4.47	2.67	3.52	77.38	80.51	64.99	78.35	75.31
12	**JVB-LS-2373**	4.13	3.20	5.80	4.67	4.45	75.44	77.52	74.31	76.54	75.95
13	**JVB-LS-2501**	3.47	2.40	4.60	2.13	3.15	80.36	75.79	65.07	61.14	70.59
14	**JVB-LS-2502**	3.47	2.87	2.60	3.27	3.05	68.32	81.34	66.92	64.36	70.23
15	**JVB-LS-2505**	2.67	3.20	2.60	3.27	2.93	83.38	62.93	61.15	75.29	70.69
16	**JVB-LS-2506**	4.53	3.07	2.20	3.13	3.23	83.31	81.84	78.70	77.42	80.32
17	**JVB-LS-2507**	3.13	4.13	2.80	3.07	3.28	86.50	79.75	85.44	68.35	80.01
18	**JVB-2508**	6.93	6.73	3.67	4.13	5.37	90.39	86.90	88.29	85.35	87.73
19	**JVB-2509**	5.67	6.27	3.73	4.13	4.95	92.32	85.12	88.37	75.52	85.33
20	**JVB-2510**	3.60	5.33	3.53	4.53	4.25	82.38	80.45	84.42	83.38	82.66
21	**JVB-2511**	3.73	5.13	2.53	2.67	3.52	73.19	75.69	70.23	76.32	73.86
22	**JVB-2512**	4.33	2.20	3.47	2.27	3.07	88.30	82.56	76.38	80.27	81.88
23	**JVB-2513**	2.87	3.27	2.27	4.20	3.15	65.32	72.32	65.34	74.55	69.38
24	**JVB-2514**	5.47	4.33	4.53	3.27	4.40	70.50	64.44	75.26	65.39	68.90
25	**JVB-2515**	4.47	2.73	2.07	3.13	3.10	73.19	65.49	75.45	75.53	72.41
26	**JVB-2516**	3.53	3.53	8.20	4.13	4.85	86.42	88.43	85.37	87.24	86.87
27	**JVB-2517**	6.53	4.07	5.73	3.80	5.03	75.47	86.12	82.26	71.88	78.93

Contd…

		Number of immature pods per plant					Sound mature kernel (SMK) %				
Sr. No.	**Genotype**	**E_1**	**E_2**	**E_3**	**E_4**	**Mean**	**E_1**	**E_2**	**E_3**	**E_4**	**Mean**
28	**JVB-2518**	3.53	2.07	5.80	3.40	3.70	86.29	83.32	72.46	74.46	79.13
29	**JVB-2519**	8.07	4.07	3.67	3.33	4.78	84.38	74.43	70.29	71.14	75.06
30	**JVB-2520**	7.73	3.13	5.60	4.13	5.15	80.34	83.32	72.35	72.43	77.11
31	**JVB-2521**	4.80	7.13	3.13	3.53	4.65	70.46	84.46	75.31	76.42	76.67
32	**JVB-2522**	3.93	6.13	3.80	4.27	4.53	78.53	79.31	75.03	77.30	77.54
33	**JVB-2523**	3.73	3.93	5.73	4.27	4.42	70.42	79.94	68.13	72.32	72.70
34	**JVB-2524**	5.13	3.93	7.53	6.13	5.68	85.51	87.72	82.45	73.38	82.27
35	**JVB-2525**	3.80	5.47	4.73	5.20	4.80	88.51	82.45	75.37	80.45	81.69
36	**JVB-2526**	4.53	3.53	2.73	5.47	4.07	88.42	76.01	82.36	63.67	77.61
37	**JVB-2527**	5.47	4.33	3.67	4.73	4.55	85.50	74.76	66.36	75.69	75.57
38	**JVB-2528**	6.53	3.40	3.67	7.80	5.35	90.11	90.12	86.45	88.47	88.79
39	**JVB-2529**	4.67	8.00	3.67	6.47	5.70	86.19	85.40	72.35	80.34	81.07
40	**JVB-2530**	3.73	5.07	2.87	4.27	3.98	80.42	81.06	75.45	82.33	79.82
41	**JVB-2531**	4.33	6.07	5.67	5.07	5.28	87.25	70.87	80.26	65.42	75.95
42	**JVB-2532**	4.53	5.93	7.47	4.60	5.63	77.54	79.35	76.30	81.89	78.77
43	**JVB-2533**	6.67	5.07	4.27	3.47	4.87	80.55	75.46	70.32	80.43	76.69
44	**JVB-2534**	4.80	9.00	3.60	3.60	5.25	82.38	83.56	82.18	84.31	83.11
45	**Kaushal**	5.47	4.20	3.53	2.20	3.85	75.56	70.35	80.30	82.41	77.15
46	**GG-20**	3.67	2.60	4.60	2.47	3.33	83.29	82.35	81.45	83.46	82.64
47	**GJG-22**	4.47	3.20	2.73	3.47	3.47	82.03	80.31	75.34	73.39	77.77
48	**GG-HPS-2**	4.80	3.27	2.80	3.73	3.65	80.37	75.76	78.45	78.58	78.29
49	**ICGV-86564**	2.87	5.00	2.20	2.27	3.08	87.90	72.69	85.25	78.47	81.08
50	**BAU-13**	3.80	2.13	5.60	4.20	3.93	85.11	70.57	82.30	82.34	80.08
	G.M.	4.51	4.46	4.13	3.93	4.26	80.67	78.54	76.47	75.66	77.84
	S.Em ±	0.20	0.30	0.27	0.28	0.08	1.37	1.53	1.75	1.64	0.46
	CD at 5 %	0.56	0.84	0.75	0.79	-	3.85	4.29	4.90	4.61	-
	CV %	7.72	11.58	11.20	12.35	-	2.94	3.37	3.95	3.76	-

Mean performance for 100-kernel weight (g) and shelling out-turn (%)

		100-kernel weight (g)					Shelling out-turn (%)				
Sr. No.	**Genotype**	**E_1**	**E_2**	**E_3**	**E_4**	**Mean**	**E_1**	**E_2**	**E_3**	**E_4**	**Mean**
1	**JSSP-59**	28.18	32.39	37.56	30.35	32.12	60.36	61.11	62.40	64.31	62.05
2	**JSSP-60**	44.31	44.39	44.30	44.38	44.34	67.39	64.34	63.38	65.49	65.15
3	**JSSP-62**	27.64	32.33	31.42	34.46	31.46	65.25	63.70	68.23	66.66	65.96
4	**JSSP-63**	27.62	30.33	32.32	35.39	31.41	69.40	72.46	71.29	68.48	70.41
5	**JVB-2453**	35.26	36.31	39.42	33.38	36.09	72.49	76.39	74.27	71.34	73.62
6	**JVB-2483**	44.54	42.47	39.31	40.43	41.69	66.25	71.44	69.46	70.40	69.39
7	**JVB-2486**	38.40	42.46	41.40	35.25	39.38	70.33	72.34	73.42	69.35	71.36
8	**JVB-2489**	47.75	44.51	45.57	42.37	45.05	71.33	74.43	72.55	70.33	72.16
9	**JVB-2494**	46.44	37.55	35.55	40.46	40.00	71.35	73.33	66.40	69.39	70.12
10	**JSSP-LS-61**	46.22	42.46	35.24	37.38	40.33	67.33	63.36	65.40	64.24	65.08
11	**JVB-LS-2436**	37.65	37.53	35.41	40.32	37.73	72.55	68.43	70.46	67.32	69.69
12	**JVB-LS-2373**	48.60	43.30	39.51	40.30	42.93	69.27	65.67	67.27	70.33	68.14
13	**JVB-LS-2501**	57.96	52.42	59.36	53.34	55.77	70.33	75.28	73.50	71.35	72.61
14	**JVB-LS-2502**	35.41	37.31	44.23	39.28	39.06	68.29	74.65	70.32	73.36	71.65
15	**JVB-LS-2505**	59.57	55.55	57.49	52.26	56.22	63.29	68.56	66.37	69.24	66.87
16	**JVB-LS-2506**	48.43	42.54	45.64	43.36	44.99	62.50	59.48	64.40	63.26	62.41
17	**JVB-LS-2507**	49.21	44.59	42.35	46.55	45.68	65.25	68.32	70.46	67.35	67.84
18	**JVB-2508**	49.74	45.47	38.36	46.55	45.03	69.28	69.51	69.37	69.27	69.36
19	**JVB-2509**	45.36	45.20	45.49	45.45	45.38	66.33	64.36	68.43	64.25	65.84
20	**JVB-2510**	40.63	37.40	34.39	35.43	36.96	71.37	69.40	72.45	68.37	70.40
21	**JVB-2511**	37.53	32.75	30.41	35.42	34.03	69.34	73.33	71.42	72.44	71.63
22	**JVB-2512**	42.42	35.50	33.38	32.30	35.90	71.01	67.54	69.35	66.54	68.61
23	**JVB-2513**	27.33	27.57	30.31	32.52	29.43	68.36	70.46	73.43	71.34	70.90
24	**JVB-2514**	37.51	37.56	36.41	42.32	38.45	66.40	67.37	65.40	69.36	67.13
25	**JVB-2515**	45.54	45.36	42.48	44.42	44.45	55.56	53.33	57.32	54.36	55.14
26	**JVB-2516**	27.43	27.45	30.54	31.43	29.21	66.33	68.37	70.31	67.32	68.08
27	**JVB-2517**	42.20	39.43	34.55	40.40	39.14	71.31	69.53	72.45	68.36	70.41

Contd…

Sr. No.	Genotype	100-kernel weight (g) E1	E2	E3	E4	Mean	Shelling out-turn (%) E1	E2	E3	E4	Mean
28	**JVB-2518**	42.50	42.34	42.50	33.47	40.20	66.46	72.35	70.32	67.26	69.10
29	**JVB-2519**	23.60	24.38	28.34	26.48	25.70	72.25	70.40	73.39	71.38	71.85
30	**JVB-2520**	33.54	29.44	35.35	30.46	32.20	76.24	73.31	72.32	74.48	74.09
31	**JVB-2521**	34.31	38.63	31.46	35.57	34.99	72.40	75.33	71.40	73.34	73.12
32	**JVB-2522**	45.39	45.20	43.35	40.45	43.60	74.39	76.46	73.27	72.26	74.10
33	**JVB-2523**	35.32	40.44	37.44	38.32	37.88	73.56	70.33	74.45	69.41	71.94
34	**JVB-2524**	34.47	30.42	28.36	27.51	30.19	62.41	59.35	64.45	58.44	61.16
35	**JVB-2525**	36.57	30.41	37.55	32.31	34.21	68.71	72.44	70.42	67.42	69.75
36	**JVB-2526**	47.53	42.44	35.35	37.63	40.74	71.33	68.32	73.48	68.31	70.36
37	**JVB-2527**	40.56	42.28	39.33	38.37	40.13	71.10	73.35	70.42	69.31	71.05
38	**JVB-2528**	47.77	47.66	47.63	47.78	47.71	66.57	66.43	66.48	66.39	66.47
39	**JVB-2529**	46.42	40.44	42.21	39.70	42.19	73.36	70.31	69.39	71.77	71.21
40	**JVB-2530**	36.51	32.35	31.31	30.35	32.63	63.43	60.26	58.42	57.33	59.86
41	**JVB-2531**	45.46	42.29	44.59	40.53	43.22	71.42	73.39	69.51	72.31	71.66
42	**JVB-2532**	46.48	45.57	47.54	43.45	45.76	71.38	72.96	70.36	68.33	70.76
43	**JVB-2533**	37.37	35.53	34.50	39.41	36.70	65.49	68.25	70.30	66.40	67.61
44	**JVB-2534**	45.57	43.42	43.56	46.59	44.78	72.49	66.35	69.44	67.38	68.92
45	**Kaushal**	30.80	26.78	28.53	32.18	29.57	68.45	72.44	70.33	69.65	70.22
46	**GG-20**	49.45	49.30	49.38	49.32	49.36	72.09	71.52	72.39	72.54	72.13
47	**GJG-22**	49.38	49.42	48.24	49.30	49.09	69.33	70.54	69.45	69.47	69.70
48	**GG-HPS-2**	52.71	45.43	44.34	46.51	47.25	55.43	58.49	60.47	57.09	57.87
49	**ICGV-86564**	48.33	44.32	42.35	40.42	43.86	63.39	65.32	67.34	64.46	65.13
50	**BAU-13**	35.98	27.60	29.32	31.52	31.11	62.45	59.43	64.43	60.44	61.69
	G.M.	41.30	39.36	39.10	39.06	39.71	68.25	68.68	69.03	67.78	68.43
	S.Em ±	1.41	0.95	0.79	0.96	0.30	1.51	1.50	1.77	1.75	0.47
	CD at 5 %	3.96	2.66	2.20	2.69	-	4.24	4.20	4.97	4.91	-
	CV %	5.92	4.18	3.48	4.25	-	3.83	3.77	4.44	4.47	-

Mean performance for pod yield per plant (g) and kernel yield per plant (g)

		Pod yield per plant (g)					Kernel yield per plant (g)				
Sr. No.	Genotype	E_1	E_2	E_3	E_4	Mean	E_1	E_2	E_3	E_4	Mean
1	**JSSP-59**	9.43	10.19	12.54	13.33	11.37	5.70	6.20	7.85	8.62	7.09
2	**JSSP-60**	18.33	19.42	22.07	16.45	19.07	12.34	12.51	13.97	10.75	12.39
3	**JSSP-62**	10.44	14.36	14.45	11.36	12.65	6.81	9.13	9.88	7.55	8.34
4	**JSSP-63**	10.79	13.11	12.37	15.48	12.94	7.51	9.49	8.77	10.62	9.10
5	**JVB-2453**	10.06	13.34	14.56	11.23	12.30	7.30	10.23	10.82	7.99	9.09
6	**JVB-2483**	22.42	17.45	13.42	15.42	17.18	14.84	12.49	9.34	10.83	11.88
7	**JVB-2486**	18.70	10.48	15.44	12.38	14.25	13.14	7.55	11.31	8.56	10.14
8	**JVB-2489**	20.35	16.45	9.38	15.42	15.40	14.50	12.27	6.79	10.89	11.11
9	**JVB-2494**	13.41	14.55	7.44	8.38	10.94	9.56	10.65	4.96	5.79	7.74
10	**JSSP-LS-61**	14.49	15.45	12.46	16.55	14.74	9.74	9.77	8.19	10.61	9.58
11	**JVB-LS-2436**	9.31	13.43	12.76	14.39	12.47	6.73	9.17	9.02	9.67	8.65
12	**JVB-LS-2373**	15.39	13.43	8.62	10.50	11.98	10.69	8.81	5.78	7.37	8.16
13	**JVB-LS-2501**	11.35	10.31	13.45	9.52	11.16	7.97	7.80	9.86	6.78	8.10
14	**JVB-LS-2502**	8.41	17.23	20.47	13.26	14.84	5.72	12.85	14.38	9.70	10.66
15	**JVB-LS-2505**	11.35	15.33	12.35	10.39	12.36	7.21	10.55	8.18	7.24	8.30
16	**JVB-LS-2506**	14.51	16.35	15.47	12.42	14.69	9.04	9.70	9.95	7.83	9.13
17	**JVB-LS-2507**	14.72	17.35	12.43	11.43	13.98	9.58	11.83	8.74	7.69	9.46
18	**JVB-2508**	20.41	20.89	20.83	20.50	20.66	14.16	14.51	14.49	14.23	14.35
19	**JVB-2509**	19.51	22.38	19.42	23.44	21.19	12.96	14.45	13.33	15.10	13.96
20	**JVB-2510**	16.19	12.45	9.43	12.51	12.64	11.53	8.67	6.88	8.59	8.92
21	**JVB-2511**	15.85	12.36	13.50	17.63	14.84	11.02	9.05	9.63	12.75	10.61
22	**JVB-2512**	10.36	23.20	22.10	16.53	18.05	7.40	15.70	15.30	10.98	12.34
23	**JVB-2513**	11.30	8.34	12.26	13.31	11.30	7.71	5.92	8.98	9.52	8.03
24	**JVB-2514**	11.09	12.45	14.42	15.51	13.37	7.35	8.38	9.47	10.77	8.99
25	**JVB-2515**	12.34	11.28	9.49	13.41	11.63	6.84	6.05	5.43	7.25	6.39
26	**JVB-2516**	20.62	20.23	20.32	21.57	20.69	13.70	13.80	14.27	14.56	14.08
27	**JVB-2517**	18.28	16.36	12.31	14.58	15.38	13.02	11.36	8.96	9.96	10.82

Contd…

Sr. No.	Genotype	Pod yield per plant (g) E_1	E_2	E_3	E_4	Mean	Kernel yield per plant (g) E_1	E_2	E_3	E_4	Mean
28	**JVB-2518**	17.36	18.28	22.48	19.33	19.36	11.52	13.27	15.78	12.98	13.39
29	**JVB-2519**	11.34	13.35	18.70	12.45	13.96	8.22	9.38	13.71	8.93	10.06
30	**JVB-2520**	14.53	11.38	9.29	12.52	11.93	11.06	8.32	6.74	9.34	8.87
31	**JVB-2521**	13.46	18.35	18.31	15.44	16.39	9.73	13.80	13.05	11.31	11.97
32	**JVB-2522**	21.32	16.28	12.41	14.48	16.12	15.92	12.42	9.09	10.46	11.97
33	**JVB-2523**	10.55	14.39	13.44	11.39	12.44	7.79	10.14	10.04	7.89	8.96
34	**JVB-2524**	13.46	15.52	13.07	11.26	13.33	8.40	9.20	8.46	6.56	8.15
35	**JVB-2525**	13.72	10.36	10.33	11.25	11.41	9.41	7.48	7.28	7.57	7.94
36	**JVB-2526**	13.53	14.35	10.29	9.49	11.91	9.67	9.83	7.54	6.46	8.37
37	**JVB-2527**	13.10	10.27	9.40	10.38	10.79	9.32	7.51	6.60	7.19	7.65
38	**JVB-2528**	22.08	22.42	22.39	22.36	22.31	14.77	14.88	14.87	14.89	14.85
39	**JVB-2529**	14.50	16.37	15.52	13.68	15.02	10.62	11.53	10.76	9.87	10.70
40	**JVB-2530**	13.38	15.54	11.40	16.41	14.18	8.47	9.36	6.67	9.38	8.47
41	**JVB-2531**	21.10	15.36	13.53	16.52	16.63	15.05	11.25	9.41	11.92	11.91
42	**JVB-2532**	21.75	21.02	21.88	21.24	21.47	15.53	15.36	15.44	14.54	15.22
43	**JVB-2533**	13.33	19.40	13.51	12.34	14.65	8.71	13.22	9.48	8.24	9.91
44	**JVB-2534**	23.35	18.58	20.62	19.37	20.48	16.98	12.31	14.33	13.03	14.16
45	**Kaushal**	12.35	10.38	11.33	13.42	11.87	8.49	7.51	7.95	9.32	8.32
46	**GG-20**	19.28	19.46	19.55	19.75	19.51	13.94	13.91	14.13	14.31	14.08
47	**GJG-22**	17.49	17.25	17.55	17.12	17.35	12.11	12.15	12.17	11.92	12.09
48	**GG-HPS-2**	10.35	11.44	13.37	15.54	12.68	5.72	6.66	8.13	8.89	7.35
49	**ICGV-86564**	17.64	15.36	13.28	14.59	15.22	11.16	10.05	8.93	9.40	9.88
50	**BAU-13**	14.55	12.32	9.39	13.51	12.44	9.07	7.31	6.04	8.18	7.65
	G.M.	15.06	15.31	14.50	14.61	14.87	10.31	10.52	10.02	9.90	10.19
	S.Em ±	1.24	1.11	0.98	1.09	0.32	0.91	0.80	0.74	0.80	0.23
	CD at 5 %	3.49	3.10	2.76	3.05	-	2.55	2.24	2.06	2.24	-
	CV %	14.31	12.51	11.73	12.87	-	15.25	13.15	12.71	13.95	-

Mean performance for biological yield per plant (g) and harvest index (%)

		Biological yield per plant (g)					Harvest index (%)				
Sr. No.	**Genotype**	**E_1**	**E_2**	**E_3**	**E_4**	**Mean**	**E_1**	**E_2**	**E_3**	**E_4**	**Mean**
1	**JSSP-59**	28.10	32.98	39.39	38.89	34.84	33.28	30.69	31.95	34.28	32.55
2	**JSSP-60**	47.96	48.27	49.82	48.12	48.54	38.30	40.43	44.36	34.21	39.33
3	**JSSP-62**	30.08	44.94	40.85	35.28	37.79	34.53	31.93	35.45	32.21	33.53
4	**JSSP-63**	30.33	32.65	33.10	40.55	34.16	35.39	40.56	37.33	38.27	37.89
5	**JVB-2453**	38.69	48.54	48.09	42.52	44.46	25.66	27.37	30.42	26.28	27.43
6	**JVB-2483**	63.06	57.13	35.90	47.89	50.99	35.53	30.68	37.39	32.22	33.96
7	**JVB-2486**	45.05	27.30	35.62	33.18	35.29	41.53	38.34	43.35	37.31	40.13
8	**JVB-2489**	45.46	38.85	23.21	39.13	36.66	44.69	42.45	40.39	39.41	41.73
9	**JVB-2494**	48.53	53.07	27.19	30.46	39.81	27.54	27.46	27.37	27.43	27.45
10	**JSSP-LS-61**	44.41	52.66	45.42	46.89	47.34	32.54	29.53	27.43	35.34	31.21
11	**JVB-LS-2436**	30.34	40.09	42.12	42.03	38.65	30.41	33.56	30.41	34.34	32.18
12	**JVB-LS-2373**	38.75	38.02	25.97	32.92	33.92	39.59	35.39	33.22	31.99	35.05
13	**JVB-LS-2501**	31.67	27.50	39.11	29.43	31.93	35.66	37.26	34.40	32.33	34.91
14	**JVB-LS-2502**	31.25	50.80	56.27	39.87	44.55	26.67	34.33	36.48	33.27	32.69
15	**JVB-LS-2505**	31.65	37.90	35.87	34.03	34.86	35.66	40.46	34.46	30.33	35.23
16	**JVB-LS-2506**	51.88	57.31	51.25	45.30	51.43	27.76	28.47	30.26	27.29	28.45
17	**JVB-LS-2507**	32.84	37.62	29.49	29.91	32.46	44.51	46.01	42.22	38.27	42.75
18	**JVB-2508**	45.01	45.05	44.95	45.31	45.08	45.28	46.50	46.42	45.32	45.88
19	**JVB-2509**	48.65	55.64	48.20	58.01	52.63	40.21	40.50	40.34	40.44	40.37
20	**JVB-2510**	45.36	33.18	27.36	35.30	35.30	35.57	37.55	34.40	35.42	35.73
21	**JVB-2511**	43.50	36.99	38.86	43.81	40.79	36.31	33.48	34.82	40.27	36.22
22	**JVB-2512**	33.74	65.50	66.22	46.44	52.97	30.52	35.52	33.43	35.64	33.78
23	**JVB-2513**	41.04	27.21	36.80	43.62	37.17	27.41	30.32	33.32	30.39	30.36
24	**JVB-2514**	33.10	41.08	41.17	42.66	39.50	33.33	30.43	35.10	36.52	33.85
25	**JVB-2515**	40.36	39.87	28.59	38.02	36.71	30.45	28.42	33.30	35.30	31.87
26	**JVB-2516**	54.47	59.11	51.77	59.31	56.16	37.91	34.38	39.30	36.45	37.01
27	**JVB-2517**	41.02	38.58	30.50	37.14	36.81	44.57	42.42	40.34	39.34	41.67

Contd…

		Biological yield per plant (g)					Harvest index (%)				
Sr. No.	**Genotype**	**E_1**	**E_2**	**E_3**	**E_4**	**Mean**	**E_1**	**E_2**	**E_3**	**E_4**	**Mean**
28	**JVB-2518**	49.08	47.67	53.14	47.92	49.45	35.56	38.41	42.32	40.39	39.17
29	**JVB-2519**	42.43	46.73	58.03	40.91	47.03	26.57	28.46	32.34	30.29	29.42
30	**JVB-2520**	42.49	34.94	30.65	35.73	35.95	34.40	32.38	30.39	35.08	33.06
31	**JVB-2521**	36.62	45.59	43.18	39.12	41.13	36.69	40.34	42.45	39.50	39.75
32	**JVB-2522**	56.59	46.14	38.53	46.29	46.89	37.55	35.27	32.29	31.40	34.13
33	**JVB-2523**	32.21	40.84	39.20	34.86	36.78	32.55	35.34	34.34	32.49	33.68
34	**JVB-2524**	35.94	38.54	36.40	30.91	35.45	37.51	40.34	35.93	36.42	37.55
35	**JVB-2525**	34.27	29.35	30.90	34.49	32.25	40.10	35.26	33.51	32.45	35.33
36	**JVB-2526**	44.34	48.98	37.78	34.70	41.45	30.84	29.42	27.42	27.42	28.77
37	**JVB-2527**	32.51	28.95	27.76	32.12	30.34	40.43	35.44	33.86	32.42	35.54
38	**JVB-2528**	46.19	47.02	47.46	47.26	46.98	47.49	47.72	47.34	47.32	47.47
39	**JVB-2529**	40.35	42.67	40.66	38.49	40.54	36.07	38.44	38.28	35.22	37.00
40	**JVB-2530**	32.94	41.36	32.65	43.93	37.72	40.46	37.73	34.99	37.35	37.63
41	**JVB-2531**	49.42	38.95	35.43	38.95	40.69	42.87	39.44	38.41	42.43	40.79
42	**JVB-2532**	41.60	41.74	42.30	40.62	41.56	52.44	50.40	51.97	52.33	51.78
43	**JVB-2533**	31.03	42.81	33.79	32.15	34.95	43.00	45.31	40.31	38.39	41.75
44	**JVB-2534**	46.13	35.57	41.04	38.45	40.30	50.49	52.37	50.45	50.36	50.92
45	**Kaushal**	30.29	29.37	31.80	35.95	31.85	40.55	35.29	35.43	37.29	37.14
46	**GG-20**	41.64	41.95	42.17	42.55	42.08	46.22	46.36	46.47	46.51	46.39
47	**GJG-22**	46.81	46.16	46.03	40.36	44.84	37.40	37.45	38.18	42.44	38.87
48	**GG-HPS-2**	32.10	33.15	37.82	44.42	36.87	32.03	34.30	35.43	35.05	34.20
49	**ICGV-86564**	49.44	40.07	38.72	43.85	43.02	35.61	38.34	34.35	33.40	35.43
50	**BAU-13**	51.53	40.73	34.15	45.70	43.03	28.20	30.28	27.63	29.47	28.90
	G.M.	40.85	41.94	39.45	40.31	40.64	36.72	36.77	36.64	36.11	36.56
	S.Em ±	2.09	2.89	2.57	2.40	0.72	1.96	1.79	1.83	1.75	0.53
	CD at 5 %	5.87	8.11	7.22	6.74	-	5.50	5.03	5.12	4.92	-
	CV %	8.86	11.93	11.29	10.32	-	9.25	8.43	8.63	8.41	-

Mean performance for oil content (%)

		Oil content (%)				
Sr. No.	**Genotype**	**E_1**	**E_2**	**E_3**	**E_4**	**Mean**
1	**JSSP-59**	50.24	51.26	49.15	50.14	50.20
2	**JSSP-60**	49.38	48.28	50.30	49.38	49.34
3	**JSSP-62**	50.41	49.36	51.12	50.11	50.25
4	**JSSP-63**	51.34	50.22	49.25	49.68	50.12
5	**JVB-2453**	50.22	49.23	48.20	49.56	49.30
6	**JVB-2483**	48.52	49.16	50.11	50.27	49.51
7	**JVB-2486**	51.20	50.20	52.17	51.42	51.25
8	**JVB-2489**	52.29	51.20	50.24	51.46	51.30
9	**JVB-2494**	53.24	52.09	51.17	52.49	52.25
10	**JSSP-LS-61**	50.21	49.25	48.18	49.32	49.24
11	**JVB-LS-2436**	48.25	48.35	49.14	48.86	48.65
12	**JVB-LS-2373**	47.18	48.32	49.32	48.57	48.35
13	**JVB-LS-2501**	46.61	47.25	48.13	47.12	47.28
14	**JVB-LS-2502**	49.22	48.25	50.14	49.58	49.30
15	**JVB-LS-2505**	46.16	47.22	48.29	47.59	47.31
16	**JVB-LS-2506**	46.24	47.25	48.17	47.51	47.30
17	**JVB-LS-2507**	51.27	50.17	49.27	50.07	50.20
18	**JVB-2508**	53.20	54.23	52.44	53.36	53.31
19	**JVB-2509**	51.24	50.17	52.22	51.47	51.28
20	**JVB-2510**	50.36	51.20	49.30	49.86	50.18
21	**JVB-2511**	53.26	52.09	51.37	52.13	52.21
22	**JVB-2512**	52.16	53.24	51.22	52.43	52.26
23	**JVB-2513**	55.18	54.20	53.25	54.17	54.20
24	**JVB-2514**	51.27	50.23	52.22	51.49	51.30
25	**JVB-2515**	47.27	48.38	49.15	48.57	48.34
26	**JVB-2516**	52.23	51.23	53.05	52.46	52.24
27	**JVB-2517**	53.16	52.20	51.41	52.44	52.30

Contd…

		Oil content (%)				
Sr. No.	**Genotype**	**E_1**	**E_2**	**E_3**	**E_4**	**Mean**
28	**JVB-2518**	52.17	53.15	51.24	52.34	52.23
29	**JVB-2519**	53.05	52.19	54.11	53.49	53.21
30	**JVB-2520**	51.09	50.12	49.32	50.21	50.18
31	**JVB-2521**	53.04	52.08	51.22	52.37	52.18
32	**JVB-2522**	49.36	50.25	48.23	49.51	49.34
33	**JVB-2523**	49.23	48.11	50.20	49.37	49.23
34	**JVB-2524**	51.23	52.34	50.25	51.49	51.33
35	**JVB-2525**	52.15	51.28	50.20	51.35	51.25
36	**JVB-2526**	52.31	51.26	53.15	52.64	52.34
37	**JVB-2527**	53.14	52.24	51.21	52.34	52.23
38	**JVB-2528**	51.21	50.21	52.18	51.46	51.27
39	**JVB-2529**	52.24	53.16	51.42	52.49	52.33
40	**JVB-2530**	50.28	49.25	48.29	49.31	49.28
41	**JVB-2531**	51.20	50.07	49.12	50.18	50.14
42	**JVB-2532**	49.36	50.22	51.22	50.63	50.36
43	**JVB-2533**	48.19	49.21	50.23	49.56	49.30
44	**JVB-2534**	53.25	52.30	54.21	53.49	53.31
45	**Kaushal**	50.23	49.19	48.24	49.21	49.22
46	**GG-20**	50.31	51.27	52.15	51.28	51.25
47	**GJG-22**	51.13	50.07	49.23	50.33	50.19
48	**GG-HPS-2**	46.11	45.38	47.24	46.31	46.26
49	**ICGV-86564**	52.27	51.19	50.13	51.49	51.27
50	**BAU-13**	49.37	52.15	51.13	50.47	50.78
	G.M.	50.66	50.42	50.44	50.66	50.54
	S.Em ±	0.42	0.41	0.41	0.56	0.13
	CD at 5 %	1.17	1.16	1.16	1.58	-
	CV %	1.43	1.42	1.41	1.93	-