# EVALUATION OF MINICORE COLLECTION OF GROUNDNUT UNDER ORGANIC AND INORGANIC FERTILIZER MANAGEMENTS

**PAPANA APARNA**
**B.Sc. (Ag.)**

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

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**BY**

**PAPANA APARNA**
**B.Sc. (Ag.)**

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

**CHAIRPERSON: Dr. M. SHANTHI PRIYA**

**DEPARTMENT OF GENETICS AND PLANT BREEDING
SRI VENKATESWARA AGRICULTURAL COLLEGE, TIRUPATI
ACHARYA N.G. RANGA AGRICULTURAL UNIVERSITY
GUNTUR–522 509**
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# DECLARATION

I, **Ms. P. APARNA** hereby declare that the thesis entitled **"EVALUATION OF MINICORE COLLECTION OF GROUNDNUT UNDER ORGANIC AND INORGANIC FERTILIZER MANAGEMENTS"** submitted to the **Acharya N.G. Ranga Agricultural University** for the award of degree of **Master of Science in Agriculture** is the result of original research work done by me. I also declare that no material contained in the thesis has been published earlier in any manner.

Place :                                                                 **(P. APARNA)**

Date :                                                        **I.D. No.: TAM/2015-029**

# CERTIFICATE

**Ms. P. APARNA** has satisfactorily prosecuted the course of research and that thesis entitled **"EVALUATION OF MINICORE COLLECTION OF GROUNDNUT UNDER ORGANIC AND INORGANIC FERTILIZER MANAGEMENTS"** submitted is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination. I also certify that neither the thesis nor its part thereof has been previously submitted by her for a degree of any university.

Place : Tirupati

Date :

(**Dr. M. SHANTHI PRIYA)**

Associate Professor
Dept. of Genetics and Plant Breeding
S.V. Agricultural College
**Tirupati – 517 502, A.P.**

# CERTIFICATE

This is to certify that the thesis entitled **"EVALUATION OF MINICORE COLLECTION OF GROUNDNUT UNDER ORGANIC AND INORGANIC FERTILIZER MANAGEMENTS"** submitted in partial fulfillment of the requirements for the award of degree of **MASTER OF SCIENCE IN AGRICULTURE** to the Acharya N.G. Ranga Agricultural University, Guntur, is a record of the bonafide research work carried out by **P. APARNA,** under our guidance and supervision.

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

**Thesis approved by the Student's Advisory Committee:**

**Chairperson** : **Dr. M. SHANTHI PRIYA** ______________
Associate Professor
Dept. of Genetics and Plant Breeding
S.V. Agricultural College
Tirupati – 517 502, A.P.

**Member** : **Dr. D. MOHAN REDDY** ______________
Professor
Dept. of Genetics and Plant Breeding
S.V. Agricultural College
Tirupati – 517 502, A.P.

**Member** : **Dr. P. LATHA** ______________
Scientist
Dept. of Crop Physiology
RARS
Tirupati– 517502, A.P.

**Date of final viva-voce:**

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**Aparna...✍**

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# LIST OF SYMBOLS AND ABBREVIATIONS

| | | |
|---|---|---|
| % | : | Per cent |
| 100SW | : | Hundred seed weight |
| ANOVA | : | Analysis of variance |
| CIMMYT | : | International Centre for Wheat and Maize Improvement |
| cm | : | Centimetre |
| CV | : | Co-efficient of variation |
| DF | : | Days to 50 % flowering |
| DM | : | Days to maturity |
| *et al.,* | : | And others |
| FYM | : | Farm yard manure |
| g | : | Gram |
| G × E | : | Genotype × environment interaction |
| $g\ kg^{-1}$ | : | Gram per kilogram |
| GA | : | Genetic advance |
| GAM | : | Genetic Advance as percent of Mean |
| GCV | : | Genotypic Co-efficient of variation |
| $h^2_{(bs)}$ | : | Heritability in broad sense |
| Ha | : | Hectare |
| HI | : | Harvest index |
| *i.e.* | : | That is |
| ICAR | : | Indian Council of Agricultural Research |
| ICRISAT | : | International Crops Research Institute for the Semi-Arid Tropics |
| Kg | : | Kilogram |
| KYP | : | Kernel yield per plant |

| | | |
|---|---|---|
| M ha | : | Million hectares |
| M t | : | Million tonne |
| mg $g^{-1}$ | : | Milligram per gram |
| ml $l^{-1}$ | : | Millilitre per litre |
| NIMP | : | Number of immature pods per plant |
| NMP | : | Number of mature pods per plant |
| NPB | : | Number of primary branches per plant |
| NPEGP | : | Number of pegs per plant |
| NPP | : | Total number of pods per plant |
| PCV | : | Phenotypic Co-efficient of Variation |
| *Per se* | : | As such with mean |
| PH | : | Plant height |
| PYP | : | Pod yield per plant |
| R | : | Simple correlation co-efficient |
| RARS | : | Regional Agricultural Research Station |
| S. No | : | Serial number |
| SCMR | : | SPAD Chlorophyll Meter Reading |
| SMK | : | Sound mature kernel |
| SP | : | Shelling percentage |
| SPAD | : | Soil Plant Analysis Development |
| t $ha^{-1}$ | : | Tonnes per hectare |
| *viz.*, | : | Namely |

| | | |
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# ABSTRACT

The present investigation was undertaken to generate information on variability and genetic parameters, character association and path analysis in 168 genotypes and five checks of groundnut under organic and inorganic fertilizer managements separately. The experiment was conducted at dryland farm of S.V. Agricultural college, Tirupati, during *kharif* 2016.

Analysis of variance in respect of 14 characters revealed the existence of significant differences among the entries for all the characters under both organic and conventional fertilizer managements except for number of primary branches per plant, shelling percentage and harvest index which were non-significant under organic fertilizer management and significant under inorganic fertilizer management indicating the presence of considerable amounts of genetic variation for different traits in the present material. Based on mean performance the genotypes viz., ICG-13099, ICG-13942, ICG-13723, ICG-10384 and ICG-11687 under organic management whereas under inorganic fertilizer management the genotypes viz., ICG-434, ICG-13942, ICG-11651, ICG-12879 and ICG-332 were found promising for yield and its contributing characters.

The high estimates of GCV and PCV were recorded for number of immature pods per plant, kernel yield per plant, pod yield per plant, number of mature pods per plant, number of pegs per plant, total number of pods per plant under both the managements; for 100 seed weight and plant height under organic management and for number of primary branches per plant under inorganic fertilizer management indicated the presence of genetic variability for these traits and less influence of environment.

High heritability coupled with high genetic advance as per cent of mean was observed for the characters days to 50% flowering, 100 kernel weight, plant height, number of mature pods per plant, number of immature pods per plant and total number of pods per plant under both the fertilizer managements. Similarly high heritability coupled with high genetic advance as per cent of mean was observed for pod yield per plant under organic management and for number of primary branches per plant and shelling percentage under inorganic fertilizer management. This indicated the preponderance of additive gene action and selection may be rewarding for improvement of these traits. Further, moderate heritability coupled with high genetic advance as per cent of mean was observed for number of pegs per plant, kernel yield per plant and sound mature kernel percentage under both the fertilizer managements, while the traits viz., harvest index and pod yield per plant also recorded moderate heritability coupled with high genetic advance as per cent of mean under inorganic fertilizer management. Improvement can be brought about in these traits through simple pedigree method of breeding and phenotypic selection would be effective.

The character association analysis revealed that significant positive association of harvest index, 100 seed weight, number of mature pods per plant, total number of pods per plant, shelling percentage, number of pegs per plant and kernel yield per plant with pod yield per plant under both the fertilizer managements, indicating the possibility for simultaneous selection of these characters would result in improvement of pod yield in the genotypes under both organic and inorganic fertilizer managements.

Path analysis revealed that kernel yield per plant under organic management and kernel yield per plant and total number of pods per plant under inorganic fertilizer management recorded high positive direct effects on pod yield per plant. Thus, emphasis could be given for these characters during selection in order to improve pod yield under both organic and inorganic fertilizer managements.

# Chapter – I

# Introduction

## Chapter I

# INTRODUCTION

Groundnut (*Arachis hypogaea* L.) (2n = 40), highly self-pollinated legume crop grown in tropical and sub-tropical regions of the world, isa good source of oil and protein. It is a segmental allotetraploid, belongs to family fabaceae. It is the major oilseed crop in India and Andhra Pradesh. Groundnut is considered as king of vegetable oilseeds and also called as wonder legume. This annual legume is native to South America (Brazil), but now grown throughout the tropical and warm temperate regions of the globe between latitudes 40° N to 40° S.

Groundnut seeds are the rich source of edible oil and protein. The seeds contain about 36-54 per cent oil, 22-36 per cent protein and 18 per cent carbohydrates and are rich source of B-complex vitamins, especially thiamine and nicotinic acid but deficient in fat soluble vitamins A and D and almost lacking vitamin C. Groundnut oil contains a higher proportion of unsaturated fatty acids including essential fatty acids like linolenic acid and linoleic acids (Desai *et al*., 1999).

China and India are the leading groundnut producers followed by USA and Nigeria. In India, groundnut is cultivated in an area of 4.4 M ha with a production of 7.15 M t and productivity 1610 kg $ha^{-1}$. In Andhra Pradesh, it is grown in area of 0.77 M ha with a production of 0.78 M t and productivity of 1017 kg $ha^{-1}$ (AICRP, 2016)

Introduction of high yielding varieties and intensive farming had led to the increased use of chemical fertilizers and pesticides. Continuous and increased/ indiscriminate use of sole chemical fertilizers leads to several harmful effects on the soil environment, ground and surface water, and even atmospheric pollution, reducing the productivity of the soil by affecting soil health. Therefore, it is imperative to find out the economically viable, environmentally friendly and sustainable system of farming. One such efficient and alternative agriculture system that will help to overcome such problems of soil degradation, declining of soil fertility, over exploitation of natural resources and excessive chemicalization of agriculture is organic farming.

Recently, people are focussing on environmental safety and food quality which can be obtained through organic farming. Demand is also more for organic produce in national and international markets. Hence, organic farming is gaining increased significance in recent years. As a consequence, there is a growing demand for varieties adapted to organic and/ or low external input farming. But the major constraint is the lack of suitable varieties specifically bred for organic farming to get higher productivity and better quality. Varieties selected under conventional agricultural management practices may not possess traits that allow for optimal production in organically managed systems (Dawson *et al*. 2011).

Organic agriculture still depends strongly on conventional plant breeding. The different requirements for varietal characteristics clearly highlight the importance of breeding and selecting varieties suitable for organic farming. In several circumstances, varieties that perform well in organic systems have different yield rankings than those that do well under conventional management. Hence, it would be a challenge for the plant breeding community to develop cultivars for the organic situations. In organic agriculture, the immediate need is to make available greater quantity of organically produced seed. The future of organic breeding may in fact include organic varieties bred solely for the intent of organic farming.

The pre-requisite for crop improvement programme is the presence of genetic variability that allows identification of favourable genes in the germplasm that can be incorporated in the breeding programmes to develop promising cultivars. Germplasm contains a vast reservoir of genetic variability, which would help to broaden the genetic base of the cultivars. Though germplasm contains a great amount of genetic diversity, it has not been extensively used in cultivar development (Knauft and Gorbet 1989).

The size of the germplasm collection has limited its use because of the costs associated with screening all the accessions for different traits that could be used in cultivar development. To overcome this problem Frankel and Brown (1984) designed the strategy of core collection. A core collection is a subset of accessions from the entire collection that captures most of the available genetic diversity of the species (Brown, 1989). Further, Upadhyaya and Ortiz (2001) suggested a strategy for sampling entire core collections for developing a mini core subset, that contains about one per cent of total accessions but is representative of the diversity of the collection. The mini core collection, because of its drastically reduced size, can be evaluated extensively to select useful parents. Hence, in the present investigation 168 germplasm lines of mini core collection were evaluated under both organic and inorganic fertilizer managements for the identification of useful parents that can be utilized in the breeding programme for development of cultivars suitable for the target environment.

The estimates of different genetic parameters are important for better understanding of the genetic variability available in the base material. Large spectrum of genetic variability among genotypes with suitable selection criteria offers better scope for selection of appropriate genotypes under target environments.

Further, information on association of characters would help in developing efficient breeding programme in the target environment which can be achieved through the studies of correlation coefficients and path coefficients. Correlation studies improve the efficiency of selection, whereas path coefficient analysis indicates separation of direct and indirect effects via other related characters by partitioning the correlation coefficients. This facilitates the plant breeders in identifying traits that are useful as selection criteria to improve crop yield under target environment through correlated response.

Keeping in view the above perspectives, the present research work was conducted with the following objectives:

1. To estimate the genetic parameters for yield, quality and their contributing characters under organic and inorganic fertilizer managements.

2. To study the extent of association existing among different component characters with yield and among themselves under organic and inorganic fertilizer managements.

3. To study the direct and indirect contributions of each component character towards yield under organic and inorganic fertilizer managements.

# Chapter – II

# Review of Literature

# Chapter II

# REVIEW OF LITERATURE

The available literature related to the objectives of present investigation in groundnut (*Arachis hypogaea* L.) was reviewed briefly and presented under the following headings.

## 2.1 COMPARATIVE STUDIES AND SELECTION STRATEGIES FOR DIFFERENT FERTILIZER MANAGEMENTS

Groundnut (*Arachis hypogaea* L.) is an annual herbaceous legume crop grown mostly in tropical, sub-tropical and warm temperature regions of the world, which are located between $40^0$ N to $40^0$ S. It is a rich source of edible oil (40-55 %) and protein (22-28 %). The ever increasing cost of chemical fertilizer has made us to realize once again that organic material will have to be utilized judiciously to maintain and improve the soil fertility and productivity and thus organic farming in recent years is gaining importance due to its realization of inherent advantages with maintenance of dynamic soil nutrient status and better price for the produce. Further, present days, a lot of emphasis is being given by ICAR in identifying organic responsive crops in the light of organic agriculture. Organic farming is gaining in recent years as it sustains crop production. Groundnut being an important exportable and edible oil seed crop, there may be large scope, if cultivated organically, in the international market. But the cultivars bred for conventional faming systems do not always perform well under organic farming conditions (Herrera and Ortiz 2015). Hence, there is a need to breed groundnut varieties especially for organic systems. Development of cultivars adapted to organic farming conditions can be successfully achieved if plant breeding programmes combine the selection of the progeny in optimal and organic or low-input environments

Since the available literature under different fertilizer managements is limited in groundnut, a brief description of current conditions in organic and conventional agriculture in a variety of crop species that has been done by several research workers was reviewed here under.

Matiwade and Sheelavantar (1994) evaluated the impact of green manuring with *Sesbania rostrata* and proportions of N- application on growth analysis of rice under irrigated conditions and reported that grain yield produced with green manuring of *Sesbania rostrata* alone was equal to or more than that of the recommended dose of nitrogen and these results were attributed to increased dry matter production and leaf area index.

Evaluation of different sources of organic manures on rice crop by Chitra and Janaki (1999), recorded highest grain and straw yields with green leaf manure *(Gliricidia)* followed by composted coir pith.

In groundnut, Subrahmaniyan *et al*. (2000) reported that application of FYM at 10 to 15 t $ha^{-1}$ increased the pod and haulm yields and improved the yield parameters like shelling percentage, 100 seed weight and sound mature kernel compared to the recommended dose of fertilizers.

Aquino and Fernandez (2001) studied different mungbean seed lots for their productivity and seed quality under organic and conventional production system and reported that organic fertilizers such as poultry manure and gliricidia leaves are effective fertilizer sources to obtain high mungbean seed yield and seed quality.

Perenzin and Matteis (2004) after evaluation of 20 soft wheat varieties at 16 locations inferred that most of the varieties showed better yields in organic cultivation with good grain quality. They concluded that new variety can perform well, if selected for their resistance to pest and adverse conditions. Further they indicated that increasing yield in organic systems through breeding would require direct selection within organic systems rather than indirect selection in conventional systems.

Murphy and Jones (2007) assessed 35 advanced breeding lines of wheat under two contrasting systems; organic and conventional systems and reported that breeding lines showed statistically significant difference in change of rank for yield and genotype by system interactions. Their results also supported the argument for the need to select varieties for organic agriculture in an organic production system in order to optimize yield potential.

Murphy *et al.* (2007) observed that the higher yielding soft white winter wheat genotypes in conventional systems were not higher yielding genotypes in organic systems. ANOVA for yield under these two systems showed highly significant G x E interactions in four of five locations when 35 genotypes of wheat were evaluated under organic and conventional systems. Finally, they concluded that increasing yield in organic systems through breeding would require direct selection within organic systems rather than indirect selection in conventional systems.

Lorenzana and Bernardo (2008) evaluated testcrosses of 119 intermated B73 x Mo17 recombinant inbreds in organic and conventional systems and revealed that organic system led to a smaller test cross genetic variance for grain yield and higher test cross genetic variances for all other traits. The organic system led to a lower heritability for grain yield and a higher heritability for root lodging, stay green and ear height. The predicted ratio between the correlated response and direct response to selection in the organic system was near 1.0 for grain yield and moisture and considerably less than 1.0 for other traits. These results suggest that high yielding cultivars for organic systems could be developed largely by screening conventional inbreds and hybrids for their performance under organic systems.

Kirk *et al.* (2008) evaluated wheat populations, chosen under both organic and conventional breeding programmes and obtained significantly higher yields under organic management than the conventionally selected populations. Under organic system yield, protein and 100-kernel weight of organically selected wheat was significantly higher than that of conventionally selected wheat indicating that selection under conventional management would not result in identifying the best lines for organic cropping systems.

Test cross performance of four different material groups of preselected lines of maize was assessed by Messmer *et al*. (2010) under organic farming and conventional farming systems for breeding new varieties optimally adapted to organic farming. Their results indicated that grain yield and grain dry matter yields were relatively less under organic farming compared to conventional farming. Phenotypic correlations between organic farming and conventional farming were small or moderate (0.31 to 0.43) for grain yield while it was strong and highly significant for dry matter content (0.89 to 0.93). Also the genotypes with top grain yields under organic farming did not show this superiority under conventional farming and *vice-versa*. Hence, they concluded that test sites managed by organic farming are indispensable for making maximum progress in developing maize varieties under target environment conditions.

Reid *et al*. (2011) studied 76 $F_6$ derived RILs from a cross between Canadian hard red spring wheat cultivar AC Barrie and the CIMMYT derived cultivar Attila on conventionally and organically managed lands in 12 environments over 3 years. Their results suggested that selection differences would occur across multi-location tests, and that selection for grain yield in organic systems should be conducted within organic systems.

Two traditional red rice varieties Jaddu and Hasoodi were evaluated by Saritha *et al*. (2013) for nutritional and cooking quality under organic and conventional farming systems and observed significant differences for the characters viz., 100 grain weight, grain length and breadth, length/breadth ratio and bulk density (g $ml^{-1}$). Evaluation for chemical composition showed that the organically grown red rice contains higher contents of protein, crude fibre, iron, zinc, manganese, polyphenols and antioxidant activity compared to conventionally grown red rice varieties. They concluded that the organically grown red rice had the potential to produce higher quality products with relevant improvements in terms of contents of anti-oxidants, phytonutrients and minerals with no pesticidal residues.

Renaud *et al.* (2014) evaluated 23 broccoli cultivars in order to compare horticultural trait performance under organic and conventional managements in two regions of the United States, including spring and fall trials (seasons) and noticed that cultivars with both greater head weight and stability under conventional conditions generally had high head weight and stability under organic growing conditions, but there were exceptions in cultivar rank between management systems. They also observed larger genotypic variances and increased error variances in organic compared with conventional management systems led to repeatability for head weight and other horticultural traits that were similar or even higher in organic compared with conventional conditions. Finally, their results suggested that direct selection in an organic environment could result in a more rapid genetic gain than indirect selection in a conventional environment.

A total of 10 genotypes of groundnut were evaluated by Kenchanagoudar *et al.* (2016) for yield and quality traits under organic, inorganic and integrated cultivation to identify the genotype suitable for organic farming and recorded higher pod yield coupled with disease resistant of LLS and rust in organic cultivation in Dh 4-3, GPBD 4 and TGLPS-3. Test weight was significantly higher in Mutant-III and GPBD-5. The oil content was significantly more in GPBD 4 and TGLPS 3 followed by Dh 86, Dh 4-3, JL 24 and mutant II. The genotypes GPBD 4, Dh 4-3, Dh 2000- 1 and GPBD 5 recorded high protein content in organic cultivation.

Finally, they identified three genotypes Dh 4-3, TGLPS 3 and GPBD 4 that suitable for organic farming. These genotypes performed very well under organic and integrated compared to inorganic cultivation practices

## 2.2 VARIABILITY AND GENETIC PARAMETERS UNDER NORMAL MANAGEMENT

The success of any breeding programme depends on the amount of variability present for different characters in a population. A plant population with higher genetic variability provides greater opportunity for improvement. The genetic coefficient of variability gives an useful measure of the magnitude of genetic variance present in the population. The amount of genetic variation considered alone will not be of much use to the breeder unless supplemented with the information on heritability estimate, which gives a measure of the heritable portion of the total variation. It has been suggested by Burton and Devane (1953) that GCV along with heritability estimate could provide a better picture of the amount of advance to be expected by phenotypic selection. Since genetic advance is dependent on phenotypic variability and heritability in addition to selection intensity, the heritability estimates in conjunction with genetic advance will be more effective and reliable in predicting the response to selection (Johnson *et al*., 1955a).

Patil *et al.* (1982) estimated genetic parameters for eight characters in 32 strains of groundnut and observed high estimates of phenotypic and genotypic co-efficients of variation for number of secondary branches followed by yield per plant, number of developed pods per plant and number of pegs per plant. All the characters studied exhibited high heritability. They also noticed high heritability accompanied with high genetic advance as per cent of mean for all the characters studied, except number of primary branches per plant indicating involvement of additive gene action and more scope for their improvement through selection.

Kandaswami *et al*. (1986) in a study involving 12 Spanish bunch groundnut varieties recorded higher heritability estimates for plant height, number of secondary branches, pod to peg ratio and number of primary branches; moderate heritability estimates for number of mature pods, number of nodes on main stem axis, sound mature kernel per cent, shelling per cent, harvest index and pod yield; and low heritability estimates for weight of mature pods, 100 kernel weight and 100 pod weight. Further, they also reported high GCV values for number of secondary branches, plant height and pod yield; high genetic gain for number of secondary branches and plant height. Whereas shelling per cent, number of nodes on main stem axis and weight of mature pods recorded lowest genetic gain.

Rao *et al*. (1988) assessed 208 accessions of groundnut germplasm for 14 characters and observed high heritability estimates for oil content, followed by number of primary branches, number of nodes on first primary branch and number of pegs. Low heritability was recorded for pod yield. Further, they revealed that the characters viz., number of primary branches, pegs number and peg to flower ratio which showed high heritability, high GCV values and high expected genetic gain and thus are important for direct selection to improve yield.

Fifty virginia groundnut genotypes were evaluated by Manoharan and Ramalingam (1993) and they noticed high PCV values than GCV for all the characters studied. High heritability for height of the main stem, 100 pod and kernel weights, shelling and oil percentages and days to 50% flowering showed that they are less influenced by the environment. They also observed higher heritability and genetic advance estimates for height of the main stem, 100 pod and kernel weights indicating that these traits are controlled by additive gene action and hence phenotypic selection can be exercised to improve the traits.

Uddin *et al.* (1995) evaluated 23 groundnut genotypes and observed high GCV for seed yield per plant, number of seeds per plant, primary branches per plant, plant height and 100-seed weight. They also recorded low heritability and moderate genetic advance for days to maturity and shelling percentage.

Francies and Ramalingam (1996) studied $F_2$ generation raised from 55 selected $F_1$s obtained from 8 interspecific hybrid derivatives and found low estimates of heritability for almost all the traits studied. They noticed that the number of primaries, number of secondary's and nodes on primary branch possessed low heritability coupled with medium estimates of genetic advance indicating the involvement of both additive and non-additive gene action. Moderate heritability accompanied by low genetic advance was observed for oil content.

Jayalakshmi *et al.* (1998) studied the extent of genetic variability, heritability and genetic advance for important physiological traits contributing water use efficiency among $F_4$ progenies of eight crosses of groundnut and identified high heritability and moderate genetic advance for specific leaf area and harvest index in ICGV 86031 x JL 24 and high heritability and greater genetic advance for total dry matter in ICGV 86031 x TG 26, TAG 24 x TPT-1 and ICGV 86031 x TAG 24 which indicated the presence of additive gene effects and inferred that crosses offer greater scope for improvement of these traits through phenotypic selection. They also identified TAG 24 x TPT-1 and TG 26 x JL 24 as superior crosses for improvement of pod weight.

In a study involving 13 geographically diverse peanut genotypes Khan *et al*. (2000) reported low heritability value for seeds per pod and high heritability value for 100-kernel weight.

Nath and Alam (2002) in a study involving 15 groundnut genotypes along with local check (Dhaka-1) recorded high estimates of GCV, heritability and genetic advance as per cent of mean for plant height, pods per plant, harvest index and pod yield per plant. They concluded that these characters could be further improved through individual plant selection.

Jayalakshmi and Reddy (2003) analysed 21 groundnut hybrids and substantial genetic variability was noticed for shoot biomass, harvest index and immature pod number per plant. High heritability and high genetic advance observed for these attributes was indicative of predominance of additive gene action for these traits.

Genetic parameters studies involving 15 $F_1$s of groundnut by Suneetha *et al.* (2004) revealed high heritability coupled with moderate genetic advance as per cent of mean for pod yield per plant and high heritability coupled with low genetic advance as per cent of mean for shelling per cent, sound mature kernel per cent and oil per cent indicating the predominance of non-additive gene action for shelling percentage and sound mature kernel per cent.

John *et al*. (2005) studied four $F_1$ crosses and parents and observed high estimates of PCV and GCV, heritability and genetic advance as per cent of mean for number of secondary branches per plant, number of mature pods per plant and pod yield per plant. Their results indicated the role of additive gene action and usefulness of phenotypic selection for bringing improvement of those traits.

Parameshwarappa *et al.* (2005) analysed 48 diverse large seeded groundnut genotypes and indicated higher genetic variability for number of primary branches, pod yield per plant, kernel yield and plant height. In their study considerable variability was also noticed for number of pods, 100-kernel weight, seed size and protein content.  However, variability observed for oil content and sound mature kernels was low. High heritability coupled with genetic advance was noticed in respect of kernel yield, sound mature kernels and 100-kernel weight indicating that additive genes govern these characters. The extent of genetic advance was quite low for kernel size, protein content and oil content indicating that these traits are influenced by environment.

Fifty seven groundnut genotypes were evaluated by Mahalakshmi *et al*. (2005) for genetic parameters and found that high heritability coupled with high genetic advance were recorded for number of secondary branches, number of unproductive pegs, number of immature pods, number of mature pods, total number of pods, total number of gynophores, maturity index, shelling percentage and 100-kernel weight. Their results indicated the governance of these characters by additive genes.

John *et al*. (2006) evaluated 100 groundnut germplasm accessions for seven characters and observed high GCV and PCV values for pod yield per plant, late leaf spot, rust, jassids and thrips damage and high heritability estimates for all the characters ranging from 66.89% (SCMR) to 96.11% (plant height). They also noticed high heritability along with high GAM for almost all the characters studied which indicated the importance of additive gene action in the inheritance of these characters, hence phenotypic selection would be effective for improvement of these characters.

Kadam *et al*. (2007) studied 40 groundnut genotypes to assess the amount of genetic variation, heritability and genetic advance with respect to pod yield and reported high heritability coupled with high genetic advance for pod yield and kernel yield.

Sudhir *et al*. (2008) conducted studies on 64 genotypes of groundnut for 14 quantitative characters and noticed that the estimates of PCV and GCV were moderate for plant height, mature pods per plant, pod yield per plant, kernel yield per plant, shelling percentage, 100- kernel weight, harvest index and specific leaf area. They also noticed that high heritability coupled with high genetic advance was found for all the characters under study except for days to 50% flowering, days to maturity, sound mature kernel per cent and oil content.

John *et al*. (2008)evaluated $F_2$ population of six single crosses and parents and found that plant height, number of secondary branches per plant, number of mature pods per plant, pod yield per plant, kernel yield per plant, haulms yield per plant and harvest index showed high estimates of GCV, PCV, heritability and genetic advance as per cent of mean.

John *et al*. (2009) assessed 60 genotypes of groundnut for 17 characters and reported that the estimates of PCV and GCV were high for the characters *viz.,* number of secondary branches per plant, number of immature pods per plant, number of mature pods per plant, pod yield per plant, shelling out turn, 100- kernel weight, sound mature kernel weight, sound mature kernel number, total number of pods, total number of gynophores and reproductive efficiency. Low GCV and PCV were recorded for days to initial flowering, days to 50 % flowering and number of primary branches per plant. Further, high heritability along with high GAM was reported for number of secondary branches per plant, number of immature pods per plant, shelling percentage, 100-kernel weight, sound mature kernel weight, total number of pods, total number of gynophores, maturity index, reproductive efficiency and pod yield.

Korat *et al*. (2009) evaluated 80 diverse groundnut genotypes and found that the estimates of PCV and GCV were high for number of secondary branches per plant and number of aerial pegs per plant. They observed high heritability along with high genetic advance as per cent of mean for number of secondary branches per plant and number of aerial pegs per plant and indicated that these characters were governed by additive gene action.

Meta and Monpara (2010) noticed high magnitude of GCV and PCV for pods per plant, kernel yield per plant and pod yield per plant which indicated large extent of genetic variability for these traits. High heritability was accompanied by high genetic advance for plant height and 100-pod weight, whereas, moderate heritability was associated with high genetic advance and high GCV for pods per plant and kernel yield per plant, indicating involvement of additive gene action for these traits. Pod yield per plant expressed high genetic advance with low heritability, however, its high magnitude of GCV suggested the scope of pod yield improvement by evaluating fifty elite genotypes of bunch groundnut

Thirty four genotypes of groundnut were evaluated by Zaman *et al.* (2011) for genetic variability and genetic parameter studies and observed highest GCV for kernel yield per hectare, followed by kernel yield per plant, branches per plant, immature and mature nuts per plant, 100 kernel weight and plant height. They found high heritability and high genetic advance for the characters *viz.,* kernel yield per plant, followed by kernel yield per hectare, 100 kernel weight, immature and mature nuts per plant, branches per plant, 100 seed weight and plant height.

Thakur *et al*. (2011) found highly significant variations for all the characters in all the genotypes. High PCV was observed for days to 75% flowering, days to maturity, plant height, pods per plant, seeds per pod, 100 seed weight, pod length, pod width, seed length, seed width, shelling percentage and SMK percentage. They also found that the character 100 seed weight showed high heritability with high genetic advance and high genetic advance as percentage of mean. Days to maturity showed high heritability, low genetic advance and genetic advance as percentage of mean by assessing 25 groundnut genotypes for genetic parameters.

Jonah *et al.* (2012) evaluated 12 accessions of bambara groundnut and observed that genotypic and phenotypic coefficient of variation as well broad sense heritability were high for characters such as pod number per plant, pod yield per plant, seed yield per plant, and seed length. Further, they reported that seed length, pod length and pod width recorded 100% broad sense heritability estimates and high genetic advance, indicating that these characters are under additive genetic control.

Noubissie *et al*. (2012) studied varietal differences for protein and oil contents of kernels in 12 groundnut genotypes and analysis of variance revealed significant differences among the studied genotypes for oil and protein contents. These biochemical characteristics were moderately to highly heritable with broad-sense heritability values of 0.52 (oil content) and 0.64 (protein content). Low values of expected genetic advance for oil and protein, showed the preponderance of non-additive gene effects.

Narasimhulu *et al.* (2012) analysed 18 selected groundnut genotypes for nine characters and found that PCV was generally higher than GCV for most of the characters studied but in some cases, the two values differed slightly. They reported low values of PCV and GCV for SMK per cent and shelling percentage, whereas high values for pod yield per plant, kernel yield per plant and test weight. They observed high heritability and high GAM for pod yield per plant, kernel yield per plant, test weight and shelling percentage indicating the importance of additive gene action and the ample scope for improvement of these traits through simple selection.

John *et al*. (2013) studied 37 advanced breeding genotypes of groundnut and observed significant differences among 37 genotypes for all the traits studied and high GCV was recorded for days to 50% flowering. They also recorded high heritability for pod yield per plant. High heritability and high genetic advance as per cent of mean was recorded for plant height, haulms 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 mature pods per plant and 100 pod weight indicating the importance of both additive and non-additive gene action in the inheritance of these characters.

Evaluation of 14 groundnut genotypes for 14 quantitative parameters by Patidar *et al.* (2014) revealed high estimates of both genotypic coefficient of variation and phenotypic coefficient variation (PCV) for seed yield per plant, followed by kernel yield, pod yield per plant, pods per plant and plant height. The high heritability and high genetic advance has been noticed for pod yield per plant and seed yield per plant indicating that these traits are less influenced by the environment. They also recorded high heritability coupled with high genetic advance as per cent of mean for kernel yield indicating predominance of additive gene effect and the possibilities of effective selection for improvement programme.

Shukla and Rai (2014) assessed 30 genotypes of groundnut for yield and quality traits and inferred that the magnitude of PCV and GCV was moderate to high for primary branches per plant at 40 DAS, pod yield, kernel yield, oil yield and oleic acid. Heritability in broad sense was high for most of the characters like oil yield, oleic acid, kernel yield, plant height, pod yield, hundred kernel weight, sound mature kernel %, oil content, days to maturity, field emergence, plant height at 60 DAS, kernel uniformity, pod yield per plant, shelling %, primary branches per plant at 40 DAS, primary branches per plant at 60 DAS and days to 50 % flowering. They also recorded high heritability coupled with high genetic advance for oil yield.

In a study involving 50 groundnut genotypes Rao *et al.* (2014) reported that the magnitude of PCV and GCV was moderate to high for number of pods per plant, plant height, kernel yield, dry pod yield, hundred kernel weight, and dry haulm yield. Further, they reported high heritability coupled with high genetic advance as per cent of mean for hundred kernel weight, dry pod yield, kernel yield, plant height and number of pods per plant indicating the role of additive gene action in expressing these traits and revealed better scope for improvement of these traits through direct selection

Variability studies for 16 plant characters in 58 spanish bunch groundnut genotypes conducted by Patil *et al*. (2014) revealed maximum broad sense heritability for days to 50 % flowering followed by plant height and 100-kernel weight. They also reported moderate to high heritability coupled with moderate to high genetic advance for characters like days to 50 % flowering, plant height, 100-pod weight, 100-kernel weight, shelling percentage and harvest index. Their results indicated the involvement of additive gene action and scope for improvement of these traits through selection.

Satish (2014) noticed high significant variation among the genotypes for all the characters studied, high GCV for number of pods per plant followed by pod yield, 100 kernel weight, number of branches per plant, plant height and days to 50 % flowering in a study involving 16 genotypes of groundnut. Further, high heritability coupled with high genetic advance was reported for the characters number of pods per plant followed by pod yield, 100 seed weight and numbers of branches per plant.

Gupta *et al.* (2015) evaluated 60 diverse genotypes of Virginia groundnut for variability parameters and inferred that PCV and GCV were high for plant height, number of primary branches per plant, number of mature pods per plant, 100-pod weight, 100-kernel weight, biological yield per plant, kernel yield per plant and harvest index. High heritability coupled with high genetic advance expressed as percentage of mean was observed for 100-pod weight, 100 kernel weight, biological yield per plant and kernel yield per plant indicating that these traits were mainly governed by additive gene action and responsive for further improvement of these traits.

Vasanthi *et al*. (2015) studied 29 groundnut cultures and reported that the characters viz., length of main axis, primary branches, 100-seed weight, harvest index and days to emergence had high GCV, heritability and genetic advance as per cent of mean indicating that these characters are under the control of additive gene action. Whereas the traits, number of fully expanded leaves, weight of immature pods per plant and pod yield per plant recorded moderate heritability and high genetic advance, while the traits, leaflet length and width, leaf length and days to 50 % flowering recorded low GCV, high heritability and high GAM indicating the influence of both additive and non-additive gene action.

Genetic variability studies were conducted for physiological traits under intermittent drought stress conditions in 299 RILS along with 2 parents and 8 checks by Srivalli and Nadaf (2016). They noticed low PCV and GCV for all the physiological traits measured at all stages during both the seasons indicating low genetic variation in the population and difference between PCV and GCV for this traits indicated prevalence of environment on these traits during both the seasons. RWC at 30 days after stress and SLA at 7 DAS had moderate to high heritability and genetic advance as per cent of mean, indicating that selection for the drought tolerance based on RWC could be effective at later stages of intermittent stress while based on SLA could be effective only at early stages

Jibrin *et al.* (2016) evaluated 25 groundnut genotypes and reported that the PCV was higher than GCV for all the studied traits portraying the importance of environment in the variation exhibited. Estimate of broad sense heritability were moderate to high for most traits except for seed size that recorded low values. This indicates that selection for traits with high heritability will lead to fast genetic improvement of a trait that is by increasing the frequency of favourable alleles by repeated mass selection or hybridization between selected genotypes.

Bhargavi *et al*. (2016) observed high PCV and GCV for harvest index and pod yield per hectare respectively. High heritability accompanied with high genetic advance as per cent of mean was recorded for number of mature pods per plant, biological yield per plant, pod yield per plant, biological yield per hectare, pod yield per hectare, harvest index, kernel yield per plant, kernel yield per hectare, 100 kernel weight and oil yield per hectare by evaluating twenty diverse genotypes of spanish bunch groundnut for 19 characters. Their results indicated the preponderance of additive gene action in the expression of these traits which may be exploited through simple selection methods.

Rao (2016) conducted studies in 30 groundnut genotypes under drought situation and observed that the magnitude of PCV and GCV was moderate to high for number of pods per plant, dry haulm yield, kernel yield, plant height and dry pod yield. High heritability coupled with high genetic advance as per cent of mean was observed for kernel yield, plant height, dry pod yield, and 100- kernel weight indicating the role of additive gene in expressing these traits.

Eighteen local collections of groundnut, along with checks (TAG -24 and Kopergoan-3) were evaluated by Kamdi *et al.* (2017) for assessment of variability. The analysis of variance revealed significant differences among the genotypes for all of the characters indicating the prevalence of genetic variability. For all traits, phenotypic coefficients of variations were higher than genotypic coefficient of variations. They also observed small differences between genotypic and phenotypic variability for number of mature pods per plant, weight of dry haulm per plant and weight of dry pods suggesting that these characters were less influenced by the environment.

## 2.3 STUDIES ON CHARACTER ASSOCIATION UNDER NORMAL MANAGEMENT

Improving seed yield is the primary objective of a plant breeder in evolving new types in any crop. However, the genotypic and environmental interactions were likely to restrict the improvement of yield which is a complex and quantitatively inherited character. Hence, it becomes difficult to select for this character directly. Therefore, attention has to be bestowed on direct and indirect methods such as determination of character association with seed yield. The existence of type and nature of association is usually determined by studying correlation coefficients. Correlation coefficients measure the degree of association, genetic or non- genetic between any pair of characters and help the plant breeder in timing selection criteria for pod yield in parental lines and segregating populations.

A sound knowledge on the extent of association of yield components with each other and with yield is helpful in improvement of yield for which direct selection is not effective. A brief review of literature on the association of characters in groundnut is presented here under.

Patil *et al.* (1982) conducted correlation studies in 32 strains of groundnut and noticed that yield per plant was positively correlated with number of developed pods per plant, number of primary branches per plant and height of the plant. Negative relationship of yield per plant was observed with number of pegs per plant and number of undeveloped pods per plant. They finally concluded that the significant association between yield per plant and other plant characters viz., number of developed pods per plant, plant height, number of primary and secondary branches per plant were very useful criteria for selecting high yielding strains.

Rao *et al*. (1988) evaluated 208 accessions of groundnut germplasm for association analysis and revealed that pod yield was strongly correlated with plant height, number of primary branches, number of nodes on first primary branch, leaf length, leaf breadth, number of flowers, number of pegs, number of mature pods, peg to flower ratio, and shelling percentage.

In a study of $F_2$ population, Manoharan *et al*. (1993) observed positive and significant association of pod yield with number of primaries, dry matter production, harvest index, pod number and 100- pod weight. Plant height had positive but non-significant association with pod yield. Among the component characters, dry matter production was positively correlated with plant height and number of primaries; pod number was positively associated with number of primaries and dry matter production whereas plant height was negatively correlated with number of primaries. They also noticed that harvest index was negatively associated with plant height and dry matter production which showed that there was no effective partitioning of assimilates. Pod number was negatively correlated with pod weight.

Fifty plants of spanish bunch groundnut genotype Jyoti were studied by Mishra (1995) for eight yield and yield determining characters and observed that pod yield recorded significant and positive association with number of secondary branches, dry matter production, harvest index and number of mature pods.

Uddin *et al.* (1995) conducted association analysis studies in 23 groundnut genotypes and reported significant and positive correlation of seed yield per plant with days to maturity, seeds per plant, plant height and primary branches per plant. However, they also revealed the negative association of seed yield with shelling percentage and 100-kernel weight.

Studies on 25 genetically diverse groundnut genotypes by Hoque and Chowdhury (1997) revealed that 100-pod weight, days to maturity and primary branches per plant were significantly associated with pod yield at the genotypic level.

Francies and Ramalingam (1997) conducted character association studies in the $F_2$ generation of 55 genotypes of groundnut for 17 component characters and revealed that length of primary branch, length of secondary branch, number of secondaries, number of mature pods, number of pegs, kernel yield, and number of kernels were significantly and positively associated with pod yield which indicated that these are important components for improvement of pod yield in groundnut and also the possibility of simultaneous improvement of these traits by selection.

Azad and Hamid (2000) evaluated nine breeding lines of groundnut along with their parent variety and found that pod number, kernel yield and 100- pod weight had significant positive genotypic and phenotypic correlation with pod yield

Jayalakshmi and Reddy (2003) conducted correlation studies in 21 groundnut hybrids and inferred that harvest index, mature pod number per plant and specific leaf area were associated with each other and also with kernel yield, indicating that selection for these attributes will be helpful in improving the productivity of groundnut.

Correlation analysis using 81 genotypes of groundnut for pod yield and oil yield with some of their component characters revealed that the genotypic correlation coefficients were relatively higher in magnitude than the corresponding phenotypic correlation coefficients, indicating strong inherent association between the characters. Their results indicated that pod yield recorded significant positive association with plant height, number of pegs, number of mature pods, kernel yield, test weight and oil yield at both genotypic and phenotypic levels (Lakshmidevamma *et al*. 2004).

Ferreira and Almida (2005) estimated the genetic parameters for agronomic traits of three cultivars and six lines of groundnut and relation between weight of 100- kernels, number of pods per plot, grain yield, number of seeds per pod and pod yield. Their results showed that grain yield was influenced positively by the number of pods per plot and weight of 100-seeds and negatively by the number of seeds per pod.

Mahalakshmi *et al*. (2005) evaluated 57 groundnut genotypes for correlation analysis and revealed significant and positive association of kernel yield per plant with days to 50 % flowering, plant height, number of secondary branches, number of unproductive pegs, number of immature pods, number of mature pods, sound mature kernel weight, sound mature kernel number, total number of pods, total number of gynophores, shelling percentage, 100-kernel weight and pod yield.

Patil *et al*. (2006) conducted correlation analysis in 13 genotypes along with four check varieties (JL-24, GPBD-4, Dh-86 and Dh-3-3-30 ) at six different locations and observed that pod yield per plant had significant positive association with number of pods per plant, shelling percent and sound mature kernel percent in at least three locations.

Venkateswarlu *et al*. (2007) studied 28 $F_1$'s derived out of 8 X 8 diallel mating system involving 8 parents for association analysis and noticed highly significant and positive association of pod yield per plant with harvest index, number of well filled and mature pods per plant and kernel yield per plant, indicating that they could be used as selection criteria for higher pod yield.

Sumathi and Muralidharan (2007) evaluated 48 diverse genotypes of groundnut and observed significant and positive association of pod yield per plant with kernel yield per plant, sound mature kernel weight and 100 seed weight at both genotypic and phenotypic levels.

Fourty five $F_1$'s obtained by crossing 10 different lines of groundnut in diallele fashion were evaluated by Sharma and Gupta (2008) with parents and two checks to estimate correlation for pod yield with yield related attributes and revealed that dry pod yield per plant had significant positive association with number of mature pods, kernel yield, shelling percent, harvest index and chlorophyll content in parents, while in hybrids, number of primary branches was also found to have significant positive association.

Sudhir *et al*. (2008) in a study involving 64 genotypes of groundnut and indicated that oil yield per plant recorded positive and significant association with matured pods per plants and kernel yield per plant.

A study involving 60 genotypes of groundnut for association analysis by John *et al*. (2009) revealed that pod and kernel yields per plant showed significant and positive association with number of secondary branches per plant, number of mature pods per plant, sound mature kernel weight, sound mature kernel number and 100-kernel weight.

Eighty bunch groundnut genotypes were evaluated by Korat *et al*. (2010) and observed that yield contributing characters like biological yield per plant, 100-kernel weight and harvest index had positive and significant association with pod yield per plant at phenotypic level. Phenotypic interrelationship between days to maturity and pod yield per plant was negative and significant. They also noticed that the genotypic correlations of above said yield components with pod yield were also strong and with similar sign.

Zaman *et al.* (2011) conducted correlation studies on 34 genotypes of groundnut and concluded that seed yield per plant showed highly significant and positive association with nut size, number of nuts per plant, kernel size and days to 50% flowering.

Association studies between pod yield and quantitative characters in three varieties of groundnut by Mukhtar *et al*. (2011) revealed that pod yield showed significant and positive association with number of mature pods, number of pods per plant, pod yield per plant, seed yield per plant, haulm yield per plant, hundred seed weight and total dry matter except shelling percentage.

Sadeghi and Niyaki (2012) studied interrelationship between oil yield and its components in 23 peanut genotypes and revealed that seed yield, total number of kernels per plant, plant height and 100- kernel weight had a high positive correlation with oil yield.

Narasimhulu *et al.* (2012) conducted correlation studies involving 18 selected groundnut genotypes for nine characters and found that pods per plant had significant positive association with kernel yield per plant, shelling percentage and sound mature kernel percent at both genotypic and phenotypic levels.

Kumar *et al*. (2012) evaluated 50 genotypes of groundnut and observed that the genotypic correlation coefficients were relatively higher in magnitude than the corresponding phenotypic correlation coefficients, indicating strong inherent association between the characters. They also noted that pod yield recorded significant positive association with kernel yield per plant, mature pods per plant, total pods per plant, harvest index, 100-seed weight, root weight, plant height and shoot weight.

Association analysis studies were carried out by Alam (2014) for pod yield and its yield components characters in 45 genotypes of groundnut and found that pod yield showed significant positive association with secondary branches per plant, harvest index, 100-pod weight, 100-kernel weight, pod size, disease incidence and canopy temperature, indicating that these are important components for improvement of pod yield in groundnut.

Rao *et al.* (2014) analysed 50 groundnut genotypes and revealed that dry pod yield had significant and positive association with kernel yield, number of pods per plant, 100- kernel weight and dry haulm yield.

Shukla and Rai (2014) in a study involving 30 genotypes of groundnut reported that pod yield was positively correlated with kernel yield, pod yield per plant, hundred kernel weight, shelling per cent and kernel uniformity %.

Pavankumar *et al*. (2014) conducted an experiment with 66 genotypes of groundnut and observed that kernel yield was significantly and positively associated with pod yield per plant, number of mature pods per plant, shelling percentage, harvest index, sound mature kernel percentage, specific leaf weight at 60 days after sowing, protein content and oil content.

In a study involving 16 genotypes of groundnut by Satish (2014), significant and positive genotypic correlations of pod yield with number of pods per plant followed by number of branches, days to 50% flowering and 100- kernel weight, whereas with plant height pod yield showed negative and non-significant correlation were recorded.

Bhargavi *et al.* (2015) studied 44 genotypes of groundnut under organic and conventional fertilizer managements and revealed that kernel yield per plant was significantly and positively correlated with days to 50% flowering, primary branches per plant, total number of pods per plant, number of mature pods per plant, pod yield per plant, harvest index, 100-kernel weight and protein content under both the managements, indicating the possibility for simultaneous selection of these characters towards the improvement of kernel yield.

Correlation studies in one groundnut cultivar Mubi white for grain yield and it's various yield characters by Maunde *et al*. (2015) revealed that there is a strong positive correlation between number of pods per plant, 100- kernel weight and harvest index with seed yield.

Significant and positive association of number of mature pods per plant, number of primary branches per plant, and 100-kernel weight with pod yield per plant was determined by Vasanthi *et al*. (2015) in a study of 29 groundnut genotypes.

Correlation analysis were carried out for pod yield and its component characters in 24 genotypes of groundnut by Jain *et al.* (2016) and noticed that genotypic correlation coefficients relatively higher magnitude than the corresponding phenotypic correlation coefficients, indicating strong inherent association between the characters. They also reported that pod yield per plant displayed significant positive association with kernel yield per plant, mature pods per plant and plant height.

Kiranmai *et al.* (2016) conducted correlation studies in 20 elite groundnut genotypes for 15 characters and noticed strong positive association between pod yield per plant and kernel yield per plant, oil yield per plant and significant and negative association with late leaf spot severity and rust incidence irrespective of the environments. Pod yield was also correlated with 100-kernel weight, plant height and oil content in environment III. Further, inter correlation estimates for yield components revealed that plant height, 100-kernel weight, kernel yield per plant, oil yield per plant, late leaf spot severity, 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 in groundnut.

Association analysis studies were conducted by John and Reddy (2016) in 24 $F_1$ 's along with six lines and four testers and inferred that pod yield had significant positive association with SPAD chlorophyll meter reading at 60 days after sowing, harvest index. Non-significant positive association of pod yield with SPAD chlorophyll meter reading at 40 days after sowing, days to maturity, specific leaf area at 60 days after sowing, relative water content at 40 days after sowing and dry haulms yield per plant.

Kamdi *et al.* (2017) evaluated 18 local collections of groundnut, along with checks (TAG -24 and Kopergoan-3) for assessment of correlation. Positive significant genotypic and phenotypic correlations were observed between number of mature pods per plant and weight of dry pods. Height of main axis had positive and significant association with number of primary and secondary branches plant.

## 2.4 STUDIES ON PATH COEFFICIENT ANALYSIS UNDER NORMAL MANAGEMENT

The technique of path analysis was developed by Wright (1921) helps in partitioning of the correlation co-efficients into direct and indirect effects of independent variable on dependant variable. Path coefficient analysis of different components of yield provides complete picture of relative importance of their direct and indirect effects and gives a clear understanding of their association with yield, which were not revealed by correlation studies. Hence, path analysis has been used by plant breeders to assist in identification of traits that are useful as selection criteria to improve crop yield. It was applied in plant breeding for the first time by Dewey and Lu (1959).

The available literature on path coefficient analysis carried out in groundnut was furnished here under.

Manoharan *et al.* (1993) conducted path analysis studies in $F_2$ population of an intersubspecific cross and indicated that both pod number and pod weight had high positive direct effect on yield. They also noticed that the dry matter production and harvest index also had less positive direct on yield. The indirect influence of dry matter production and harvest index via pod number was also positive and high.

Uddin *et al.* (1995) conducted path coefficient analysis for 23 groundnut genotypes and reported that days to maturity, primary branches per plant and nuts per plant had large direct effects on seed yield per plant.

Francies and Ramalingam (1997) assessed 55 genotypes of groundnut in the $F_2$ generation for seventeen component characters and inferred that nodes on main axis, nodes on primary branch and number of kernels were influencing pod yield directly as well as indirectly and the genotypic correlation coefficients for these characters were also positive and highly significant. Hence, an emphasis on these traits in selection for groundnut improvement may be rewarding.

Hoque and Chowdhury (1997) in a study involving 25 genetically diverse groundnut genotypes reported that 100-pod weight, primary branches per plant and mature pods per plant were related with pod yield through direct effects.

Azad and Hamid (2000) conducted path analysis studies in nine breeding lines of groundnut together with their parents and revealed highest direct effect of pod number on pod yield followed by 100-pod weight and kernel yield. Pod number, 100-pod weight and kernel yield contributed significantly both directly and indirectly to pod yield.

Thirteen geographically diverse peanut genotypes were evaluated by Khan *et al*. (2000) and reported that 100-kernel weight had the highest direct effect on pod yield followed by pods per plant, seeds per pod and sound mature kernel percent.

Dashora and Nagda (2002) conducted an experiment with 22 germplasm lines along with one local check to study path analysis for yield and its component traits. They observed high direct effect of shelling percentage and kernel yield on dry pod yield and hence, inferred that these two traits were the major components of dry pod yield.

High direct effects of kernel yield and oil content on pod yield and oil yield, respectively were recorded in a study involving 81 genotypes of groundnut by Lakshmidevamma *et al*. (2004).

Ferreira and Almida (2005) analysed three cultivars and six lines of groundnut and revealed that number of pods per plot was the trait of greatest direct influence on kernel yield.

Patil *et al*. (2006) assessed 13 genotypes along with four checks (JL-24, GPBD-4, Dh-86 and Dh-3-3-30 ) for path analysis at six different locations and concluded that the traits number of pods per plant, shelling percentage and sound mature kernel per cent had maximum direct effect on pod yield per plant at minimum three locations. These results indicated that increase in pod number per plant, shelling per cent and sound mature kernel per cent would improve the pod yield of groundnut.

Venkateswarlu *et al*. (2007) evaluated 28 $F_1$'s derived out of 8 * 8 diallel mating system involving 8 parents and reported high positive direct effects of kernel yield per plant followed by specific leaf nitrogen, root length, shelling percent and number of well filled and mature pods per plant on pod yield indicating that these characters should be given greater emphasis while making selections for higher pod yield.

Path coefficient analysis conducted for 48 diverse genotypes of groundnut by Sumathi and Muralidharan (2007) revealed that kernel yield per plant exerted maximum positive direct effect on pod yield per plant. The traits number of mature pods per plant, sound mature kernel weight and shelling percentage showed negative direct effect on pod yield per plant.

Sudhir *et al*. (2008) determined high direct effects of kernel yield and oil content on oil yield per plant by evaluating sixty four genotypes of groundnut.

Genotypic and phenotypic path analysis were conducted by Korat *et al*. (2010) in 80 bunch groundnut genotypes and found highest positive direct effects of biological yield per plant and harvest index towards pod yield. They also found that 100-kernel weight contributed indirectly via biological yield per plant and harvest index.

Path coefficient analysis studies on 34 genotypes of groundnut revealed that number of mature nuts per plant had high positive direct effect on seed yield per hectare followed by nut size, shelling percentage, days to 50% flowering and days to maturity (Zaman *et al.* 2011).

Mukhtar *et al*. (2011) evaluated three varieties of groundnut to study path analysis between pod yield and quantitative characters and noticed that the total dry matter exhibited highest positive direct effect, followed by hundred seed weight, seed yield per plant, number of mature pods and number of pods per plant, on pod yield.

Sadeghi and Niyaki (2012) evaluated 23 groundnut genotypes in order to study interrelationships among various agronomic traits under drought stress and irrigated conditions and reported that under 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 effects on seed yield. They also noticed that high indirect contribution was via 100-kernel weight and total number of kernels per plant.

Evaluation of 50 genotypes of groundnut for pod yield and its component characters by Kumar *et al*. (2012) revealed high direct effect of kernel yield per plant and harvest index on pod yield. Hence, they suggested that it would be rewarding to give due importance to these characters in selection for rapid improvement in pod yield of groundnut.

In a study involving 66 genotypes of groundnut by Pavankumar *et al*. (2014) pod yield per plant and shelling percentage had high positive direct effect on kernel yield signifying the importance of these traits in the improvement of seed yield. Hence, these characters should be given more importance in the improvement of kernel yield.

Rao *et al.* (2014) studied 50 groundnut genotypes and revealed that kernel yield, days to maturity, number of pods per plant and hundred kernel weight had highest positive direct effects on pod yield. Hence, direct selection criterion should be followed for these traits to improve the pod yield.

Satish (2014) evaluated 16 genotypes of groundnut and reported that pod yield per plant followed by 100 seed weight, number of branches per plant and days to 50% flowering had positive direct effect on number of pods per plant signifying the importance of these traits in the improvement of pod yield.

Path analysis for kernel yield and its various yield characters in groundnut cultivar (Mubi white) revealed harvest index showed highest direct positive effect with kernel yield followed by number of pods per plant while direct effect by number of seeds per pod was negative. Most of the yield characters exhibited highest indirect effect to kernel yield through number of pods per plant and harvest index. Finally they concluded that number of pods per plant and harvest index were the most important yield components which should be exploited through a breeding programme for improving its yield potentials (Maunde *et al*. 2015).

Vasanthi *et al*. (2015) evaluated 29 groundnut cultivars and observed that high positive direct effect on pod yield per plant was exhibited by the traits viz., number of mature pods per plant, length of main axis, 100-seed weight, number of primary branches per plant, number of immature pods per plant, harvest index, weight of immature pods per plant, shelling percentage and days to 50 % flowering.

John and Reddy (2016) analysed 24 $F_1$'s along with six lines and four testers and revealed that, the maximum positive direct effect on pod yield per plant was contributed by days to maturity, SPAD chlorophyll meter reading at 40 days after sowing and 60 days after sowing, specific leaf area at 60 days after sowing, specific leaf area at 40 days after sowing and 60 days after sowing, dry haulms yield per plant and harvest index indicating that these traits are the important yield contributing characters.

High direct effects of kernel yield per plant, plant height and matured pods per plant on pod yield per plant were reported by Jain *et al.* (2016) by evaluating 24 genotypes of groundnut.

Kamdi *et al.* (2017) evaluated 18 local collections of groundnut, along with two checks for path co-efficient analysis and indicated that number of mature pods per plant, number of primary branches per plant and days to 50 % flowering had positive direct effect on weight of dry pods. Hence, proper attention should be given to increase in number of mature pods plant, number of primary branches plant and days to 50 % flowering for improving pod yield of groundnut.

# Chapter – III

# Material and Methods

## Chapter III

# MATERIAL AND METHODS

The experimental materials used and methods followed pertaining to the present investigation are briefly described here under.

### 3.1 LOCATION OF THE EXPERIMENTAL SITE

The present investigation "Evaluation of minicore collection of groundnut under organic and inorganic fertilizer managements" was taken up at dry land farm of Sri Venkateswara Agricultural College, Tirupati during *kharif 2016*, which is located at an altitude of 182.9 m above mean sea level, 13°N latitude and 79°E longitude and situated in southern agroclimatic zone of Andhra Pradesh.

### 3.2 MATERIAL

The experimental material for the present investigation consisted of 168 germplasm lines and five checks viz., Narayani, Dharani, K-6, TCGS-1157 and TCGS-1330 of groundnut were received from ICRISAT, Patancheru and RARS, Tirupati, Andhra Pradesh, respectively. The list of genotypes is presented in Table 3.1.

### 3.3.1 Field Layout

The experiment was laid out in an augmented design II (Federer, 1956) with 168 germplasm lines and five checks during *kharif* 2016 under organic (Plate 1a) and inorganic fertilizer (Plate 1b) managements. The field was ploughed and harrowed until a fine tilth of soil was obtained. The crop was sown on $8^{th}$ July 2016. Under each management practice whole plot was divided into 6 blocks. In each block 28 germplasm lines along with five checks were sown. In each management practice every germplasm line was sown in single row of 2 m length with a spacing of 30 cm between the rows and 10 cm between the plants within the row.

### 3.3.2 Crop Husbandry

In organic management practice, FYM @ of 5 t $ha^{-1}$ at the time of field preparation was applied. Seed treatment was done with *bijamrutha* before one day of sowing. *Jeevamruth* was applied at 15 days interval and *panchagavya* was applied on $25^{th}$ and $35^{th}$ day after sowing and also whenever pest incidence occurred. The details of preparation of *bijamrutham*, *jeevamrutha* and *panchagavya* are given in Appendix A, B and C, respectively.

In inorganic fertilizer management practice, recommended dose of chemical fertilizers @ of 20 kg N, 40 kg $P_2O_5$ and 40 kg $K_2O$ per hectare in the form of urea, single super phosphate and murate of potash were broadcasted before sowing. Seed treatment was done with bavistin @ of 3 g $kg^{-1}$. For the control of insect pests chlorofenopyr @ 2 ml $l^{-1}$ was used.

Except disease and pest control measures, cultural practices like weeding, gypsum (500 kg $ha^{-1}$) application and irrigation were followed in common for both practices to maintain good crop growth.

### 3.3.3 Data Recording

In organic and inorganic fertilizer management practices observations were recorded on randomly chosen five competitive plants in each germplasm line for all the characters (except for oil, protein, total carbohydrates and total free amino acids) considered in the study. The values of five competitive plants were averaged and expressed as mean of the respective characters for each germplasm line. The details of the data are recorded as follows.

**Table 3.1. List of 168 germplasm lines and five checks of groundnut**

| S. No | ICG Number | Origin | Species | Sub species |
|---|---|---|---|---|
| 1 | 36 | India | *hypogaea* | *fastigiata* |
| 2 | 76 | India | *hypogaea* | *hypogaea* |
| 3 | 81 | Unknown | *hypogaea* | *fastigiata* |
| 4 | 111 | Unknown | *hypogaea* | *hypogaea* |
| 5 | 115 | India | *hypogaea* | *fastigiata* |
| 6 | 118 | India | *hypogaea* | *fastigiata* |
| 7 | 163 | Unknown | *hypogaea* | *hypogaea* |
| 8 | 188 | India | *hypogaea* | *hypogaea* |
| 9 | 297 | USA | *hypogaea* | *fastigiata* |
| 10 | 332 | Brazil | *hypogaea* | *fastigiata* |
| 11 | 334 | China | *hypogaea* | *fastigiata* |
| 12 | 397 | USA | *hypogaea* | *fastigiata* |
| 13 | 434 | USA | *hypogaea* | *fastigiata* |
| 14 | 442 | USA | *hypogaea* | *fastigiata* |
| 15 | 513 | India | *hypogaea* | *hypogaea* |
| 16 | 532 | Unknown | *hypogaea* | *hypogaea* |
| 17 | 721 | USA | *hypogaea* | *hypogaea* |
| 18 | 862 | India | *hypogaea* | *hypogaea* |
| 19 | 875 | India | *hypogaea* | *hypogaea* |
| 20 | 928 | Unknown | *hypogaea* | *hypogaea* |
| 21 | 1137 | India | *hypogaea* | *fastigiata* |
| 22 | 1399 | Malawi | *hypogaea* | *fastigiata* |
| 23 | 1415 | Senegal | *hypogaea* | *fastigiata* |
| 24 | 1519 | India | *hypogaea* | *fastigiata* |
| 25 | 1668 | USA | *hypogaea* | *hypogaea* |
| 26 | 1711 | Bolivia | *hypogaea* | *fastigiata* |
| 27 | 1973 | India | *hypogaea* | *fastigiata* |
| 28 | 2019 | India | *hypogaea* | *fastigiata* |
| 29 | 2106 | India | *hypogaea* | *fastigiata* |
| 30 | 2511 | India | *hypogaea* | *hypogaea* |
| 31 | 2772 | Nigeria | *hypogaea* | *hypogaea* |
| 32 | 2773 | Tanzania | *hypogaea* | *hypogaea* |
| 33 | 2777 | India | *hypogaea* | *hypogaea* |
| 34 | 2857 | Argentina | *hypogaea* | *hypogaea* |
| 35 | 2925 | India | *hypogaea* | *hypogaea* |
| 36 | 3027 | India | *hypogaea* | *hypogaea* |
| 37 | 3053 | India | *hypogaea* | *hypogaea* |
| 38 | 3102 | India | *hypogaea* | *fastigiata* |
| 39 | 3240 | Uganda | *hypogaea* | *fastigiata* |
| 40 | 3343 | India | *hypogaea* | *fastigiata* |
| 41 | 3421 | India | *hypogaea* | *fastigiata* |
| 42 | 3584 | India | *hypogaea* | *fastigiata* |

| S. No | ICG Number | Origin | Species | Sub species |
|---|---|---|---|---|
| 43 | 3673 | Korea | *hypogaea* | *fastigiata* |
| 45 | 3746 | Argentina | *hypogaea* | *fastigiata* |
| 46 | 3775 | Brazil | *hypogaea* | *fastigiata* |
| 47 | 3992 | India | *hypogaea* | *hypogaea* |
| 48 | 4156 | Unknown | *hypogaea* | *hypogaea* |
| 49 | 4343 | India | *hypogaea* | *hypogaea* |
| 50 | 4412 | USA | *hypogaea* | *hypogaea* |
| 51 | 4527 | Uganda | *hypogaea* | *hypogaea* |
| 52 | 4538 | India | *hypogaea* | *hypogaea* |
| 53 | 4543 | Unknown | *hypogaea* | *fastigiata* |
| 54 | 4598 | India | *hypogaea* | *fastigiata* |
| 55 | 4670 | Sudan | *hypogaea* | *fastigiata* |
| 56 | 4684 | USA | *hypogaea* | *fastigiata* |
| 57 | 4729 | China | *hypogaea* | *fastigiata* |
| 58 | 4750 | Paraguay | *hypogaea* | *fastigiata* |
| 59 | 4911 | Malawi | *hypogaea* | *fastigiata* |
| 60 | 4955 | India | *hypogaea* | *fastigiata* |
| 61 | 4998 | China | *hypogaea* | *hypogaea* |
| 62 | 5016 | USA | *hypogaea* | --- |
| 63 | 5195 | Sudan | *hypogaea* | *fastigiata* |
| 64 | 5221 | Argentina | *hypogaea* | *fastigiata* |
| 65 | 5236 | Chile | *hypogaea* | *fastigiata* |
| 66 | 5286 | Zambia | *hypogaea* | *hypogaea* |
| 67 | 5327 | USA | *hypogaea* | *hypogaea* |
| 68 | 5475 | Kenya | *hypogaea* | *fastigiata* |
| 69 | 5494 | Malaysia | *hypogaea* | *fastigiata* |
| 70 | 5662 | China | *hypogaea* | *hypogaea* |
| 71 | 5663 | China | *hypogaea* | *hypogaea* |
| 72 | 5745 | Puerto Rico | *hypogaea* | *hypogaea* |
| 73 | 5779 | India | *hypogaea* | *fastigiata* |
| 74 | 5827 | USA | *hypogaea* | *hypogaea* |
| 75 | 6022 | Sudan | *hypogaea* | *fastigiata* |
| 76 | 6057 | USA | *hypogaea* | *hypogaea* |
| 77 | 6201 | Cuba | *hypogaea* | *fastigiata* |
| 78 | 6263 | Burkina Faso | *hypogaea* | *fastigiata* |
| 79 | 6375 | Unknown | *hypogaea* | *fastigiata* |
| 80 | 6402 | Unknown | *hypogaea* | *hypogaea* |
| 81 | 6407 | Zimbabwe | *hypogaea* | *fastigiata* |
| 82 | 6646 | Unknown | *hypogaea* | *fastigiata* |
| 83 | 6654 | Unknown | *hypogaea* | *fastigiata* |
| 84 | 6766 | USA | *hypogaea* | *hypogaea* |

| S. No | ICG Number | Origin | Species | Sub species |
|---|---|---|---|---|
| 85 | 6888 | Brazil | *hypogaea* | *fastigiata* |
| 87 | 6993 | Brazil | *hypogaea* | *hypogaea* |
| 88 | 7000 | USA | *hypogaea* | *hypogaea* |
| 89 | 7153 | India | *hypogaea* | *hypogaea* |
| 90 | 7181 | India | *hypogaea* | *fastigiata* |
| 91 | 7190 | Brazil | *hypogaea* | *vulgaris* |
| 92 | 7243 | USA | *hypogaea* | *hypogaea* |
| 93 | 7906 | Zimbabwe | *hypogaea* | *vulgaris* |
| 94 | 7963 | USA | *hypogaea* | *hypogaea* |
| 95 | 7969 | Zimbabwe | *hypogaea* | *vulgaris* |
| 96 | 8106 | Peru | *hypogaea* | *fastigiata* |
| 97 | 8285 | USA | *hypogaea* | *hypogaea* |
| 98 | 8490 | Somalia | *hypogaea* | *hypogaea* |
| 99 | 8517 | Bolivia | *hypogaea* | *fastigiata* |
| 100 | 8567 | Uruguay | *hypogaea* | *vulgaris* |
| 101 | 8760 | Zambia | *hypogaea* | *hypogaea* |
| 102 | 9037 | Cote d'llvoire | *hypogaea* | *hypogaea* |
| 103 | 9157 | Puerto Rica | *hypogaea* | *vulgaris* |
| 104 | 9315 | USA | *hypogaea* | *fastigiata* |
| 105 | 9507 | Philippines | *hypogaea* | *vulgaris* |
| 106 | 9666 | India | *hypogaea* | *hypogaea* |
| 107 | 9809 | Mozambique | *hypogaea* | *vulgaris* |
| 108 | 9842 | Tanzania | *hypogaea* | *hypogaea* |
| 109 | 9961 | Unknown | *hypogaea* | *hypogaea* |
| 110 | 10036 | Peru | *hypogaea* | *peruviana* |
| 111 | 10092 | Zimbabwe | *hypogaea* | *fastigiata* |
| 112 | 10185 | USA | *hypogaea* | *hypogaea* |
| 113 | 10384 | Nigeria | *hypogaea* | *vulgaris* |
| 114 | 10474 | Cuba | *hypogaea* | *fastigiata* |
| 115 | 10479 | Uruguay | *hypogaea* | *hypogaea* |
| 116 | 10554 | Argentina | *hypogaea* | *fastigiata* |
| 117 | 10566 | Congo | *hypogaea* | *fastigiata* |
| 118 | 10890 | Peru | *hypogaea* | *fastigiata* |
| 119 | 11088 | Peru | *hypogaea* | *peruviana* |
| 120 | 11109 | Taiwan | *hypogaea* | *hypogaea* |
| 121 | 11144 | Argentina | *hypogaea* | *fastigiata* |
| 122 | 11219 | Mexico | *hypogaea* | *hypogaea* |
| 123 | 11249 | Tanzania | *hypogaea* | *vulgaris* |
| 124 | 11322 | India | *hypogaea* | *hypogaea* |
| 125 | 11426 | India | *hypogaea* | *hypogaea* |
| 126 | 11457 | India | *hypogaea* | *hypogaea* |

| S. No | ICG Number | Origin | Species | Sub species |
|---|---|---|---|---|
| 127 | 11515 | China | *hypogaea* | *vulgaris* |
| 128 | 11651 | China | *hypogaea* | *vulgaris* |
| 129 | 11687 | India | *hypogaea* | *vulgaris* |
| 130 | 11855 | Korea | *hypogaea* | *hypogaea* |
| 131 | 12000 | Mali | *hypogaea* | *hypogaea* |
| 132 | 12189 | Unknown | *hypogaea* | *vulgaris* |
| 133 | 12276 | Bolivia | *hypogaea* | *hypogaea* |
| 134 | 12370 | India | *hypogaea* | *hypogaea* |
| 135 | 12625 | Ecuador | *hypogaea* | *aequatoriana* |
| 136 | 12672 | Bolivia | *hypogaea* | *hypogaea* |
| 137 | 12682 | India | *hypogaea* | *vulgaris* |
| 138 | 12697 | India | *hypogaea* | *vulgaris* |
| 139 | 12879 | Myanmar | *hypogaea* | *vulgaris* |
| 140 | 156 | Unknown | *hypogaea* | *fastigiata* |
| 141 | 2738 | India | *hypogaea* | *fastigiata* |
| 142 | 12921 | Zimbabwe | *hypogaea* | *vulgaris* |
| 143 | 12988 | India | *hypogaea* | *vulgaris* |
| 144 | 13099 | Unknown | *hypogaea* | *hypogaea* |
| 145 | 13603 | Indonesia | *hypogaea* | *vulgaris* |
| 146 | 13723 | Niger | *hypogaea* | *hypogaea* |
| 147 | 13787 | Niger | *hypogaea* | *hypogaea* |
| 148 | 13858 | Uganda | *hypogaea* | *fastigiata* |
| 149 | 13941 | ICRISAT | *hypogaea* | *fastigiata* |
| 150 | 13942 | ICRISAT | *hypogaea* | *hypogaea* |
| 151 | 13982 | USA | *hypogaea* | *hypogaea* |
| 152 | 14008 | C.A. republic | *hypogaea* | *hypogaea* |
| 153 | 14106 | United Kingdom | *hypogaea* | *fastigiata* |
| 154 | 14118 | United Kingdom | *hypogaea* | *vulgaris* |
| 155 | 14127 | United Kingdom | *hypogaea* | *fastigiata* |
| 156 | 14466 | Nigeria | *hypogaea* | *hypogaea* |
| 157 | 14475 | Nigeria | *hypogaea* | *hypogaea* |
| 158 | 14482 | Nigeria | *hypogaea* | *hypogaea* |
| 159 | 14523 | Unknown | *hypogaea* | --- |
| 160 | 14630 | Brazil | *hypogaea* | *fastigiata* |
| 161 | 14705 | Cameroon | *hypogaea* | *hypogaea* |
| 162 | 14710 | Cameroon | *hypogaea* | *fastigiata* |
| 163 | 14985 | Unknown | *hypogaea* | *vulgaris* |
| 164 | 15042 | Unknown | *hypogaea* | *fastigiata* |
| 165 | 15190 | Costa Rica | *hypogaea* | *hypogaea* |
| 166 | 15287 | Brazil | *hypogaea* | *fastigiata* |
| 167 | 15309 | Brazil | *hypogaea* | *fastigiata* |
| 168 | 15419 | Ecuador | *hypogaea* | *fastigiata* |

| S. No | Checks | Origin | Species | Sub species |
|---|---|---|---|---|
| 1 | $C_1$- Narayani | India | *hypogaea* | *fastigiata* |
| 2 | $C_2$- Dharani | India | *hypogaea* | *fastigiata* |
| 3 | $C_3$- K-6 | India | *hypogaea* | *fastigiata* |
| 4 | $C_4$- TCGS-1157 | India | *hypogaea* | *fastigiata* |
| 5 | $C_5$- TCGS-1330 | India | *hypogaea* | *fastigiata* |

#### 3.3.3.1 Days to 50 % flowering

Number of days taken from the date of sowing to the attainment of flowering by 50% per cent of the plants in each line was recorded.

#### 3.3.3.2 Days to maturity

It was recorded as the number of days taken from the date of sowing to complete maturity of the crop by visual maturity indices of leaves and pods.

#### 3.3.3.3 Plant height (cm)

Height of the plant was measured in centimeters using a scale as the vertical distance of the main axis from ground level to the apical leaflet.

#### 3.3.3.4 Number of primary branches per plant

Number of primary branches originating from the main axis were counted at the time of harvest and recorded.

#### 3.3.3.5 Number of pegs per plant

Number of pegs was determined by counting all pegs at the time of harvest.

#### 3.3.3.6 Number of pods per plant

Number of pods in each plant were counted manually and recorded as total number of pods at harvest.

#### 3.3.3.7 Number of mature pods per plant

Number of well filled and mature pods per plant were counted at the time of harvest and recorded.


**Plate 1a. Organic field experiment**


**Plate 1b. Inorganic field experiment**

**3.3.3.8 Number of immature pods per plant**

Number of immature pods per plant was counted at the time of harvest and recorded

**3.3.3.9 Pod yield per plant (g).**

Weight of all the pods obtained from each individual plant was recorded in grams with the help of electronic top pan balance (precision of 0.001 g).

**3.3.3.10 Kernel yield per plant (g).**

Weight of all kernels obtained from each individual plant was recorded in grams with the help of electronic top pan balance (precision of 0.001 g).

**3.3.3.11 100- kernel weight (g).**

Hundred kernels were counted randomly and weighed for each genotype and was recorded as 100-kernel weight.

**3.3.3.12 Sound mature kernel per cent**

Sound mature kernel per cent was calculated using the following formula:

$$\text{SMK \%} = \frac{\text{Weight of sound mature kernels (g)}}{\text{weight of total kernels (g)}} \text{ x } 100$$

**3.3.3.13 Shelling percentage**

Shelling percentage was calculated using the following formula.

$$\text{Shelling percentage} = \frac{\text{Kernel yield plant}^{-1}\text{ (g)}}{\text{Pod yield plant}^{-1}\text{ (g)}} \text{ x } 100$$

#### 3.3.3.14 Harvest index

Harvest index was estimated after harvest using the formula:

$$HI = \frac{\text{Economic yield plant}^{-1}\text{ (g)}}{\text{Biological yield plant}^{-1}\text{ (g)}} \times 100$$

The data was recorded for the top 25 genotypes in organic and inorganic fertilizer managements for the following characters.

#### 3.3.3.15 Oil content (%)

Oil content in the seed was estimated with the help of Nuclear Magnetic Resonance (model: New Port Analyser). About 100 g of dried seed samples was taken and fed into the analyzer and the oil content was recorded directly as percentage of oil.

#### 3.3.3.16 Protein content (%)

Protein content in the seed was estimated with the help of Nuclear Magnetic Resonance (model: New Port Analyser). About 100 g of dried seed samples was taken and fed into the analyzer and the protein content was recorded directly as percentage of protein.

#### 3.3.3.17 Total carbohydrates (%)

Carbohydrates are the important components of storage and structural materials in plants. They exist as free sugars and polysaccharides. The basic units of carbohydrates are the monosaccharides which cannot be split by hydrolysis into more simple sugars. The carbohydrate content can be measured by hydrolyzing the polysaccharides into simple sugars by acid hydrolysis and estimating the resultant monosaccharides. The basic principle is that the carbohydrates are first hydrolyzed into simple sugars using dilute hydrochloric acid. In hot acidic medium glucose is dehydrated to hydroxymethyl furfural. This compound condenses with anthrone to form blue-green colored product which is measured at 630 nm (Hedge *et al*., 1962).

For extraction, 100 mg of kernel cotyledons were weighed from the respective genotypes and made into small pieces and poured into test tubes to which 5 ml of 2.5 N HCl was added and kept in hot water bath for 3hrs and later cooled to room temperature. Simultaneously, solid sodium carbonate was added until the effervescence ceases to neutralize it and later on the volume was made up to 50 ml with distilled water. Then centrifuged for 20 min at 3000 rpm and the supernatant was collected. For estimation, 1 ml of aliquot was taken for analysis and 4 ml of ice cold anthrone reagent was added. Subsequently, kept them in hot water bath for 10 minutes at 65°C and cooled the samples rapidly. Finally, green color intensity was read in a spectrophotometer using photometric method at 630 nm. The concentration of the total carbohydrates in the sample was found out by using standard regression equation and expressed as mg per g fresh weight.

**3.3.3.18 Total free amino acids (g/ 100g)**

The amino acids are the organic compounds that form the basic building blocks of proteins. The common features of the structure of amino acids is having a minimum of two ionizable groups; the acidic carboxyl (-COOH) and the basic amino ($-NH_2$) groups on the same carbon atom called as α- carbon atom. The amino acids also exist in the free form and not bound to proteins are known as free amino acids. They are mostly water soluble in nature. Very often in plant during disease conditions, the free amino acids composition exhibits a change and hence, the measurement of the total free amino acids give the physiological and health status of the plants. The basic principle of estimation of total free amino acids is a powerful oxidizing agent (Ninhydrin), decarboxylates the alpha amino acids and carboxylates to give an intensely coloured bluish purple product which is calorimetrically measured at 570 nm (Moore and Stein 1948; Misra *et al.,* 1975; Balsubramaniyan and Sadasivam, 1987).

For extraction, 500 mg of the seed sample is weighed and grinded it in a pestle and mortar with 5-10 ml of 80 % ethanol. The samples are centrifuged at 6000 rpm for 30 minutes and collect the supernatant is collected. For estimation, 0.1 ml of extract is taken and 1ml of Ninhydrin solution is added and mixed thoroughly and then the volume is made up to 2 ml with distilled water. The tubes are heated in boiling water bath for 20 min and thereafter cooled to room temperature. Simultaneously, 5 ml of the diluents are added and mixed. After 15 minutes, the intensity of purple color is read against a reagent blank in a spectrophotometer using photometric method at 570 nm. Finally, the concentration of the free amino acids is found out in the sample using standard regression equation and expressed as gram per 100 grams of fresh weight.

## 3.4 STATISTICAL ANALYSIS

The genotype means for all the characters (except for oil, protein, total carbohydrates and total free amino acids) for each experiment i.e., organic and inorganic fertilizer managements were subjected to the following statistical analysis. The statistical package used was OPSTAT. Com and IASRI. Com.

### 3.4.1 Analysis of variance

Analysis of variance for each character was carried out by using the method described by Federer (1956).

| **Source of variation** | **Df** | **Mean squares** | **MSS** | **"F" ratio** |
|---|---|---|---|---|
| Blocks | (b-1) | bSS | bMSS | bMSS/EMS |
| Entries | (e-1) | eSS | eMSS | eMSS/EMS |
| Checks | (c-1) | cSS | cMSS | cMSS/EMS |
| Varieties | (v-1) | vSS | vMSS | vMSS/EMS |
| Checks vs.Varieties | 1 | cvSS | cvMSS | cvMSS/EMS |
| Error | (c-1) (b-1) | ESS | EMSS | |
| Total | (N-1) | TSS | | |

Where,

b = number of blocks

v = number of genotypes

e = number of entries

c = number of checks

The significance of "F" value was tested by comparing the computed value with the table value as given by Fisher and Yates (1967).

### 3.4.2 Estimation of genetic parameters

#### 3.4.2.1 Variance

The genotypic and phenotypic variances were calculated as per the formulae proposed by Burton (1952)

$$\text{Genotypic variance } \left(\sigma_g^2\right) = \frac{\text{MSS due to genotypes} - \text{MSS due to error}}{\text{Number of blocks}}$$

$$\text{Phenotypic variance } \left(\sigma_p^2\right) = \sigma_g^2 + \sigma_e^2$$

Where,

$\sigma_g^2$ = Genotypic variance

$\sigma_e^2$ = Error variance

### 3.4.2.2 Genotypic and phenotypic coefficient of variation

The genotypic (GCV) and phenotypic (PCV) coefficient of variation was calculated by the formulae given by Burton (1952).

$$GCV\ (\%) = \frac{\sigma_g}{\bar{\bar{X}}} \times 100$$

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

where,

$\sigma_g$ = Genotypic standard deviation

$\sigma_p$ = Phenotypic standard deviation

$\bar{X}$ = General mean of the character

Categorization of the range of variation was done as proposed by Sivasubramanian and Madhavamenon (1973)

| | | |
|---|---|---|
| Less than 10% | - | Low |
| 10 – 20 % | - | Moderate |
| More than 20% | - | High |

### 3.4.2.3 Broad sense Heritability

Heritability in broad sense refers to the proportion of genotypic variance to the total variance of the population. Heritability in broad sense [$h^2_{(bs)}$] was calculated by the formula given by Lush (1940).

$$\text{Broad sense Heritability} = \frac{\sigma^2_g}{\sigma^2_p} \times 100$$

where,

$h^2_{(bs)}$= Heritability in broad sense

$\sigma^2_g$ = Genotypic variance

$\sigma^2_p$ = Phenotypic variance ($\sigma^2_g + \sigma^2_e$)

$\sigma^2_e$ = Environmental variance

Heritability estimates were categorized as per Johnson *et al.* (1955a) as given below.

| | | |
|---|---|---|
| Less than 30% | - | Low |
| 30 – 60 % | - | Moderate |
| More than 60% | - | High |

**3.4.2.4 Genetic advance**

Genetic advance refers to the expected genetic gain or improvement obtained in the next generation by selecting the superior individuals under certain amount of selection pressure. From the heritability estimates, the genetic advance was estimated by the following formula given by Johnson *et al.* (1955a).

$$GA = k\ \sigma_p\ H$$

where,

GA = Genetic advance

$\sigma_p$ = Phenotypic standard deviation

H = Heritability (broad sense)

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

### 3.4.2.5 Genetic advance as per cent of mean (GA as per cent mean)

Genetic advance as percent of mean was calculated as per the formula.

$$\text{GA as percent of mean} = \frac{GA}{\bar{X}} \times 100$$

where,

GA = Genetic advance

$\bar{X}$ = Grand mean of the character

The range of genetic advance as per cent of mean was classified as suggested by Johnson *et al.* (1955a).

| | | |
|---|---|---|
| Less than 10% | - | Low |
| 10 – 20 % | - | Moderate |
| More than 20% | - | High |

### 3.4.3 Simple correlation coefficients

The simple correlation coefficients were calculated as per the method suggested by Panse and Sukhatme (1985). Significance was tested by referring to the correlation coefficient table at (n-2) degrees of freedom.

$$r\,(xy) = \frac{\text{CoV}\,(x\,y)}{\sqrt{\text{Var}\,(x)\,\text{Var}\,(y)}}$$

where,

r (x y) = Correlation coefficient between “x” and “y” characters

Var (x) = Variance of "x" character

Var (y) = Variance of "y" character

Cov (x y) = Covariance between "x" and "y" characters.

x, y = Variables

### 3.4.4 Path Coefficient Analysis

Path coefficient analysis was carried out by the procedure originally proposed by Wright (1921) which was subsequently elaborated by Dewey and Lu (1959) to estimate the direct and indirect effects of the individual character on yield.

The following set of simultaneous equations were formulated and solved for estimating various direct and indirect effects.

$r_{1y} = p_{1y} + r_{12}p_{2y} + r_{13}p_{3y} + \ldots\ldots\ldots\ldots\ldots + r_{1i}p_{iy}$

$r_{2y} = r_{21}p_{1y} + p_{2y} + r_{23}p_{3y} + \ldots\ldots\ldots\ldots\ldots + r_{2i}p_{iy}$

. . . . . .

. . . . . .

$r_{iy} = r_{i1}p_{1y} + r_{i2}p_{2y} + r_{i3}p_{3y} + \ldots\ldots\ldots\ldots\ldots + p_{iy}$

where,

$r_{1y}$ to $r_{iy}$ = Coefficient of correlation between causal factors 1 to i and dependent character 'y'.

$r_{12}$ to $r_{i1}$ = Correlation coefficients among causal factors.

$p_{1y}$ to $p_{iy}$ = Direct effects of characters '1' to i on character 'y'.

The above equations were written in matrix forms as under:

$$\underset{A}{\begin{pmatrix} r_{1y} \\ r_{2y} \\ r_{3y} \\ . \\ . \\ r_{iy} \end{pmatrix}} = \underset{C}{\begin{pmatrix} 1 & r_{12} & r_{13} \ldots\ldots\ldots\ldots\ r_{1i} \\ r_{21} & 1 & r_{23} \ldots\ldots\ldots\ldots\ r_{2i} \\ r_{31} & r_{32} & 1 \ldots\ldots\ldots\ldots\ r_{3i} \\ . & . & . \qquad\qquad . \\ . & . & . \qquad\qquad . \\ r_{i1} & r_{i2} & r_{i3} \ldots\ldots\ldots\ldots 1 \end{pmatrix}} \underset{B}{\begin{pmatrix} P_{1y} \\ P_{2y} \\ P_{3y} \\ . \\ . \\ P_{iy} \end{pmatrix}}$$

Then $B = [C]^{-1}A$

where,

$$[C]^{-1} = \begin{pmatrix} C_{11} & C_{12} & C_{13} \ldots\ldots\ldots\ldots\ C_{1i} \\ C_{21} & C_{22} & C_{23} \ldots\ldots\ldots\ldots\ C_{2i} \\ . & . & . \qquad\qquad . \\ . & . & . \qquad\qquad . \\ C_{i1} & C_{i2} & C_{i3} \ldots\ldots\ldots\ldots\ C_{ii} \end{pmatrix}$$

Then, direct effects were calculated as follows:

$$P_{1y} = \sum_{i=1}^{I} C_{1i}\, r_{1y}$$

$$P_{2y} = \sum_{i=1}^{I} C_{2i}\, r_{2y}$$

$$P_{iy} = \sum_{i=1}^{I} C_{ii}\, r_{iy}$$

Besides the direct and indirect effects, the residual effect which measures the contribution of the characters not considered in the causal scheme was obtained as residual effect.

$$\text{Residual effect } (P_{Ry}) = \sqrt{1 - [P_{1y}r_{1y} + p_{2y}r_{2y} + \ldots\ldots\ldots + p_{iy}r_{iy}]^2}$$

where, $P_{Ry}$ = Residual effect

$p_{iy}$ = Direct effect of ‘$X_i$’ on ‘y’

$r_{iy}$ = Correlation coefficient of ‘$X_i$’ with ‘y’.

The scale for path coefficients as proposed by Lenka and Mishra (1973) is as follows:

| **Value for Direct or Indirect effect** | **Rate or Scale** |
|---|---|
| 0.00-0.09 | Negligible |
| 0.10-0.19 | Low |
| 0.20-0.29 | Moderate |
| 0.30-0.99 | High |
| More than 1.00 | Very high |

# Chapter – IV

# Results& Discussion

## Chapter IV

# RESULTS AND DISCUSSION

Groundnut (*Arachis hypogaea* L.) is a good source of oil and protein, ranked as 5$^{th}$ most important oilseed crop in the world. It is a segmental allotetraploid (2n = 40), highly self-pollinated legume crop and grown successfully in tropical and sub-tropical areas of the world.

Use of high yielding varieties led to increased use of chemical fertilizers and pesticides resulting in several harmful effects which affected the environment. Therefore, in order to overcome these harmful effects, recently people are focusing on organic farming. But the major constraint for organic farming is the lack of suitable varieties specifically bred to get higher productivity and better quality. Varieties selected under conventional agricultural management practices may not possess traits that allow for optimal production in organically managed systems. Hence, it would be a challenge for the plant breeders to develop cultivars especially for organic condition. In order to reach this goal, evaluation of germplasm lines is required to identify superior genotypes along with their important traits that could give rise to optimum yields in the organic farming system. Similarly, the knowledge on genetic variability, heritability, genetic advance and correlation between yield and its contributing characters would also play an important role in success of breeding programme.

Genetic improvement of yield is the primary concern of plant breeders but, yield is a complex, quantitatively inherited character and is greatly influenced by one or more of the yield components under a specific environment. Thus, for effective yield improvement, a knowledge of these traits is very important in selection and improvement of crops. Therefore, it is important to understand the relationships between yield and component characters associated with it. Correlation analysis measures the mutual association between a pair of variables independent of other variables under consideration. Though, the correlations give information about the components traits, they do not provide a true picture of relative importance of direct and indirect effects of these component traits on pod yield, which can be achieved by path coefficient analysis. Hence correlation in combination with path analysis provides an opportunity to study the degree and direction of association of yield with its component characters. Thus, it helps in establishing suitable selection criteria for improving the yield in the target environments.

Keeping in view the above prospectives, the present investigation was undertaken to estimate the extent of genetic variation, to obtain information on correlation among yield and yield component traits and to determine the direct and indirect effects of component traits on pod yield in 168 germplasm lines and five checks of groundnut during *kharif* 2016 under organic and inorganic fertilizer managements.

Results obtained in the present study were presented under the following subheadings separately for organic and inorganic fertilizer managements.

4.1 Analysis of variance

4.2 Mean performance

4.3 Variability and Genetic parameters

4.4 Character association analysis

4.5 Path coefficient analysis.

**Table 4.1. Analysis of variance for 14 characters in 168 germplasm lines and five checks of groundnut under organic fertilizer management**

| S.No | Character | Block (df=5) | Entries (df=172) | Checks (df=4) | Error (df=20) |
|---|---|---|---|---|---|
| 1 | Days to 50% flowering | 2.77 | 16.36** | 23.05** | 1.09 |
| 2 | Days to maturity | 23.60** | 104.01* | 117.38* | 7.68 |
| 3 | Plant height (cm) | 8.24 | 77.32** | 382.21** | 17.41 |
| 4 | Number of primary branches per plant | 0.64 | 1.07 | 2.49* | 0.64 |
| 5 | Number of pegs per plant | 78.75 | 127.69* | 94.83 | 65.10 |
| 6 | Number of mature pods per plant | 14.24 | 32.84** | 12.81 | 11.27 |
| 7 | Number of immature pods per plant | 0.82 | 2.71** | 3.15* | 0.79 |
| 8 | Number of pods per plant | 21.54 | 35.62** | 27.07 | 12.19 |
| 9 | 100 kernel weight (g) | 80.15* | 56.92* | 435.55* | 12.45 |
| 10 | Shelling percentage | 84.64 | 50.52 | 91.82 | 39.68 |
| 11 | Sound mature kernel percentage | 105.51 | 131.45* | 171.54* | 58.48 |
| 12 | Harvest index (%) | 35.57 | 97.84 | 117.76 | 64.56 |
| 13 | Kernel yield per plant (g) | 2.51 | 12.99* | 22.57* | 5.22 |
| 14 | Pod yield per plant (g) | 15.51 | 27.57** | 55.26** | 8.76 |

*, ** indicate significant at 5 % and 1 % level of probability

## 4.1 ANALYSIS OF VARIANCE

The analysis of variance was performed for each character separately and total variation was partitioned into different sources of variation. The results were presented separately for organic and inorganic fertilizer managements in Table 4.1 and 4.2.

### 4.1.1 Analysis of Variance under Organic Fertilizer Management

The analysis of variance in respect of 14 quantitative characters recorded significant differences among the entries for the characters *viz*., days to 50 % flowering, days to maturity, plant height, number of pegs per plant, number of mature pods per plant, number of immature pods per plant, number of pods per plant, 100 kernel weight, sound mature kernel percentage, kernel yield per plant and pod yield per plant.

The mean sum of squares due to checks were significant for days to 50 % flowering, days to maturity, plant height, number of primary branches per plant, number of immature pods per plant, 100 kernel weight, sound mature kernel percentage, kernel yield per plant and pod yield per plant (Table 4.1).

### 4.1.2 Analysis of Variance under Inorganic Fertilizer Management

Analysis of variance carried out for 14 characters revealed significant differences among the entries for all the characters *viz*., days to 50 % flowering, days to maturity, plant height, number of primary branches per plant, number of pegs per plant, number of mature pods per plant, number of immature pods per plant, number of pods per plant, 100 kernel weight, shelling percentage, sound mature kernel percentage, harvest index, kernel yield per plant and pod yield per plant.

**Table 4.2. Analysis of variance for 14 characters in 168 germplasm lines and five checks of groundnut under inorganic fertilizer management**

| S. No | Character | Block (df=5) | Entries (df=172) | Checks (df=4) | Error (df=20) |
|---|---|---|---|---|---|
| 1 | Days to 50% flowering | 5.20* | 16.41** | 33.13** | 1.63 |
| 2 | Days to maturity | 27.10* | 57.63** | 104.00** | 7.80 |
| 3 | Plant height (cm) | 21.10 | 35.87** | 183.57** | 10.44 |
| 4 | Number of primary branches per plant | 1.44 | 4.67** | 7.20** | 0.77 |
| 5 | Number of pegs per plant | 387.03* | 228.21* | 155.58 | 103.56 |
| 6 | Number of mature pods per plant | 38.58* | 43.53** | 59.36** | 12.05 |
| 7 | Number of immature pods per plant | 0.96* | 4.22** | 2.78** | 0.35 |
| 8 | Number of pods per plant | 41.26* | 52.43** | 71.59** | 14.31 |
| 9 | 100 kernel weight (g) | 18.25 | 24.61** | 72.06** | 8.70 |
| 10 | Shelling percentage | 18.53 | 59.09** | 154.232** | 13.95 |
| 11 | Sound mature kernel percentage | 15.30 | 173.31* | 397.83** | 81.68 |
| 12 | Harvest index (%) | 53.99 | 69.31* | 43.38 | 28.29 |
| 13 | Kernel yield per plant (g) | 14.33* | 8.95* | 13.62* | 4.47 |
| 14 | Pod yield per plant (g) | 34.23* | 21.55* | 41.19* | 10.18 |

*, ** indicate significant at 5 % and 1 % level of probability

The mean sum of squares due to checks were significant for all characters except for number of pegs per plant and harvest index (Table 4.2).

The above results under organic and inorganic fertilizer managements indicated that the significant difference for the characters among the entries was mainly due to the presence of considerable amount of genetic variation.

## 4.2 MEAN PERFORMANCE

The mean performance for all the 14 characters under two different managements viz., organic and inorganic fertilizer managements has been examined separately here under.

### 4.2.1 Mean Performance under Organic Fertilizer Management

The mean performance of 168 germplasm lines and five checks was furnished in Table 4.3; the grand mean, range, best check and number of germplasm lines superior to best check for 14 characters under organic fertilizer management are presented in Table 4.4 and the top five genotypes based on the mean performance for 14 characters under organic fertilizer management are furnished in Table 4.5. The adjusted means with block effect and critical differences were furnished in Appendix D.

#### 4.2.1.1 Days to 50 % flowering

Mean value for days to 50 % flowering ranged from 24 to 37 days with a general mean of 29.59 days. Among the genotypes, ICG -6407, ICG -6888, ICG -8567, ICG -9666 and ICG -15287 were earlier (24 days) in flowering, whereas ICG -4343 and ICG -10185 took maximum days (37) to flower. Five genotypes were earlier in flowering than the best check dharani (24.33 days).

**Table 4.3. Mean performance of 168 germplasm lines and five checks for 14 characters under organic fertilizer management**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 36 | 26.00 | 102.00 | 35.65 | 4.20 | 39.20 | 7.80 | 5.00 | 12.80 | 21.62 | 60.82 | 55.77 | 18.59 | 3.12 | 5.13 |
| 76 | 28.00 | 102.00 | 35.60 | 4.60 | 31.00 | 13.00 | 2.60 | 15.60 | 23.76 | 66.71 | 74.10 | 33.10 | 5.29 | 7.93 |
| 81 | 29.00 | 119.00 | 34.75 | 5.00 | 33.50 | 19.75 | 3.50 | 23.25 | 34.34 | 67.19 | 66.18 | 38.66 | 10.32 | 15.36 |
| 111 | 32.00 | 119.00 | 42.40 | 4.80 | 45.60 | 23.00 | 2.20 | 25.20 | 26.14 | 64.41 | 29.78 | 47.32 | 13.70 | 21.27 |
| 115 | 28.00 | 102.00 | 37.80 | 4.60 | 25.80 | 10.60 | 2.20 | 12.80 | 25.56 | 67.70 | 68.90 | 40.10 | 7.46 | 11.02 |
| 118 | 31.00 | 102.00 | 38.33 | 5.66 | 33.33 | 13.00 | 6.00 | 19.00 | 25.41 | 67.27 | 62.80 | 33.03 | 7.85 | 11.67 |
| 163 | 35.00 | 124.00 | 20.00 | 4.00 | 67.00 | 28.00 | 3.00 | 31.00 | 31.37 | 62.94 | 58.88 | 38.61 | 12.72 | 20.21 |
| 188 | 33.00 | 119.00 | 30.20 | 3.60 | 33.80 | 23.20 | 1.40 | 24.60 | 35.52 | 62.59 | 79.68 | 50.23 | 11.71 | 18.71 |
| 297 | 29.00 | 113.00 | 41.00 | 4.60 | 31.80 | 13.00 | 4.20 | 17.20 | 37.86 | 56.60 | 65.10 | 40.67 | 7.25 | 12.81 |
| 332 | 28.00 | 119.00 | 48.75 | 5.00 | 48.50 | 25.25 | 5.75 | 31.00 | 37.92 | 56.45 | 77.23 | 52.57 | 13.35 | 23.65 |
| 334 | 27.00 | 113.00 | 58.00 | 6.00 | 40.00 | 20.00 | 5.00 | 25.00 | 29.66 | 71.64 | 49.61 | 33.45 | 14.12 | 19.71 |
| 397 | 30.00 | 102.00 | 36.20 | 4.20 | 54.60 | 16.00 | 2.40 | 18.40 | 27.21 | 63.99 | 66.80 | 32.10 | 7.41 | 11.58 |
| 434 | 27.00 | 110.00 | 46.20 | 5.00 | 53.20 | 12.40 | 2.40 | 14.80 | 29.04 | 67.48 | 74.10 | 21.51 | 6.95 | 10.30 |
| 442 | 26.00 | 110.00 | 46.00 | 4.00 | 38.00 | 11.00 | 3.00 | 14.00 | 21.20 | 48.13 | 57.42 | 24.24 | 3.21 | 6.67 |
| 513 | 33.00 | 127.00 | 39.25 | 4.50 | 36.25 | 16.75 | 6.50 | 23.25 | 44.15 | 58.42 | 64.80 | 34.79 | 8.92 | 15.27 |
| 532 | 28.00 | 127.00 | 25.60 | 4.00 | 25.80 | 16.40 | 2.80 | 19.20 | 29.67 | 63.99 | 70.21 | 45.77 | 8.76 | 13.69 |
| 721 | 36.00 | 127.00 | 33.00 | 4.00 | 29.80 | 16.40 | 1.40 | 17.80 | 26.59 | 50.42 | 63.26 | 35.90 | 6.07 | 12.04 |
| 862 | 34.00 | 127.00 | 21.00 | 7.00 | 36.50 | 17.50 | 4.00 | 21.50 | 25.70 | 66.44 | 62.33 | 49.49 | 5.84 | 8.79 |
| 875 | 35.00 | 127.00 | 30.60 | 5.40 | 34.20 | 21.40 | 3.00 | 24.40 | 35.10 | 65.24 | 62.97 | 55.76 | 12.36 | 18.94 |
| 928 | 35.00 | 127.00 | 39.00 | 6.00 | 47.00 | 22.00 | 4.00 | 26.00 | 29.06 | 60.30 | 52.32 | 37.95 | 10.13 | 16.80 |
| 1137 | 27.00 | 102.00 | 35.00 | 5.33 | 28.93 | 13.60 | 3.33 | 16.93 | 20.20 | 66.39 | 69.50 | 30.78 | 4.82 | 7.26 |
| 1399 | 25.00 | 119.00 | 45.66 | 4.00 | 38.66 | 20.00 | 3.00 | 23.00 | 22.58 | 59.51 | 76.42 | 34.36 | 7.04 | 11.83 |
| 1415 | 26.00 | 119.00 | 39.60 | 4.20 | 26.20 | 17.80 | 2.40 | 20.20 | 24.17 | 63.95 | 80.40 | 49.18 | 7.45 | 11.65 |

**Table 4.3. contd . . .**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1519 | 27.00 | 119.00 | 43.30 | 5.00 | 33.33 | 18.33 | 3.00 | 21.33 | 24.80 | 67.16 | 77.17 | 42.25 | 7.71 | 11.48 |
| 1668 | 31.00 | 119.00 | 30.00 | 4.66 | 31.66 | 17.00 | 3.33 | 20.33 | 29.10 | 51.63 | 58.64 | 45.81 | 8.10 | 15.69 |
| 1711 | 25.00 | 119.00 | 31.00 | 4.33 | 31.99 | 19.33 | 3.66 | 22.99 | 25.33 | 68.17 | 77.35 | 50.70 | 7.86 | 11.53 |
| 1973 | 26.00 | 102.00 | 34.00 | 7.00 | 57.00 | 14.00 | 5.00 | 19.00 | 23.93 | 32.41 | 53.33 | 22.40 | 4.20 | 12.96 |
| 2019 | 25.00 | 119.00 | 36.00 | 4.00 | 33.60 | 22.20 | 3.20 | 25.40 | 29.50 | 64.39 | 81.23 | 54.35 | 11.03 | 17.13 |
| 2106 | 25.00 | 119.00 | 35.00 | 4.20 | 33.60 | 23.60 | 1.80 | 25.40 | 25.09 | 69.19 | 72.30 | 50.83 | 12.96 | 18.73 |
| 2511 | 34.00 | 127.00 | 26.50 | 5.50 | 27.50 | 14.50 | 2.00 | 16.50 | 52.10 | 65.96 | 65.82 | 38.11 | 8.66 | 13.13 |
| 2772 | 33.00 | 127.00 | 35.50 | 6.00 | 26.50 | 16.00 | 2.50 | 18.50 | 23.52 | 51.22 | 84.68 | 32.72 | 6.07 | 11.85 |
| 2773 | 31.00 | 127.00 | 33.00 | 5.00 | 25.99 | 17.33 | 1.33 | 18.66 | 33.14 | 69.69 | 73.81 | 51.42 | 11.38 | 16.33 |
| 2777 | 32.00 | 127.00 | 41.00 | 4.66 | 37.33 | 22.00 | 2.33 | 24.33 | 40.32 | 68.68 | 75.43 | 51.93 | 16.36 | 23.82 |
| 2857 | 30.00 | 119.00 | 27.00 | 4.40 | 28.60 | 18.00 | 2.00 | 20.00 | 49.72 | 75.68 | 78.29 | 57.83 | 12.85 | 16.98 |
| 2925 | 35.00 | 127.00 | 24.00 | 5.00 | 44.00 | 19.00 | 5.00 | 24.00 | 37.30 | 74.31 | 49.07 | 50.89 | 15.65 | 21.06 |
| 3027 | 33.00 | 127.00 | 32.66 | 5.00 | 46.00 | 23.00 | 5.00 | 28.00 | 37.96 | 63.56 | 62.34 | 40.37 | 14.18 | 22.31 |
| 3053 | 32.00 | 127.00 | 41.50 | 5.00 | 38.00 | 21.00 | 6.00 | 27.00 | 30.92 | 71.61 | 73.22 | 38.42 | 13.62 | 19.02 |
| 3102 | 30.00 | 110.00 | 51.60 | 5.00 | 29.40 | 8.20 | 3.00 | 11.20 | 29.34 | 64.58 | 56.91 | 30.28 | 4.34 | 6.72 |
| 3240 | 29.00 | 102.00 | 42.50 | 6.50 | 32.00 | 15.00 | 4.20 | 19.20 | 25.56 | 75.08 | 61.08 | 37.32 | 9.97 | 13.28 |
| 3343 | 26.00 | 110.00 | 40.20 | 5.00 | 37.86 | 13.40 | 2.86 | 16.26 | 30.90 | 69.84 | 66.16 | 29.57 | 7.18 | 10.28 |
| 3421 | 25.00 | 102.00 | 50.40 | 4.20 | 25.00 | 8.20 | 1.60 | 9.80 | 31.55 | 63.02 | 70.78 | 25.14 | 3.97 | 6.30 |
| 3584 | 26.00 | 102.00 | 49.00 | 7.00 | 83.00 | 26.00 | 2.00 | 28.00 | 25.83 | 71.05 | 80.12 | 32.17 | 10.31 | 14.51 |
| 3673 | 25.00 | 110.00 | 55.00 | 5.00 | 33.00 | 19.00 | 2.00 | 21.00 | 23.58 | 68.51 | 75.77 | 32.69 | 10.77 | 15.72 |
| 3681 | 25.00 | 98.00 | 41.60 | 4.40 | 25.05 | 10.00 | 2.25 | 12.25 | 26.62 | 57.77 | 68.40 | 35.61 | 5.76 | 9.97 |
| 3746 | 26.00 | 102.00 | 48.00 | 4.00 | 29.00 | 11.00 | 3.00 | 14.00 | 31.66 | 64.26 | 57.60 | 38.31 | 6.58 | 10.24 |
| 3775 | 25.00 | 102.00 | 41.00 | 4.80 | 37.40 | 13.80 | 1.00 | 14.80 | 27.87 | 71.32 | 56.22 | 31.12 | 7.56 | 10.60 |
| 3992 | 35.00 | 127.00 | 35.00 | 7.66 | 47.33 | 22.00 | 5.00 | 27.00 | 34.18 | 68.39 | 61.04 | 44.44 | 15.45 | 22.59 |

**Table 4.3. contd . . .**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4156 | 36.00 | 127.00 | 35.20 | 4.40 | 32.00 | 24.20 | 1.20 | 25.40 | 35.76 | 67.27 | 65.84 | 61.54 | 12.61 | 18.74 |
| 4343 | 37.00 | 127.00 | 36.33 | 4.66 | 27.99 | 15.33 | 1.66 | 16.99 | 33.92 | 69.12 | 64.41 | 49.50 | 11.66 | 16.87 |
| 4412 | 35.00 | 127.00 | 37.66 | 4.66 | 43.66 | 14.33 | 4.00 | 18.33 | 34.50 | 70.94 | 69.34 | 43.23 | 11.84 | 16.69 |
| 4527 | 26.00 | 127.00 | 54.33 | 5.33 | 50.99 | 20.00 | 4.33 | 24.33 | 30.04 | 68.08 | 72.47 | 52.70 | 12.97 | 19.05 |
| 4538 | 33.00 | 127.00 | 37.50 | 5.00 | 26.50 | 16.50 | 3.00 | 19.50 | 41.62 | 65.61 | 81.03 | 48.98 | 11.60 | 17.68 |
| 4543 | 25.00 | 110.00 | 39.00 | 4.00 | 29.00 | 11.00 | 5.00 | 16.00 | 26.35 | 48.84 | 71.97 | 47.28 | 4.21 | 8.62 |
| 4598 | 34.00 | 127.00 | 50.66 | 4.66 | 33.99 | 20.33 | 4.33 | 24.66 | 32.57 | 69.60 | 70.64 | 47.69 | 12.91 | 18.55 |
| 4670 | 26.00 | 127.00 | 47.00 | 5.66 | 40.32 | 21.66 | 1.00 | 22.66 | 35.52 | 69.62 | 69.62 | 43.01 | 13.89 | 19.95 |
| 4684 | 25.00 | 102.00 | 50.00 | 7.00 | 57.00 | 18.00 | 5.00 | 23.00 | 21.34 | 75.47 | 67.50 | 31.69 | 11.66 | 15.45 |
| 4729 | 26.00 | 102.00 | 56.00 | 4.00 | 68.00 | 11.00 | 3.00 | 14.00 | 21.25 | 65.96 | 41.30 | 19.03 | 5.00 | 7.58 |
| 4750 | 26.00 | 102.00 | 35.00 | 4.00 | 35.00 | 15.00 | 2.00 | 17.00 | 23.83 | 66.39 | 54.73 | 47.97 | 8.77 | 13.21 |
| 4911 | 26.00 | 102.00 | 58.00 | 4.00 | 43.00 | 20.00 | 6.00 | 26.00 | 20.10 | 64.35 | 64.98 | 41.12 | 8.88 | 13.80 |
| 4955 | 26.00 | 102.00 | 40.00 | 4.00 | 35.00 | 16.00 | 4.00 | 20.00 | 34.80 | 61.42 | 63.78 | 49.80 | 9.25 | 15.06 |
| 4998 | 32.00 | 119.00 | 39.50 | 5.00 | 45.00 | 20.50 | 10.50 | 31.00 | 35.33 | 63.50 | 62.61 | 41.10 | 12.09 | 19.04 |
| 5016 | 32.00 | 119.00 | 46.33 | 5.00 | 33.99 | 22.66 | 2.33 | 24.99 | 26.65 | 58.39 | 52.04 | 37.77 | 8.84 | 15.14 |
| 5195 | 26.00 | 110.00 | 40.00 | 4.60 | 27.60 | 12.80 | 2.40 | 15.20 | 19.22 | 69.89 | 56.68 | 27.02 | 3.97 | 5.68 |
| 5221 | 25.00 | 102.00 | 48.20 | 4.00 | 34.80 | 13.40 | 2.60 | 16.00 | 26.04 | 60.11 | 66.52 | 36.01 | 6.66 | 11.08 |
| 5236 | 26.00 | 102.00 | 29.80 | 5.60 | 23.40 | 10.00 | 3.40 | 13.40 | 35.41 | 71.26 | 76.84 | 38.45 | 6.52 | 9.15 |
| 5286 | 30.00 | 119.00 | 40.40 | 4.20 | 42.40 | 20.60 | 3.00 | 23.60 | 37.10 | 57.84 | 69.36 | 44.76 | 11.62 | 20.09 |
| 5327 | 30.00 | 119.00 | 35.66 | 5.33 | 36.99 | 21.00 | 3.66 | 24.66 | 29.22 | 64.70 | 49.81 | 49.47 | 10.54 | 16.29 |
| 5475 | 26.00 | 102.00 | 52.00 | 4.00 | 55.00 | 18.00 | 5.00 | 23.00 | 27.60 | 61.24 | 61.12 | 41.01 | 9.26 | 15.12 |
| 5494 | 26.00 | 102.00 | 28.00 | 5.00 | 37.00 | 15.00 | 2.00 | 17.00 | 28.90 | 67.08 | 59.40 | 51.42 | 8.62 | 12.85 |
| 5662 | 30.00 | 119.00 | 30.20 | 4.80 | 25.80 | 12.60 | 1.80 | 14.40 | 50.38 | 60.70 | 75.48 | 49.64 | 8.85 | 14.58 |
| 5663 | 30.00 | 119.00 | 43.66 | 4.33 | 31.33 | 20.00 | 3.33 | 23.33 | 38.20 | 65.63 | 75.32 | 41.72 | 12.02 | 18.31 |

**Table 4.3. contd . . .**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5745 | 32.00 | 102.00 | 37.33 | 4.33 | 27.66 | 19.33 | 4.00 | 23.33 | 29.76 | 62.63 | 74.61 | 49.97 | 9.57 | 15.28 |
| 5779 | 25.00 | 102.00 | 43.60 | 5.20 | 73.60 | 24.40 | 4.20 | 28.60 | 27.68 | 66.35 | 77.04 | 31.11 | 9.19 | 13.85 |
| 5827 | 35.00 | 119.00 | 54.00 | 5.00 | 46.00 | 20.00 | 2.00 | 22.00 | 35.57 | 67.41 | 58.33 | 24.27 | 9.12 | 13.53 |
| 6022 | 36.00 | 119.00 | 58.00 | 4.00 | 19.00 | 11.00 | 3.00 | 14.00 | 31.05 | 49.14 | 50.44 | 32.76 | 6.88 | 14.00 |
| 6057 | 35.00 | 119.00 | 34.00 | 4.00 | 30.00 | 15.00 | 4.00 | 19.00 | 22.52 | 57.65 | 61.10 | 35.71 | 7.12 | 12.35 |
| 6201 | 26.00 | 102.00 | 61.00 | 4.00 | 27.00 | 14.00 | 4.00 | 18.00 | 26.30 | 63.89 | 72.40 | 54.65 | 11.34 | 17.75 |
| 6263 | 25.00 | 102.00 | 37.00 | 4.00 | 15.80 | 6.00 | 2.80 | 8.80 | 28.00 | 45.84 | 58.03 | 20.45 | 1.93 | 4.21 |
| 6375 | 26.00 | 102.00 | 47.00 | 4.00 | 40.00 | 18.00 | 2.00 | 20.00 | 20.10 | 57.74 | 74.91 | 34.40 | 10.96 | 18.98 |
| 6402 | 25.00 | 119.00 | 36.25 | 4.50 | 27.00 | 20.50 | 2.75 | 23.25 | 14.93 | 50.99 | 51.81 | 34.43 | 3.96 | 7.76 |
| 6407 | 24.00 | 102.00 | 39.00 | 4.40 | 26.20 | 12.40 | 3.60 | 16.00 | 36.80 | 58.69 | 81.21 | 40.95 | 6.28 | 10.70 |
| 6646 | 31.00 | 102.00 | 56.00 | 4.00 | 58.00 | 13.00 | 6.00 | 19.00 | 16.40 | 45.32 | 25.30 | 28.92 | 6.68 | 14.74 |
| 6654 | 30.00 | 119.00 | 36.67 | 5.00 | 29.33 | 19.00 | 3.66 | 22.66 | 30.56 | 62.32 | 75.90 | 47.22 | 9.46 | 15.18 |
| 6766 | 33.00 | 119.00 | 26.00 | 5.00 | 16.00 | 9.00 | 2.00 | 11.00 | 35.91 | 56.40 | 70.81 | 33.56 | 5.07 | 8.99 |
| 6888 | 24.00 | 127.00 | 31.60 | 4.00 | 21.20 | 14.00 | 1.00 | 15.00 | 28.33 | 63.55 | 55.72 | 49.94 | 7.34 | 11.55 |
| 6892 | 25.00 | 127.00 | 32.00 | 6.66 | 41.76 | 30.30 | 1.66 | 31.96 | 18.73 | 55.08 | 38.90 | 24.05 | 6.94 | 12.60 |
| 6993 | 33.00 | 127.00 | 23.30 | 5.00 | 35.33 | 20.33 | 4.00 | 24.33 | 47.81 | 73.43 | 77.06 | 47.53 | 9.81 | 13.36 |
| 7000 | 31.00 | 127.00 | 33.50 | 8.50 | 65.00 | 26.00 | 4.50 | 30.50 | 33.48 | 66.01 | 59.66 | 32.96 | 15.32 | 23.21 |
| 7153 | 32.00 | 127.00 | 28.50 | 5.00 | 40.25 | 25.00 | 2.25 | 27.25 | 35.55 | 68.09 | 65.74 | 56.69 | 13.25 | 19.46 |
| 7181 | 32.00 | 127.00 | 29.25 | 5.00 | 25.50 | 16.50 | 2.50 | 19.00 | 39.84 | 68.75 | 77.97 | 59.60 | 11.35 | 16.51 |
| 7190 | 30.00 | 127.00 | 54.00 | 5.00 | 25.00 | 13.00 | 2.00 | 15.00 | 20.80 | 59.48 | 76.44 | 14.00 | 4.33 | 7.28 |
| 7243 | 34.00 | 102.00 | 32.00 | 6.50 | 33.00 | 23.00 | 3.50 | 26.50 | 37.95 | 62.93 | 79.61 | 56.04 | 12.41 | 19.72 |
| 7906 | 32.00 | 102.00 | 41.80 | 4.80 | 16.80 | 8.80 | 2.80 | 11.60 | 24.14 | 60.87 | 67.50 | 20.17 | 2.80 | 4.60 |
| 7963 | 31.00 | 110.00 | 39.40 | 4.40 | 16.80 | 14.80 | 1.00 | 15.80 | 35.21 | 62.49 | 74.85 | 39.59 | 6.88 | 11.01 |
| 7969 | 31.00 | 102.00 | 31.20 | 3.60 | 26.20 | 19.20 | 3.20 | 22.40 | 38.63 | 54.95 | 76.95 | 43.71 | 5.38 | 9.79 |

**Table 4.3. contd . . .**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8106 | 26.00 | 127.00 | 57.50 | 4.00 | 39.00 | 26.00 | 4.50 | 30.50 | 26.06 | 70.27 | 81.53 | 50.76 | 12.67 | 18.03 |
| 8285 | 26.00 | 127.00 | 40.80 | 4.00 | 25.00 | 12.80 | 2.20 | 15.00 | 34.90 | 58.11 | 62.64 | 43.29 | 7.20 | 12.39 |
| 8490 | 25.00 | 127.00 | 38.50 | 4.50 | 35.25 | 18.75 | 3.25 | 22.00 | 33.35 | 62.46 | 53.18 | 44.09 | 10.68 | 17.10 |
| 8517 | 26.00 | 105.00 | 39.50 | 5.00 | 25.50 | 12.00 | 2.00 | 14.00 | 31.66 | 59.43 | 71.55 | 44.28 | 6.02 | 10.13 |
| 8567 | 24.00 | 110.00 | 43.00 | 4.00 | 44.00 | 15.00 | 4.00 | 19.00 | 25.83 | 60.28 | 61.63 | 40.44 | 8.21 | 13.62 |
| 8760 | 27.00 | 127.00 | 45.30 | 6.00 | 24.66 | 16.00 | 4.00 | 20.00 | 28.25 | 61.68 | 45.03 | 47.59 | 8.95 | 14.51 |
| 9037 | 35.00 | 127.00 | 29.00 | 5.30 | 39.32 | 27.66 | 1.66 | 29.32 | 34.86 | 65.48 | 62.97 | 46.03 | 14.53 | 22.19 |
| 9315 | 26.00 | 110.00 | 34.00 | 4.00 | 38.00 | 11.00 | 3.00 | 14.00 | 18.90 | 58.14 | 43.65 | 38.67 | 4.00 | 6.88 |
| 9507 | 26.00 | 102.00 | 37.80 | 4.80 | 37.20 | 14.00 | 3.80 | 17.80 | 27.46 | 64.35 | 69.19 | 36.04 | 6.75 | 10.49 |
| 9666 | 24.00 | 127.00 | 39.00 | 5.50 | 38.50 | 24.50 | 4.50 | 29.00 | 27.78 | 57.17 | 54.26 | 43.25 | 10.56 | 18.47 |
| 9809 | 25.00 | 113.00 | 48.30 | 4.60 | 43.26 | 22.60 | 5.00 | 27.60 | 27.67 | 73.46 | 73.27 | 46.92 | 12.98 | 17.67 |
| 9842 | 33.00 | 127.00 | 34.67 | 4.00 | 24.67 | 15.00 | 1.67 | 16.67 | 31.80 | 59.09 | 56.36 | 51.02 | 7.70 | 13.03 |
| 9905 | 33.00 | 127.00 | 41.00 | 5.00 | 36.00 | 19.00 | 7.00 | 26.00 | 43.33 | 66.25 | 58.47 | 23.47 | 8.91 | 13.45 |
| 9961 | 36.00 | 127.00 | 35.00 | 7.00 | 43.00 | 21.00 | 5.00 | 26.00 | 27.00 | 63.31 | 60.46 | 27.11 | 9.23 | 14.58 |
| 10036 | 36.00 | 127.00 | 36.00 | 5.00 | 24.20 | 15.00 | 1.40 | 16.40 | 27.86 | 72.88 | 55.49 | 37.94 | 10.29 | 14.12 |
| 10092 | 36.00 | 127.00 | 37.20 | 4.00 | 30.00 | 20.80 | 2.00 | 22.80 | 29.74 | 56.14 | 59.18 | 48.28 | 9.78 | 17.42 |
| 10185 | 37.00 | 127.00 | 34.00 | 4.50 | 32.25 | 16.50 | 1.50 | 18.00 | 43.40 | 66.06 | 76.75 | 33.48 | 10.12 | 15.32 |
| 10384 | 33.00 | 127.00 | 27.00 | 4.60 | 40.86 | 28.60 | 1.60 | 30.20 | 39.01 | 63.69 | 70.89 | 58.75 | 16.66 | 26.16 |
| 10474 | 31.00 | 102.00 | 36.40 | 4.40 | 29.00 | 12.60 | 1.80 | 14.40 | 32.57 | 63.60 | 65.16 | 44.35 | 7.06 | 11.10 |
| 10479 | 35.00 | 127.00 | 30.50 | 9.00 | 52.50 | 20.75 | 2.25 | 23.00 | 33.33 | 63.59 | 66.64 | 37.02 | 10.88 | 17.11 |
| 10554 | 35.00 | 119.00 | 31.30 | 4.60 | 37.00 | 20.00 | 3.00 | 23.00 | 18.71 | 39.02 | 50.00 | 45.97 | 4.12 | 10.56 |
| 10566 | 26.00 | 119.00 | 46.00 | 4.00 | 37.00 | 15.00 | 4.00 | 19.00 | 31.50 | 62.32 | 57.26 | 35.97 | 10.67 | 17.12 |
| 10890 | 26.00 | 102.00 | 11.00 | 4.20 | 25.60 | 9.80 | 2.00 | 11.80 | 19.17 | 54.74 | 54.33 | 36.43 | 3.35 | 6.12 |
| 11088 | 34.00 | 113.00 | 32.40 | 4.20 | 26.60 | 13.60 | 2.00 | 15.60 | 22.32 | 49.88 | 33.01 | 38.66 | 6.18 | 12.39 |

**Table 4.3. contd . . .**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11109 | 35.00 | 113.00 | 28.00 | 4.00 | 34.00 | 16.50 | 4.50 | 21.00 | 25.25 | 64.02 | 70.46 | 40.09 | 6.94 | 10.84 |
| 11144 | 31.00 | 127.00 | 43.00 | 4.00 | 40.00 | 20.00 | 6.00 | 26.00 | 33.36 | 63.41 | 64.90 | 41.44 | 11.11 | 17.52 |
| 11219 | 27.00 | 127.00 | 33.50 | 4.00 | 31.00 | 16.50 | 3.50 | 20.00 | 39.62 | 59.69 | 62.25 | 38.59 | 9.67 | 16.20 |
| 11249 | 30.00 | 102.00 | 33.60 | 5.00 | 28.60 | 8.80 | 7.20 | 16.00 | 31.21 | 64.24 | 70.24 | 30.47 | 4.67 | 7.27 |
| 11322 | 25.00 | 113.00 | 28.20 | 4.80 | 38.60 | 17.40 | 10.40 | 27.80 | 30.76 | 65.91 | 59.99 | 58.87 | 14.87 | 22.56 |
| 11426 | 25.00 | 113.00 | 28.50 | 6.00 | 60.00 | 28.50 | 3.00 | 31.50 | 30.38 | 69.67 | 36.51 | 42.78 | 14.79 | 21.23 |
| 11457 | 25.00 | 127.00 | 25.30 | 6.30 | 44.50 | 19.60 | 2.60 | 22.20 | 29.12 | 65.22 | 57.78 | 44.12 | 10.99 | 16.85 |
| 11515 | 26.00 | 106.00 | 27.80 | 5.00 | 26.00 | 11.00 | 2.60 | 13.60 | 28.05 | 59.73 | 70.40 | 29.64 | 5.71 | 9.56 |
| 11651 | 26.00 | 119.00 | 33.00 | 4.00 | 30.60 | 23.00 | 2.00 | 25.00 | 33.45 | 69.07 | 70.22 | 52.72 | 14.54 | 21.05 |
| 11687 | 27.00 | 119.00 | 42.80 | 4.20 | 52.60 | 28.00 | 3.60 | 31.60 | 26.86 | 53.89 | 74.24 | 51.57 | 13.24 | 24.57 |
| 11855 | 27.00 | 119.00 | 30.60 | 7.25 | 26.00 | 14.75 | 2.25 | 17.00 | 36.17 | 60.13 | 73.03 | 49.27 | 9.53 | 15.85 |
| 12000 | 34.00 | 127.00 | 29.60 | 4.30 | 38.20 | 21.60 | 4.60 | 26.20 | 27.20 | 57.66 | 59.64 | 33.80 | 8.92 | 15.47 |
| 12189 | 25.00 | 127.00 | 34.50 | 4.25 | 42.50 | 22.75 | 2.50 | 25.25 | 34.90 | 59.99 | 63.73 | 54.17 | 11.80 | 19.67 |
| 12276 | 25.00 | 102.00 | 28.60 | 9.00 | 32.20 | 14.00 | 3.40 | 17.40 | 22.73 | 60.66 | 57.46 | 42.02 | 6.23 | 10.27 |
| 12370 | 34.00 | 106.00 | 32.00 | 8.00 | 38.00 | 19.50 | 1.50 | 21.00 | 34.66 | 64.65 | 65.04 | 33.78 | 10.04 | 15.53 |
| 12625 | 34.00 | 102.00 | 40.00 | 4.00 | 21.08 | 16.00 | 1.50 | 17.50 | 32.30 | 51.78 | 63.31 | 37.97 | 7.55 | 14.58 |
| 12672 | 36.00 | 106.00 | 52.50 | 5.00 | 33.50 | 16.50 | 3.50 | 20.00 | 24.05 | 53.39 | 69.45 | 35.93 | 6.22 | 11.65 |
| 12682 | 27.00 | 106.00 | 54.00 | 5.00 | 41.00 | 12.00 | 2.00 | 14.00 | 29.30 | 65.54 | 70.24 | 30.47 | 7.36 | 11.23 |
| 12697 | 27.00 | 110.00 | 45.00 | 4.00 | 53.00 | 20.00 | 4.00 | 24.00 | 24.46 | 56.54 | 45.34 | 41.05 | 9.55 | 16.89 |
| 12879 | 33.00 | 127.00 | 30.00 | 4.50 | 31.00 | 17.00 | 2.00 | 19.00 | 35.50 | 65.28 | 67.98 | 49.87 | 11.15 | 17.08 |
| 156 | 35.00 | 127.00 | 24.50 | 4.40 | 36.50 | 22.75 | 4.50 | 27.25 | 36.75 | 59.93 | 64.48 | 47.76 | 12.64 | 21.09 |
| 2738 | 32.00 | 119.00 | 34.60 | 4.00 | 39.00 | 24.80 | 3.20 | 28.00 | 32.72 | 73.97 | 71.95 | 52.94 | 13.87 | 18.75 |
| 12921 | 33.00 | 113.00 | 30.40 | 5.40 | 43.80 | 23.20 | 2.00 | 25.20 | 34.90 | 65.69 | 78.02 | 49.44 | 13.06 | 19.88 |
| 12988 | 33.00 | 113.00 | 37.80 | 5.20 | 28.20 | 2.40 | 9.00 | 11.40 | 23.95 | 40.77 | 61.68 | 44.36 | 2.12 | 5.20 |

**Table 4.3. contd . . .**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13099 | 35.00 | 127.00 | 62.67 | 4.80 | 71.20 | 35.80 | 6.00 | 41.80 | 40.09 | 64.42 | 62.33 | 46.88 | 18.85 | 29.26 |
| 13603 | 33.00 | 102.00 | 33.80 | 6.00 | 27.40 | 12.00 | 4.20 | 16.20 | 22.33 | 47.40 | 39.05 | 35.16 | 4.20 | 8.86 |
| 13723 | 36.00 | 119.00 | 27.80 | 5.60 | 44.80 | 31.00 | 2.40 | 33.40 | 33.91 | 66.55 | 62.34 | 55.88 | 16.57 | 24.90 |
| 13787 | 35.00 | 119.00 | 26.40 | 4.40 | 40.20 | 26.40 | 2.40 | 28.80 | 32.36 | 61.46 | 62.09 | 47.76 | 14.48 | 23.56 |
| 13858 | 26.00 | 113.00 | 36.00 | 4.00 | 23.80 | 10.40 | 2.80 | 13.20 | 25.65 | 54.06 | 59.68 | 24.84 | 4.39 | 8.12 |
| 13941 | 30.00 | 127.00 | 26.33 | 5.33 | 14.93 | 2.33 | 6.00 | 8.33 | 28.56 | 40.00 | 59.98 | 55.19 | 2.00 | 5.00 |
| 13942 | 32.00 | 127.00 | 26.00 | 6.00 | 43.00 | 31.00 | 2.00 | 33.00 | 34.82 | 73.06 | 57.36 | 52.88 | 17.52 | 23.98 |
| 13982 | 27.00 | 110.00 | 30.20 | 4.00 | 28.60 | 12.80 | 3.80 | 16.60 | 30.75 | 62.61 | 77.16 | 37.41 | 6.48 | 10.35 |
| 14008 | 35.00 | 110.00 | 27.40 | 4.80 | 42.40 | 24.40 | 4.20 | 28.60 | 29.44 | 54.91 | 55.85 | 44.82 | 11.80 | 21.49 |
| 14106 | 36.00 | 113.00 | 32.50 | 5.50 | 32.50 | 20.00 | 1.50 | 21.50 | 25.65 | 52.61 | 56.40 | 36.98 | 9.68 | 18.40 |
| 14118 | 27.00 | 113.00 | 31.60 | 5.00 | 31.20 | 19.30 | 2.60 | 21.90 | 25.47 | 63.08 | 82.33 | 37.73 | 8.15 | 12.92 |
| 14127 | 28.00 | 110.00 | 30.80 | 6.60 | 29.20 | 13.40 | 2.80 | 16.20 | 21.85 | 64.24 | 67.50 | 34.18 | 7.60 | 11.83 |
| 14466 | 34.00 | 110.00 | 31.80 | 7.20 | 19.40 | 8.80 | 7.80 | 16.60 | 28.25 | 51.11 | 64.11 | 22.10 | 4.82 | 9.43 |
| 14475 | 29.00 | 127.00 | 33.40 | 5.40 | 38.40 | 12.00 | 1.80 | 13.80 | 22.14 | 54.47 | 63.05 | 24.34 | 4.33 | 7.95 |
| 14482 | 32.00 | 127.00 | 30.80 | 4.80 | 29.60 | 12.40 | 3.20 | 15.60 | 28.67 | 57.04 | 61.22 | 28.78 | 6.24 | 10.94 |
| 14523 | 31.00 | 110.00 | 33.40 | 5.20 | 38.80 | 16.80 | 2.80 | 19.60 | 26.65 | 63.30 | 55.67 | 28.91 | 5.64 | 8.91 |
| 14630 | 29.00 | 106.00 | 35.00 | 4.00 | 28.50 | 11.60 | 4.30 | 15.90 | 29.54 | 54.14 | 59.89 | 36.94 | 5.36 | 9.90 |
| 14705 | 25.00 | 106.00 | 29.80 | 6.00 | 30.60 | 21.80 | 1.00 | 22.80 | 29.01 | 57.79 | 53.85 | 50.06 | 10.08 | 17.45 |
| 14710 | 26.00 | 106.00 | 34.00 | 3.60 | 26.60 | 11.60 | 2.60 | 14.20 | 18.52 | 52.17 | 23.84 | 31.76 | 4.32 | 8.28 |
| 14985 | 26.00 | 106.00 | 25.40 | 6.80 | 27.80 | 14.20 | 4.80 | 19.00 | 25.62 | 52.29 | 50.33 | 44.65 | 6.06 | 11.59 |
| 15042 | 31.00 | 106.00 | 23.60 | 4.20 | 24.20 | 12.20 | 3.40 | 15.60 | 26.47 | 48.62 | 65.91 | 32.00 | 4.40 | 9.05 |
| 15190 | 33.00 | 127.00 | 27.80 | 5.80 | 36.00 | 20.60 | 2.80 | 23.40 | 33.72 | 56.63 | 62.01 | 52.21 | 9.95 | 17.57 |
| 15287 | 24.00 | 106.00 | 32.60 | 4.00 | 28.20 | 13.40 | 3.40 | 16.80 | 23.61 | 61.83 | 54.78 | 28.89 | 4.60 | 7.44 |
| 15309 | 29.00 | 119.00 | 28.50 | 4.00 | 27.00 | 15.50 | 4.50 | 20.00 | 25.77 | 51.74 | 52.39 | 41.47 | 6.70 | 12.95 |

**Table 4.3. contd . . .**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15419 | 32.00 | 119.00 | 36.00 | 4.00 | 20.00 | 9.00 | 1.00 | 10.00 | 22.60 | 49.75 | 17.65 | 26.92 | 3.91 | 7.86 |
| Narayani ($C_1$) | 26.00 | 103.50 | 46.87 | 4.92 | 42.00 | 21.30 | 4.07 | 25.37 | 28.80 | 60.09 | 71.04 | 37.67 | 9.03 | 14.96 |
| Dharani ($C_2$) | 24.33 | 101.50 | 32.45 | 4.50 | 31.86 | 17.89 | 2.57 | 20.46 | 32.38 | 65.76 | 65.97 | 40.91 | 10.48 | 16.05 |
| K-6 ($C_3$) | 25.83 | 106.00 | 40.35 | 4.79 | 40.28 | 20.78 | 3.55 | 24.33 | 29.47 | 54.89 | 56.92 | 43.31 | 9.41 | 17.14 |
| TCGS- 1157 ($C_4$) | 29.00 | 112.33 | 27.42 | 5.90 | 37.07 | 20.98 | 4.50 | 25.48 | 38.09 | 61.91 | 62.69 | 47.83 | 12.69 | 20.75 |
| TCGS- 1330 ($C_5$) | 28.50 | 109.67 | 30.26 | 5.86 | 39.91 | 21.38 | 3.83 | 25.21 | 49.38 | 60.48 | 67.52 | 47.87 | 13.35 | 21.95 |

DF : Days to 50% flowering; DM : days to maturity; PH : Plant height (cm); NPB : Number of primary branches per plant (No); NPEGP : Number of pegs per plant (No); NMP : Number of mature pods per plant (No); NIMP : Number of immature pods per plant (No); NPP : Number of pods per plant (No); 100KW : 100 kernel weight (g); SP : Shelling percentage(%); SMK% : Sound mature kernel percentage(%); HI : Harvest index (%); KYP : Kernel yield per plant (g); PYP : Pod yield per plant (g)

#### 4.2.1.2 Days to maturity

One genotype was earlier in maturity than the best check dharani (101.50 days). Days to maturity ranged from 98 to 127 days with a general mean of 115.28 days. Among the genotypes evaluated ICG -3681 matured early, while others matured lately. The five genotypes that showed early maturity are ICG -3681 (98 days), ICG -36 (102 days), ICG -76 (102 days), ICG -115 (102 days) and ICG-118 (102 days).

#### 4.2.1.3 Plant height (cm)

Plant height varied from 11 cm (ICG-10890) to 62.67 cm (ICG-13099) with a general mean of 37.12 cm. Twenty seven genotypes were found taller than the best check narayani (46.87 cm). The five genotypes viz., ICG -13099 (62.67 cm), ICG -6201 (61.00 cm), ICG -334 (58.00 cm), ICG -4911(58.00 cm) and ICG-6022 (58.00 cm) were taller.

#### 4.2.1.4 Number of primary branches per plant

For number of primary branches per plant the mean value ranged from 3.60 to 9 with a general mean of 4.93. Among the genotypes ICG -188, ICG- 7969, ICG- 14710 recorded less (3.60) number of primary branches per plant, whereas highest number of primary branches per plant was registered by ICG- 10479 and ICG- 12276. Twenty seven genotypes recorded more number of primary branches per plant than the best check TCGS-1157 (5.90). The top five genotypes that recorded more number of primary branches are ICG- 10479 (9.00), ICG- 12276 (9.00), ICG- 7000 (8.50), ICG- 12370 (8.00) and ICG- 3992 (7.66).

#### 4.2.1.5 Number of pegs per plant

The mean value for number of pegs per plant ranged from 14.93 (ICG-13941) to 83 (ICG-3584) with a general mean of 35.63. More number of pegs per plant than the best check narayani (42) was observed in 37 genotypes. The top five genotypes that recorded more number of pegs are ICG- 3584 (83.00), ICG- 5779 (73.60), ICG- 13099 (71.20), ICG- 4729 (68.00) and ICG- 163 (67.00).

**4.2.1.6 Number of mature pods per plant**

Thirty nine genotypes registered more number of mature pods per plant than the best check TCGS-1330 (21.38). The range of number of mature pods per plant was from 2.33 (ICG-13941) to 35.8 (ICG-13099) with a general mean of 17.44. The top five genotypes that registered more number of mature pods are ICG- 13099 (35.80), ICG- 13723 (31.00), ICG- 13942 (31.00), ICG- 6892 (30.30) and ICG- 10384 (28.60).

**4.2.1.7 Number of immature pods per plant**

Sixty two genotypes recorded less number of immature pods per plant than the best check dharani (2.57). Among the genotypes, lowest (1.00) number of immature pods per plant was recorded by ICG -3775, ICG -4670, ICG -6888, ICG -7963, ICG -14705, ICG -15419, whereas highest (10.50) number of immature pods per plant was registered by ICG -4998. The range of number of mature pods per plant was from 1.00 (ICG-6888) to 10.5 (ICG-4998) with a general mean of 3.33. The five genotypes that recorded less (1.00) number of immature pods are ICG- 6888, ICG- 3775, ICG- 4670, ICG- 7963 and ICG- 14705.

**4.2.1.8 Number of pods per plant**

Number of pods per plant ranged from 8.33 (ICG-13941) to 41.8 (ICG-13099) with a general mean of 20.77. Thirty three genotypes recorded more number of pods per plant than the best check TCGS-1157 (25.48). The top five genotypes that recorded more number of pods are ICG- 13099 (41.80), ICG- 13723 (33.40), ICG- 13942 (33.00), ICG- 6892 (31.96) and ICG-11687(31.60).

**Table 4.4. Grand mean, range, best check and number of germplasm lines superior to best check for 14 characters under organic fertilizer management**

| S.No | ICG Number | Range | | Mean | Best check | Number of germplasm lines |
|---|---|---|---|---|---|---|
| | | Min | Max | | | |
| 1 | DF (Early) | 24.00(ICG-6407) | 37.00 (ICG-10185) | 29.59 | $C_2$-Dharani (24.33) | 5.00 |
| 2 | DM (Early) | 98.00 (ICG-3681) | 127.00 (ICG-15190) | 115.28 | $C_2$-Dharani (101.50) | 1.00 |
| 3 | PH (Tall) | 11.00 (ICG-10890) | 62.67 (ICG-13099) | 37.12 | $C_1$-Narayani (46.87) | 27.00 |
| 4 | NPB | 3.60 (ICG-14710) | 9.00 (ICG-10479) | 4.93 | $C_4$-TCGS-1157 (5.90) | 27.00 |
| 5 | NPEGP | 14.93 (ICG-13941) | 83.00 (ICG-3584) | 35.63 | $C_1$-Narayani (42) | 37.00 |
| 6 | NMP | 2.33 (ICG-13941) | 35.80 (ICG-13099) | 17.44 | $C_5$- TCGS-1330 (21.38) | 39.00 |
| 7 | NIMP (Less) | 1.00 (ICG-3775) | 10.50 (ICG-4998) | 3.33 | $C_2$-Dharani (2.57) | 62.00 |
| 8 | NPP | 8.33 (ICG-13941) | 41.80 (ICG-13099) | 20.77 | $C_4$-TCGS-1157 (25.48) | 33.00 |
| 9 | 100KW | 14.93 (ICG-6402) | 52.10 (ICG-2511) | 30.05 | $C_5$- TCGS-1330 (49.38) | 3.00 |
| 10 | SP | 32.41 (ICG-1973) | 75.68 (ICG-2857) | 61.67 | $C_2$-Dharani (65.76) | 52.00 |
| 11 | SMK % | 17.65 (ICG-15419) | 84.68 (ICG-2772) | 63.66 | $C_1$-Narayani (71.04) | 45.00 |
| 12 | HI | 14.00 (ICG-7190) | 61.54 (ICG-4156) | 40.50 | $C_5$- TCGS-1330 (47.87) | 43.00 |
| 13 | KYP | 1.93 (ICG-6263) | 18.85 (ICG-13099) | 9.04 | $C_5$- TCGS-1330 (13.35) | 20.00 |
| 14 | PYP | 4.21 (ICG-6263) | 29.26 (ICG-13099) | 14.45 | $C_5$- TCGS-1330 (21.95) | 13.00 |

DF : Days to 50% flowering; DM : days to maturity; PH : Plant height (cm); NPB : Number of primary branches per plant (No); NPEGP : Number of pegs per plant (No); NMP : Number of mature pods per plant (No); NIMP : Number of immature pods per plant (No); NPP : Number of pods per plant (No); 100SW : 100 kernel weight (g); SP : Shelling percentage(%); SMK% : Sound mature kernel percentage(%); HI : Harvest index (%); KYP : Kernel yield per plant (g); PYP : Pod yield per plant (g)

#### 4.2.1.9 100 kernel weight (g)

For 100 kernel weight mean value ranged from 14.93 g (ICG-6402) to 52.1 g (ICG-2511) with a general mean of 30.05 g. Three genotypes recorded higher 100 seed weight than the best check TCGS-1330 (49.38 g). The top five genotypes that recorded high 100 kernel weight are ICG- 2511 (52.10 g), ICG- 5662 (50.38 g), ICG- 2857 (49.72 g), ICG- 6993 (47.81 g) and ICG- 513 (44.15 g).

#### 4.2.1.10 Shelling percentage

Highest shelling percentage than the best check dharani (65.76 %) was registered by 52 genotypes. The top five genotypes that recorded high shelling percentage are ICG- 2857 (75.68 %), ICG- 4684 (75.47 %), ICG- 3240 (75.08 %), ICG- 2925 (74.31 %) and ICG- 2738 (73.97 %). Mean value for shelling percentage ranged from 32.41 % (ICG-1973) to 75.68 % (ICG-2857) with a general mean of 61.67 %.

#### 4.2.1.11 Sound mature kernel percentage

Sound mature kernel percentage ranged from 17.65 % (ICG-15419) to 84.68 % (ICG-2772) with a general mean of 63.66 %. High sound mature kernel percentage than the best check narayani (71.04 %) was registered by 45 genotypes. The top five genotypes that recorded high sound mature kernel percentage are ICG- 2772 (84.68 %), ICG- 14118 (82.33 %), ICG- 8106 (81.53 %), ICG- 2019 (81.23 %) and ICG- 6407 (81.21 %).

#### 4.2.1.12 Harvest index (%)

For harvest index, the mean value ranged from 14.00 % (ICG-7190) to 61.54 % (ICG-4156) with a general mean of 40.50 %. The top five genotypes that recorded high harvest index are ICG- 4156 (61.54 %), ICG- 7181 (59.60 %), ICG- 11322 (58.87 %), ICG- 10384 (58.75 %) and ICG-

**Table 4.5. Summary of top five germplasm lines based on the mean performance for yield and yield contributing characters under organic fertilizer management.**

| S. No | Characters | Germplasm lines |
|---|---|---|
| 1 | Days to 50% flowering (Early) | ICG- 6407, ICG- 6888, ICG- 8567, ICG- 9666, ICG- 15287 |
| 2 | Days to maturity (Early) | ICG- 3681, ICG- 36, ICG- 76, ICG- 115, ICG- 118 |
| 3 | Plant height (Taller in cm) | ICG- 13099, ICG- 6201, ICG- 334, ICG- 4911, ICG- 6022 |
| 4 | Number of primary branches per plant | ICG- 10479, ICG- 12276, ICG- 7000, ICG- 12370, ICG- 3992 |
| 5 | Number of pegs per plant | ICG- 3584, ICG- 5779, ICG- 13099, ICG- 4729, ICG- 163 |
| 6 | Number of mature pods per plant | ICG- 13099, ICG- 13723, ICG- 13942, ICG- 6892, ICG- 10384 |
| 7 | Number of immature pods per plant (Less) | ICG- 6888, ICG- 3775, ICG- 4670, ICG- 7963, ICG- 14705 |
| 8 | Number of pods per plant | ICG- 13099, ICG- 13723, ICG- 13942, ICG- 6892, ICG- 11687 |
| 9 | 100 kernel weight (g) | ICG- 2511, ICG- 5662, ICG- 2857, ICG- 6993, ICG- 513 |
| 10 | Shelling percentage | ICG- 2857, ICG- 4684, ICG- 3240, ICG- 2925, ICG- 2738 |
| 11 | Sound mature kernel percentage | ICG- 2772, ICG- 14118, ICG- 8106, ICG- 2019, ICG- 6407 |
| 12 | Harvest index (%) | ICG- 4156, ICG- 7181, ICG- 11322, ICG- 10384, ICG- 2857 |
| 13 | Kernel yield per plant (g) | ICG- 13099, ICG- 13942, ICG- 10384, ICG- 13723, ICG- 2777 |
| 14 | Pod yield per plant (g) | ICG- 13099, ICG- 10384, ICG- 13723, ICG- 11687, ICG- 13942 |

2857 (57.83 %). Highest harvest index than the best check TCGS-1330 (47.87 %) was registered by 43 genotypes.

#### 4.2.1.13 Kernel yield per plant (g)

Mean value ranged from 1.93 g (ICG-6263) to 18.85 g (ICG-13099) for this trait with a general mean of 9.04 g. Twenty genotypes recorded high kernel yield per plant than the best check TCGS-1330 (13.35 g). The top five genotypes that recorded high kernel yield are ICG- 13099 (18.85 g), ICG- 13942 (17.52 g), ICG- 10384 (16.66 g), ICG- 13723 (16.57 g) and ICG- 2777 (16.36 g).

#### 4.2.1.14 Pod yield per plant (g)

Thirteen genotypes registered high pod yield per plant than the best check TCGS-1330 (21.95 g). Pod yield per plant ranged from 4.21 g (ICG-6263) to 29.26 g (ICG-13099) with a general mean of 14.45 g. The top five genotypes that recorded high pod yield are ICG- 13099 (29.26 g), ICG-10384 (26.16 g), ICG- 13723 (24.90 g), ICG- 11687 (24.57 g) and ICG-13942 (23.98 g).

The top five genotypes presented under each character are worthy of utilization in improvement of the respective character under organic management.

### 4.2.2 Mean Performance under Inorganic Fertilizer Management

The mean performance of 168 germplasm lines and five checks was presented in Table 4.6; the grand mean, range, best check and number of germplasm lines superior to best check for fourteen characters under inorganic fertilizer management were presented in Table 4.7 and the top five genotypes based on the mean performance for 14 characters under inorganic fertilizer management are presented in Table 4.8. The adjusted means with block effect and critical differences were furnished in Appendix E.

**Table 4.6. Mean performance of 168 germplasm lines and five checks for 14 characters under inorganic fertilizer management**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 36 | 29.00 | 113.00 | 27.00 | 5.00 | 48.40 | 21.40 | 2.00 | 23.40 | 21.05 | 64.20 | 43.07 | 33.86 | 6.85 | 10.67 |
| 76 | 29.00 | 106.00 | 25.20 | 4.80 | 40.40 | 19.20 | 4.20 | 23.40 | 21.31 | 62.86 | 54.03 | 33.01 | 6.33 | 10.07 |
| 81 | 29.00 | 124.00 | 25.80 | 7.80 | 72.80 | 15.60 | 3.40 | 19.00 | 22.68 | 52.65 | 42.73 | 21.86 | 5.57 | 10.58 |
| 111 | 33.00 | 119.00 | 20.80 | 6.80 | 57.00 | 24.80 | 3.60 | 28.40 | 24.55 | 59.56 | 47.15 | 41.39 | 9.31 | 15.63 |
| 115 | 30.00 | 114.00 | 30.20 | 4.60 | 23.60 | 9.40 | 1.60 | 11.00 | 22.28 | 49.45 | 49.01 | 30.82 | 4.06 | 8.21 |
| 118 | 33.00 | 114.00 | 29.00 | 5.40 | 43.40 | 22.60 | 1.60 | 24.20 | 31.83 | 66.15 | 74.50 | 41.53 | 11.96 | 18.08 |
| 163 | 36.00 | 124.00 | 26.60 | 6.33 | 47.32 | 14.33 | 7.66 | 21.99 | 29.68 | 54.86 | 49.93 | 25.82 | 7.17 | 13.07 |
| 188 | 35.00 | 124.00 | 24.60 | 6.00 | 33.20 | 6.60 | 5.00 | 11.60 | 28.62 | 45.93 | 51.94 | 28.23 | 4.12 | 8.97 |
| 297 | 30.00 | 113.00 | 28.40 | 4.40 | 33.00 | 8.20 | 1.00 | 9.20 | 23.87 | 47.96 | 45.89 | 25.71 | 3.53 | 7.36 |
| 332 | 30.00 | 106.00 | 35.60 | 8.60 | 70.00 | 23.40 | 4.20 | 27.60 | 29.21 | 53.31 | 55.13 | 31.97 | 12.66 | 23.75 |
| 334 | 30.00 | 106.00 | 32.60 | 4.60 | 33.60 | 12.00 | 1.60 | 13.60 | 15.97 | 40.66 | 26.85 | 28.09 | 2.57 | 6.32 |
| 397 | 30.00 | 119.00 | 29.20 | 4.00 | 52.00 | 18.60 | 4.00 | 22.60 | 20.39 | 55.46 | 49.56 | 34.97 | 5.69 | 10.26 |
| 434 | 30.00 | 106.00 | 29.60 | 7.60 | 112.00 | 35.20 | 3.20 | 38.40 | 29.57 | 61.65 | 56.72 | 36.41 | 14.95 | 24.25 |
| 442 | 28.00 | 124.00 | 34.20 | 6.60 | 73.00 | 23.20 | 4.20 | 27.40 | 23.15 | 64.40 | 66.71 | 27.36 | 8.41 | 13.06 |
| 513 | 35.00 | 124.00 | 24.00 | 7.50 | 45.50 | 9.50 | 3.50 | 13.00 | 18.75 | 42.29 | 68.23 | 9.32 | 1.92 | 4.54 |
| 532 | 28.00 | 124.00 | 19.40 | 4.60 | 27.60 | 7.00 | 1.00 | 8.00 | 18.91 | 58.88 | 46.28 | 17.65 | 2.42 | 4.11 |
| 721 | 37.00 | 124.00 | 19.60 | 7.60 | 55.40 | 3.80 | 2.40 | 6.20 | 19.76 | 40.31 | 19.23 | 6.99 | 1.04 | 2.58 |
| 862 | 35.00 | 124.00 | 15.66 | 6.66 | 43.99 | 8.33 | 9.33 | 17.66 | 17.66 | 56.44 | 46.37 | 18.17 | 3.99 | 7.07 |
| 875 | 36.00 | 124.00 | 23.20 | 7.00 | 37.40 | 13.00 | 5.40 | 18.40 | 20.19 | 48.62 | 42.63 | 24.63 | 4.41 | 9.07 |
| 928 | 37.00 | 124.00 | 21.20 | 6.00 | 34.60 | 5.20 | 9.20 | 14.40 | 19.28 | 48.93 | 54.85 | 15.59 | 2.06 | 4.21 |
| 1137 | 28.00 | 106.00 | 31.80 | 4.80 | 52.34 | 24.20 | 3.40 | 27.60 | 23.88 | 67.36 | 71.30 | 36.69 | 8.71 | 12.93 |
| 1399 | 27.00 | 119.00 | 31.75 | 4.50 | 59.75 | 15.50 | 3.00 | 18.50 | 22.65 | 54.70 | 52.70 | 21.84 | 5.18 | 9.47 |
| 1415 | 27.00 | 119.00 | 30.80 | 5.00 | 49.40 | 24.60 | 3.20 | 27.80 | 20.13 | 58.57 | 62.68 | 33.42 | 8.44 | 14.41 |

**Table 4.6. contd. . .**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1519 | 27.00 | 113.00 | 29.40 | 5.60 | 53.00 | 21.40 | 4.00 | 25.40 | 24.03 | 67.75 | 63.19 | 35.00 | 8.15 | 12.03 |
| 1668 | 33.00 | 124.00 | 24.00 | 8.20 | 49.40 | 8.80 | 10.40 | 19.20 | 20.53 | 48.06 | 40.37 | 22.67 | 4.83 | 10.05 |
| 1711 | 27.00 | 119.00 | 24.00 | 5.60 | 76.00 | 15.00 | 5.40 | 20.40 | 22.81 | 63.05 | 47.98 | 34.22 | 8.65 | 13.72 |
| 1973 | 27.00 | 106.00 | 22.60 | 6.60 | 60.40 | 20.40 | 1.20 | 21.60 | 18.69 | 59.89 | 29.24 | 25.82 | 5.54 | 9.25 |
| 2019 | 27.00 | 119.00 | 27.60 | 4.80 | 59.60 | 25.00 | 6.00 | 31.00 | 23.92 | 61.80 | 45.65 | 33.38 | 9.77 | 15.81 |
| 2106 | 27.00 | 119.00 | 30.60 | 5.20 | 59.80 | 24.00 | 4.00 | 28.00 | 24.71 | 62.62 | 53.73 | 28.17 | 9.38 | 14.98 |
| 2511 | 36.00 | 124.00 | 12.60 | 15.00 | 40.60 | 11.60 | 3.40 | 15.00 | 19.51 | 53.41 | 47.07 | 25.45 | 3.76 | 7.04 |
| 2772 | 34.00 | 124.00 | 24.40 | 5.40 | 56.00 | 12.60 | 2.00 | 14.60 | 19.91 | 50.41 | 44.40 | 25.43 | 4.91 | 9.74 |
| 2773 | 33.00 | 124.00 | 23.40 | 4.40 | 36.80 | 9.20 | 2.80 | 12.00 | 19.65 | 57.48 | 40.64 | 20.94 | 3.42 | 5.95 |
| 2777 | 34.00 | 106.00 | 24.00 | 7.00 | 47.20 | 13.40 | 3.80 | 17.20 | 22.36 | 58.57 | 49.03 | 25.28 | 5.16 | 8.81 |
| 2857 | 31.00 | 124.00 | 27.40 | 5.80 | 69.00 | 16.40 | 3.80 | 20.20 | 24.91 | 57.01 | 45.31 | 29.43 | 6.71 | 11.77 |
| 2925 | 37.00 | 119.00 | 15.80 | 5.60 | 52.00 | 8.60 | 6.80 | 15.40 | 24.83 | 58.74 | 66.67 | 25.76 | 4.47 | 7.61 |
| 3027 | 35.00 | 124.00 | 29.40 | 6.20 | 56.00 | 11.20 | 2.20 | 13.40 | 27.64 | 55.23 | 48.18 | 27.55 | 5.23 | 9.47 |
| 3053 | 33.00 | 119.00 | 29.50 | 6.75 | 25.75 | 17.00 | 1.20 | 18.20 | 29.05 | 55.70 | 55.48 | 27.46 | 7.48 | 13.43 |
| 3102 | 31.00 | 119.00 | 39.40 | 5.00 | 44.20 | 17.80 | 2.40 | 20.20 | 30.82 | 60.59 | 57.97 | 35.81 | 7.78 | 12.84 |
| 3240 | 27.00 | 106.00 | 31.00 | 4.80 | 38.40 | 16.60 | 3.80 | 20.40 | 31.95 | 63.41 | 77.13 | 36.59 | 8.44 | 13.31 |
| 3343 | 27.00 | 119.00 | 31.80 | 4.00 | 34.40 | 15.20 | 3.60 | 18.80 | 27.71 | 58.52 | 48.38 | 33.16 | 6.49 | 11.09 |
| 3421 | 27.00 | 113.00 | 32.40 | 5.20 | 40.60 | 16.80 | 3.20 | 20.00 | 21.86 | 65.04 | 69.28 | 35.05 | 5.99 | 9.21 |
| 3584 | 27.00 | 106.00 | 34.00 | 4.80 | 86.00 | 31.20 | 2.00 | 33.20 | 22.08 | 67.30 | 36.07 | 36.67 | 11.34 | 16.85 |
| 3673 | 27.00 | 119.00 | 32.40 | 4.80 | 51.00 | 17.60 | 5.40 | 23.00 | 25.71 | 65.71 | 47.70 | 28.86 | 8.05 | 12.25 |
| 3681 | 27.00 | 106.00 | 29.00 | 5.40 | 53.60 | 25.60 | 4.20 | 29.80 | 19.72 | 66.13 | 48.31 | 40.29 | 8.26 | 12.49 |
| 3746 | 27.00 | 119.00 | 30.80 | 4.80 | 27.80 | 12.00 | 2.60 | 14.60 | 25.36 | 55.23 | 60.40 | 37.61 | 6.92 | 12.53 |
| 3775 | 27.00 | 113.00 | 39.40 | 5.40 | 63.00 | 25.40 | 2.80 | 28.20 | 23.77 | 48.67 | 67.56 | 31.44 | 7.86 | 16.15 |
| 3992 | 37.00 | 124.00 | 28.80 | 6.80 | 62.60 | 17.00 | 2.60 | 19.60 | 24.42 | 57.57 | 52.58 | 15.67 | 6.01 | 10.44 |

**Table 4.6.contd . . .**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4156 | 37.00 | 124.00 | 19.40 | 6.60 | 20.20 | 5.40 | 1.20 | 6.60 | 16.65 | 47.60 | 35.57 | 14.16 | 1.49 | 3.13 |
| 4343 | 37.00 | 124.00 | 15.80 | 7.80 | 70.80 | 17.20 | 9.80 | 27.00 | 21.42 | 53.87 | 44.02 | 29.02 | 6.61 | 12.27 |
| 4412 | 37.00 | 124.00 | 25.60 | 6.40 | 26.80 | 8.20 | 2.00 | 10.20 | 13.97 | 42.39 | 41.45 | 15.95 | 2.34 | 5.52 |
| 4527 | 27.00 | 124.00 | 28.60 | 4.80 | 52.47 | 17.40 | 3.20 | 20.60 | 19.93 | 56.19 | 53.70 | 30.71 | 6.22 | 11.07 |
| 4538 | 35.00 | 124.00 | 18.60 | 7.80 | 45.20 | 13.00 | 8.80 | 21.80 | 25.65 | 50.62 | 31.05 | 36.11 | 7.31 | 14.44 |
| 4543 | 27.00 | 113.00 | 25.60 | 5.20 | 45.40 | 21.60 | 4.20 | 25.80 | 20.31 | 64.44 | 52.10 | 44.77 | 7.14 | 11.08 |
| 4598 | 35.00 | 124.00 | 24.60 | 6.60 | 43.60 | 14.40 | 5.40 | 19.80 | 20.89 | 55.32 | 40.38 | 28.20 | 5.77 | 10.43 |
| 4670 | 27.00 | 124.00 | 25.25 | 9.50 | 43.75 | 10.75 | 5.00 | 15.75 | 28.71 | 58.31 | 62.20 | 19.35 | 4.63 | 7.94 |
| 4684 | 27.00 | 106.00 | 31.40 | 4.80 | 41.80 | 21.20 | 4.60 | 25.80 | 24.04 | 67.11 | 66.75 | 39.68 | 8.06 | 12.01 |
| 4729 | 27.00 | 106.00 | 29.00 | 5.40 | 80.80 | 31.00 | 5.00 | 36.00 | 23.92 | 61.54 | 60.82 | 38.91 | 11.28 | 18.33 |
| 4750 | 27.00 | 106.00 | 32.40 | 4.40 | 44.00 | 19.60 | 6.60 | 26.20 | 17.91 | 53.11 | 11.06 | 30.33 | 5.97 | 11.24 |
| 4911 | 27.00 | 106.00 | 23.00 | 4.40 | 34.40 | 17.40 | 2.60 | 20.00 | 20.21 | 44.98 | 45.84 | 40.57 | 4.21 | 9.36 |
| 4955 | 27.00 | 113.00 | 31.20 | 5.20 | 29.80 | 12.40 | 2.60 | 15.00 | 22.88 | 60.99 | 47.12 | 32.30 | 4.69 | 7.69 |
| 4998 | 34.00 | 124.00 | 23.00 | 3.40 | 29.00 | 10.20 | 5.00 | 15.20 | 24.08 | 44.01 | 45.60 | 50.58 | 3.86 | 8.77 |
| 5016 | 34.00 | 124.00 | 28.75 | 7.50 | 53.50 | 17.75 | 7.00 | 24.75 | 21.65 | 49.45 | 41.74 | 40.63 | 8.53 | 17.25 |
| 5195 | 27.00 | 113.00 | 29.80 | 4.40 | 55.60 | 29.20 | 4.20 | 33.40 | 22.35 | 73.20 | 44.64 | 42.88 | 9.23 | 12.61 |
| 5221 | 27.00 | 119.00 | 39.00 | 4.20 | 32.40 | 14.40 | 1.80 | 16.20 | 21.52 | 52.36 | 39.11 | 43.51 | 7.44 | 14.21 |
| 5236 | 27.00 | 119.00 | 23.40 | 7.00 | 49.60 | 30.00 | 5.60 | 35.60 | 29.76 | 63.99 | 53.22 | 56.92 | 13.06 | 20.41 |
| 5286 | 33.00 | 127.00 | 26.40 | 6.00 | 41.20 | 8.20 | 2.40 | 10.60 | 23.72 | 50.63 | 59.28 | 20.42 | 3.61 | 7.13 |
| 5327 | 33.00 | 127.00 | 30.00 | 4.60 | 28.80 | 10.00 | 2.60 | 12.60 | 24.57 | 61.25 | 61.07 | 27.47 | 4.11 | 6.71 |
| 5475 | 27.00 | 113.00 | 30.40 | 4.20 | 37.20 | 13.60 | 2.20 | 15.80 | 26.92 | 61.04 | 34.53 | 37.63 | 6.11 | 10.01 |
| 5494 | 27.00 | 119.00 | 25.60 | 4.40 | 32.60 | 9.80 | 2.20 | 12.00 | 22.51 | 65.47 | 67.47 | 21.74 | 4.55 | 6.95 |
| 5662 | 32.00 | 119.00 | 27.80 | 6.20 | 35.00 | 14.60 | 3.80 | 18.40 | 38.06 | 47.56 | 62.64 | 28.82 | 6.05 | 12.72 |
| 5663 | 32.00 | 119.00 | 25.20 | 5.00 | 16.20 | 8.60 | 1.40 | 10.00 | 28.82 | 60.34 | 63.17 | 31.35 | 4.29 | 7.11 |

**Table 4.6.contd . . .**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5745 | 32.00 | 113.00 | 37.40 | 5.20 | 79.20 | 15.20 | 3.20 | 18.40 | 26.67 | 59.98 | 46.01 | 21.52 | 6.76 | 11.27 |
| 5779 | 27.00 | 106.00 | 28.13 | 4.20 | 27.80 | 10.20 | 2.60 | 12.80 | 21.31 | 48.82 | 60.51 | 20.29 | 3.52 | 7.21 |
| 5827 | 35.00 | 124.00 | 29.60 | 4.40 | 27.00 | 9.60 | 1.60 | 11.20 | 22.71 | 48.41 | 47.01 | 26.89 | 3.51 | 7.25 |
| 6022 | 37.00 | 124.00 | 40.60 | 4.40 | 26.60 | 10.40 | 1.03 | 11.43 | 21.88 | 36.14 | 53.11 | 27.66 | 3.86 | 10.68 |
| 6057 | 36.00 | 124.00 | 28.60 | 5.60 | 30.20 | 11.00 | 4.60 | 15.60 | 24.60 | 44.83 | 47.27 | 24.79 | 4.21 | 9.39 |
| 6201 | 27.00 | 119.00 | 37.00 | 4.60 | 28.40 | 11.40 | 1.60 | 13.00 | 17.47 | 45.70 | 36.34 | 27.39 | 3.88 | 8.49 |
| 6263 | 27.00 | 119.00 | 31.20 | 6.00 | 38.20 | 17.00 | 1.60 | 18.60 | 15.47 | 48.67 | 39.94 | 27.41 | 3.48 | 7.15 |
| 6375 | 27.00 | 124.00 | 27.40 | 4.80 | 48.60 | 18.80 | 4.60 | 23.40 | 16.53 | 64.69 | 51.96 | 34.17 | 5.35 | 8.27 |
| 6402 | 27.00 | 124.00 | 22.80 | 6.80 | 77.00 | 27.00 | 4.20 | 31.20 | 13.87 | 41.12 | 32.39 | 25.55 | 3.52 | 8.56 |
| 6407 | 27.00 | 113.00 | 22.20 | 5.40 | 35.40 | 17.80 | 3.00 | 20.80 | 24.48 | 54.26 | 52.68 | 37.22 | 7.84 | 14.45 |
| 6646 | 32.00 | 124.00 | 28.00 | 4.00 | 31.20 | 8.40 | 5.80 | 14.20 | 16.71 | 26.09 | 33.97 | 33.70 | 2.09 | 8.01 |
| 6654 | 33.00 | 124.00 | 26.00 | 4.40 | 47.00 | 19.80 | 2.00 | 21.80 | 21.39 | 57.65 | 50.72 | 37.17 | 6.29 | 10.91 |
| 6766 | 35.00 | 124.00 | 30.40 | 7.40 | 26.40 | 5.80 | 1.60 | 7.40 | 19.95 | 33.46 | 14.61 | 11.32 | 1.78 | 5.32 |
| 6888 | 27.00 | 102.00 | 34.40 | 4.00 | 35.60 | 11.60 | 4.20 | 15.80 | 17.61 | 48.77 | 40.30 | 34.17 | 4.74 | 9.72 |
| 6892 | 27.00 | 124.00 | 25.60 | 8.40 | 86.80 | 35.40 | 5.00 | 40.40 | 17.91 | 52.62 | 20.37 | 30.72 | 8.54 | 16.23 |
| 6993 | 35.00 | 124.00 | 22.00 | 9.50 | 40.00 | 20.50 | 5.00 | 25.50 | 17.11 | 59.55 | 14.06 | 33.71 | 6.83 | 11.47 |
| 7000 | 32.00 | 124.00 | 27.40 | 4.80 | 25.60 | 13.00 | 1.40 | 14.40 | 16.35 | 54.36 | 43.55 | 17.86 | 3.49 | 6.42 |
| 7153 | 33.00 | 119.00 | 28.00 | 5.80 | 69.20 | 32.60 | 4.00 | 36.60 | 27.27 | 61.43 | 42.45 | 45.89 | 13.57 | 22.09 |
| 7181 | 33.00 | 119.00 | 28.40 | 5.60 | 29.40 | 18.80 | 2.20 | 21.00 | 28.92 | 59.35 | 49.28 | 44.65 | 9.01 | 15.18 |
| 7190 | 31.00 | 113.00 | 42.60 | 5.80 | 37.00 | 14.80 | 4.00 | 18.80 | 22.02 | 51.30 | 61.20 | 24.17 | 4.33 | 8.44 |
| 7243 | 37.00 | 119.00 | 28.60 | 5.20 | 25.00 | 13.00 | 1.40 | 14.40 | 32.85 | 61.70 | 61.13 | 31.48 | 7.46 | 12.09 |
| 7906 | 33.00 | 113.00 | 37.00 | 5.00 | 59.80 | 26.80 | 2.80 | 29.60 | 24.92 | 59.73 | 56.45 | 35.67 | 9.76 | 16.34 |
| 7963 | 33.00 | 113.00 | 28.60 | 4.80 | 49.20 | 23.40 | 4.80 | 28.20 | 29.32 | 64.66 | 78.61 | 39.89 | 10.19 | 15.76 |
| 7969 | 33.00 | 119.00 | 34.40 | 5.60 | 51.80 | 20.80 | 5.20 | 26.00 | 27.15 | 54.95 | 28.59 | 38.50 | 8.43 | 15.34 |

**Table 4.6.contd . . .**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8106 | 27.00 | 119.00 | 42.00 | 4.40 | 25.00 | 17.80 | 1.20 | 19.00 | 22.47 | 67.04 | 52.22 | 34.19 | 7.87 | 11.74 |
| 8285 | 27.00 | 124.00 | 30.60 | 7.60 | 34.00 | 15.80 | 1.60 | 17.40 | 27.41 | 52.91 | 71.93 | 35.16 | 6.27 | 11.85 |
| 8490 | 27.00 | 124.00 | 35.00 | 5.40 | 58.20 | 23.00 | 7.60 | 30.60 | 22.39 | 49.17 | 12.24 | 43.38 | 8.25 | 16.78 |
| 8517 | 27.00 | 119.00 | 29.40 | 4.00 | 36.60 | 18.60 | 1.30 | 19.90 | 25.67 | 56.74 | 46.41 | 38.69 | 8.92 | 15.72 |
| 8567 | 24.00 | 113.00 | 29.80 | 5.00 | 59.40 | 28.20 | 4.20 | 32.40 | 22.93 | 66.82 | 69.82 | 46.12 | 10.47 | 15.67 |
| 8760 | 27.00 | 119.00 | 20.80 | 5.40 | 25.00 | 15.00 | 3.00 | 18.00 | 22.02 | 60.13 | 41.68 | 35.23 | 7.15 | 11.89 |
| 9037 | 37.00 | 124.00 | 24.60 | 5.20 | 36.20 | 10.20 | 2.40 | 12.60 | 21.91 | 54.61 | 64.82 | 27.02 | 3.61 | 6.61 |
| 9315 | 27.00 | 113.00 | 20.20 | 5.00 | 43.60 | 15.40 | 2.80 | 18.20 | 21.47 | 64.84 | 61.56 | 35.13 | 6.14 | 9.47 |
| 9507 | 27.00 | 119.00 | 20.40 | 4.60 | 37.20 | 15.20 | 3.40 | 18.60 | 22.07 | 57.01 | 64.17 | 32.61 | 5.33 | 9.35 |
| 9666 | 27.00 | 119.00 | 23.80 | 4.60 | 45.20 | 21.60 | 2.40 | 24.00 | 23.99 | 60.33 | 39.33 | 33.98 | 6.28 | 10.41 |
| 9809 | 27.00 | 124.00 | 24.40 | 6.20 | 56.00 | 22.60 | 4.80 | 27.40 | 20.96 | 51.19 | 55.33 | 35.99 | 7.97 | 15.57 |
| 9842 | 27.00 | 124.00 | 22.60 | 4.40 | 47.00 | 20.40 | 5.60 | 26.00 | 19.18 | 60.12 | 54.10 | 36.43 | 7.19 | 11.96 |
| 9905 | 35.00 | 124.00 | 18.60 | 7.00 | 57.40 | 25.40 | 8.00 | 33.40 | 20.12 | 51.10 | 39.33 | 46.82 | 11.11 | 21.74 |
| 9961 | 37.00 | 124.00 | 31.40 | 6.40 | 49.60 | 24.20 | 5.40 | 29.60 | 22.43 | 45.22 | 38.44 | 30.84 | 6.01 | 13.29 |
| 10036 | 35.00 | 124.00 | 31.40 | 3.80 | 39.20 | 14.60 | 3.00 | 17.60 | 18.51 | 47.77 | 35.88 | 36.07 | 5.88 | 12.31 |
| 10092 | 35.00 | 113.00 | 28.60 | 4.00 | 20.20 | 4.20 | 1.06 | 5.26 | 17.51 | 51.87 | 54.95 | 21.75 | 1.11 | 2.14 |
| 10185 | 37.00 | 124.00 | 29.80 | 5.20 | 33.80 | 11.80 | 4.20 | 16.00 | 25.33 | 56.38 | 43.98 | 25.51 | 5.48 | 9.72 |
| 10384 | 34.00 | 113.00 | 24.80 | 5.40 | 38.40 | 17.80 | 3.20 | 21.00 | 24.43 | 68.60 | 51.23 | 43.20 | 7.32 | 10.67 |
| 10474 | 34.00 | 113.00 | 22.60 | 5.60 | 33.80 | 15.80 | 3.80 | 19.60 | 21.84 | 59.14 | 54.44 | 49.37 | 6.76 | 11.43 |
| 10479 | 35.00 | 124.00 | 29.60 | 6.40 | 41.40 | 9.20 | 2.20 | 11.40 | 16.55 | 42.32 | 30.25 | 20.06 | 2.81 | 6.64 |
| 10554 | 33.00 | 113.00 | 27.40 | 5.20 | 46.40 | 21.80 | 3.80 | 25.60 | 18.42 | 48.98 | 31.55 | 41.81 | 5.99 | 12.23 |
| 10566 | 27.00 | 113.00 | 38.00 | 4.60 | 38.20 | 15.20 | 3.40 | 18.60 | 25.85 | 49.77 | 41.95 | 41.65 | 7.58 | 15.23 |
| 10890 | 27.00 | 113.00 | 7.80 | 4.00 | 30.00 | 10.60 | 4.20 | 14.80 | 13.45 | 62.68 | 50.84 | 40.46 | 2.99 | 4.77 |
| 11088 | 34.00 | 124.00 | 33.60 | 4.60 | 43.40 | 18.80 | 4.60 | 23.40 | 16.61 | 43.55 | 35.39 | 41.22 | 7.29 | 16.74 |

**Table 4.6.contd . . .**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11109 | 35.00 | 124.00 | 28.20 | 5.60 | 44.40 | 19.40 | 5.40 | 24.80 | 21.31 | 57.24 | 41.31 | 37.17 | 6.56 | 11.46 |
| 11144 | 32.00 | 113.00 | 34.00 | 6.60 | 44.80 | 23.20 | 4.20 | 27.40 | 21.22 | 60.00 | 48.90 | 39.76 | 9.51 | 15.85 |
| 11219 | 27.00 | 124.00 | 30.40 | 4.80 | 34.60 | 11.40 | 3.00 | 14.40 | 23.49 | 52.02 | 41.04 | 26.44 | 5.02 | 9.65 |
| 11249 | 32.00 | 106.00 | 33.20 | 5.20 | 47.00 | 23.20 | 1.40 | 24.60 | 22.16 | 58.69 | 35.13 | 37.09 | 8.17 | 13.92 |
| 11322 | 27.00 | 119.00 | 27.20 | 6.20 | 33.40 | 19.20 | 4.80 | 24.00 | 29.71 | 62.74 | 49.84 | 38.63 | 9.31 | 14.84 |
| 11426 | 27.00 | 124.00 | 29.00 | 7.33 | 79.99 | 31.66 | 6.00 | 37.66 | 18.34 | 47.95 | 14.11 | 33.67 | 8.29 | 17.29 |
| 11457 | 27.00 | 119.00 | 31.40 | 5.60 | 35.00 | 12.40 | 3.60 | 16.00 | 23.39 | 52.27 | 68.12 | 20.48 | 6.21 | 11.88 |
| 11515 | 27.00 | 119.00 | 32.20 | 5.20 | 38.40 | 18.60 | 2.60 | 21.20 | 33.16 | 57.44 | 58.31 | 42.83 | 10.65 | 18.54 |
| 11651 | 27.00 | 119.00 | 31.40 | 4.40 | 39.00 | 26.20 | 3.80 | 30.00 | 35.04 | 63.95 | 54.79 | 47.44 | 14.62 | 22.86 |
| 11687 | 27.00 | 113.00 | 31.20 | 4.80 | 65.80 | 29.00 | 4.00 | 33.00 | 25.36 | 67.08 | 56.26 | 41.73 | 10.86 | 16.19 |
| 11855 | 27.00 | 119.00 | 23.60 | 6.80 | 45.00 | 23.00 | 5.20 | 28.20 | 30.84 | 56.23 | 45.42 | 44.18 | 11.56 | 20.56 |
| 12000 | 36.00 | 119.00 | 27.20 | 7.00 | 50.80 | 21.00 | 4.00 | 25.00 | 24.25 | 59.29 | 45.41 | 25.08 | 8.39 | 14.15 |
| 12189 | 27.00 | 119.00 | 28.40 | 4.60 | 31.60 | 13.80 | 4.60 | 18.40 | 28.15 | 58.75 | 38.90 | 53.76 | 8.02 | 13.65 |
| 12276 | 27.00 | 119.00 | 23.20 | 7.20 | 42.00 | 24.00 | 5.20 | 29.20 | 31.21 | 60.01 | 68.42 | 46.55 | 12.38 | 20.63 |
| 12370 | 33.00 | 124.00 | 25.40 | 6.60 | 45.20 | 19.80 | 5.60 | 25.40 | 24.79 | 55.72 | 61.03 | 29.74 | 7.16 | 12.85 |
| 12625 | 33.00 | 124.00 | 34.20 | 4.00 | 36.60 | 16.60 | 2.40 | 19.00 | 24.66 | 48.35 | 41.18 | 37.36 | 6.29 | 13.01 |
| 12672 | 35.00 | 124.00 | 26.00 | 7.80 | 74.60 | 21.80 | 7.80 | 29.60 | 29.32 | 45.80 | 50.74 | 31.16 | 7.41 | 16.18 |
| 12682 | 27.00 | 106.00 | 30.80 | 5.00 | 40.40 | 13.60 | 4.80 | 18.40 | 23.25 | 57.33 | 66.32 | 28.78 | 4.81 | 8.39 |
| 12697 | 27.00 | 106.00 | 28.20 | 5.20 | 62.00 | 23.60 | 2.00 | 25.60 | 26.05 | 66.58 | 48.63 | 37.92 | 10.22 | 15.35 |
| 12879 | 35.00 | 124.00 | 22.60 | 8.20 | 55.20 | 26.40 | 10.80 | 37.20 | 27.65 | 53.93 | 29.91 | 48.38 | 12.57 | 23.31 |
| 156 | 36.00 | 106.00 | 25.20 | 6.00 | 42.00 | 21.80 | 10.20 | 32.00 | 28.61 | 50.83 | 36.58 | 45.68 | 9.46 | 18.61 |
| 2738 | 34.00 | 113.00 | 33.20 | 5.00 | 51.80 | 21.40 | 4.60 | 26.00 | 25.07 | 65.14 | 52.46 | 36.56 | 8.52 | 13.08 |
| 12921 | 33.00 | 106.00 | 22.00 | 5.00 | 27.27 | 17.87 | 2.00 | 19.87 | 24.28 | 55.10 | 45.78 | 37.34 | 6.75 | 12.25 |
| 12988 | 33.00 | 113.00 | 32.20 | 5.20 | 53.40 | 23.20 | 3.80 | 27.00 | 21.41 | 64.74 | 68.37 | 40.58 | 8.41 | 12.99 |

**Table 4.6.contd . . .**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13099 | 37.00 | 124.00 | 22.60 | 7.20 | 48.80 | 22.80 | 5.20 | 28.00 | 23.52 | 52.59 | 54.56 | 38.16 | 8.01 | 15.23 |
| 13603 | 31.00 | 113.00 | 26.60 | 5.60 | 36.20 | 18.80 | 3.80 | 22.60 | 25.38 | 59.37 | 62.55 | 39.99 | 7.13 | 12.01 |
| 13723 | 37.00 | 124.00 | 29.20 | 5.40 | 37.40 | 16.40 | 4.40 | 20.80 | 19.78 | 60.73 | 44.32 | 34.36 | 7.13 | 11.74 |
| 13787 | 37.00 | 124.00 | 25.20 | 6.20 | 40.80 | 17.60 | 8.40 | 26.00 | 20.86 | 46.00 | 42.29 | 32.47 | 5.58 | 12.13 |
| 13858 | 27.00 | 124.00 | 23.00 | 8.00 | 30.00 | 13.00 | 2.00 | 15.00 | 18.66 | 57.73 | 41.58 | 29.07 | 6.83 | 11.83 |
| 13941 | 33.00 | 124.00 | 23.20 | 7.60 | 34.60 | 18.00 | 4.20 | 22.20 | 25.21 | 54.52 | 48.23 | 45.22 | 10.43 | 19.13 |
| 13942 | 34.00 | 124.00 | 23.60 | 6.20 | 43.40 | 28.60 | 3.40 | 32.00 | 33.82 | 59.22 | 53.13 | 48.66 | 14.23 | 24.03 |
| 13982 | 27.00 | 119.00 | 28.00 | 4.60 | 35.20 | 20.80 | 2.40 | 23.20 | 28.74 | 63.97 | 60.43 | 42.78 | 9.73 | 15.21 |
| 14008 | 37.00 | 124.00 | 30.20 | 6.80 | 51.80 | 19.80 | 6.60 | 27.40 | 20.21 | 46.69 | 41.75 | 25.90 | 6.85 | 14.67 |
| 14106 | 37.00 | 115.00 | 35.40 | 6.00 | 53.00 | 27.60 | 3.00 | 30.60 | 20.25 | 55.58 | 44.71 | 37.44 | 10.11 | 18.19 |
| 14118 | 27.00 | 113.00 | 34.80 | 5.40 | 60.80 | 28.60 | 6.60 | 35.20 | 26.77 | 61.08 | 69.00 | 39.64 | 10.42 | 17.06 |
| 14127 | 27.00 | 110.00 | 39.00 | 5.80 | 42.80 | 22.40 | 3.60 | 26.00 | 22.24 | 51.71 | 78.70 | 43.91 | 10.75 | 20.79 |
| 14466 | 35.00 | 119.00 | 35.40 | 8.60 | 64.40 | 20.80 | 7.60 | 28.40 | 32.52 | 56.16 | 48.90 | 29.54 | 9.57 | 17.04 |
| 14475 | 27.00 | 121.00 | 43.00 | 7.40 | 61.00 | 19.20 | 10.00 | 29.20 | 29.01 | 59.89 | 59.73 | 28.49 | 8.84 | 14.76 |
| 14482 | 34.00 | 119.00 | 34.20 | 6.60 | 44.80 | 13.40 | 4.00 | 17.40 | 28.62 | 57.67 | 76.36 | 25.77 | 6.43 | 11.15 |
| 14523 | 29.00 | 106.00 | 39.20 | 6.40 | 48.00 | 23.80 | 3.20 | 27.00 | 24.31 | 63.12 | 53.14 | 40.33 | 10.20 | 16.16 |
| 14630 | 27.00 | 106.00 | 43.40 | 5.20 | 50.60 | 14.40 | 6.20 | 20.60 | 25.71 | 53.50 | 48.55 | 32.70 | 8.26 | 15.44 |
| 14705 | 27.00 | 119.00 | 30.00 | 5.40 | 25.40 | 15.20 | 7.40 | 22.60 | 28.44 | 58.83 | 42.66 | 45.20 | 7.43 | 12.63 |
| 14710 | 29.00 | 121.00 | 34.40 | 4.40 | 21.00 | 13.40 | 3.00 | 16.40 | 23.91 | 53.39 | 64.34 | 37.34 | 6.45 | 12.08 |
| 14985 | 27.00 | 121.00 | 21.00 | 4.80 | 27.20 | 14.40 | 3.40 | 17.80 | 29.22 | 57.97 | 51.38 | 36.85 | 6.87 | 11.85 |
| 15042 | 34.00 | 119.00 | 24.20 | 4.60 | 40.00 | 19.20 | 4.40 | 23.60 | 28.54 | 55.56 | 50.56 | 42.68 | 9.85 | 17.73 |
| 15190 | 34.00 | 124.00 | 27.40 | 6.80 | 40.80 | 23.80 | 3.20 | 27.00 | 29.01 | 57.22 | 43.49 | 38.81 | 9.91 | 17.32 |
| 15287 | 27.00 | 119.00 | 33.40 | 4.40 | 29.60 | 17.60 | 2.80 | 20.40 | 25.91 | 61.94 | 68.61 | 34.48 | 7.39 | 11.93 |
| 15309 | 27.00 | 119.00 | 37.00 | 6.00 | 51.60 | 25.60 | 2.20 | 27.80 | 23.61 | 58.44 | 52.91 | 37.80 | 12.70 | 21.73 |

**Table 4.6.contd . . .**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15419 | 33.00 | 119.00 | 32.20 | 4.00 | 27.40 | 11.20 | 2.60 | 13.80 | 28.09 | 47.01 | 58.87 | 33.00 | 6.37 | 13.55 |
| Narayani ($C_1$) | 27.83 | 105.33 | 37.13 | 4.88 | 41.60 | 23.20 | 3.47 | 26.67 | 27.37 | 55.52 | 60.99 | 40.21 | 9.35 | 16.86 |
| Dharani ($C_2$) | 25.32 | 102.50 | 31.20 | 4.97 | 40.97 | 17.58 | 3.83 | 21.42 | 30.42 | 68.88 | 64.32 | 40.52 | 9.88 | 14.34 |
| K-6 ($C_3$) | 25.50 | 106.33 | 31.20 | 5.47 | 42.40 | 19.53 | 3.40 | 22.93 | 26.10 | 57.99 | 48.27 | 34.62 | 9.28 | 15.93 |
| TCGS- 1157 ($C_4$) | 30.50 | 113.00 | 23.27 | 6.47 | 52.10 | 24.53 | 5.05 | 29.58 | 27.18 | 59.31 | 45.34 | 41.28 | 11.10 | 18.60 |
| TCGS- 1330 ($C_5$) | 29.17 | 110.33 | 25.08 | 7.45 | 49.38 | 24.49 | 3.60 | 28.09 | 34.63 | 60.55 | 52.46 | 40.17 | 12.85 | 21.16 |

DF : Days to 50% flowering; DM : days to maturity; PH : Plant height (cm); NPB : Number of primary branches per plant (No); NPEGP : Number of pegs per plant (No); NMP : Number of mature pods per plant (No); NIMP : Number of immature pods per plant (No); NPP : number of pods per plant (No); 100KW : 100 kernel weight (g); SP : Shelling percentage(%); SMK% : Sound mature kernel percentage(%); HI : Harvest index (%); KYP : Kernel yield per plant (g); PYP : Pod yield per plant (g).

#### 4.2.2.1 Days to 50 % flowering

Days to 50 % flowering ranged from 24 to 37 days with a general mean of 30.73 days. One genotype was earlier in flowering than the best check dharani (25.32 days). Among the genotypes ICG- 8567 was earliest (24 days) in flowering, whereas, many genotypes took up to 37 days to flower. The five genotypes viz., ICG- 8567 (24 days), ICG- 1399 (27 days), ICG- 1415 (27 days), ICG- 1519 (27 days) and ICG- 1711 (27 days) recorded early flowering.

#### 4.2.2.2 Days to maturity

One genotype was earlier in flowering than the best check dharani (102.50). Mean value for days to maturity ranged from 102 (ICG-6888) to 127 days (ICG-5327) with a general mean of 117.76 days. Among the genotypes ICG- 6888 matured early (102 days). Whereas, ICG- 5286, ICG-5327 matured late (127 days). The five genotypes viz., ICG- 6888 (102 days), ICG- 76 (106 days), ICG- 332 (106 days), ICG- 334 (106 days) and ICG- 434 (106 days) matured early.

#### 4.2.2.3 Plant height (cm)

Twelve genotypes were found taller in height than the best check narayani (37.13 cm). For plant height the mean value ranged from 7.80 cm (ICG-10890) to 43.40 cm (ICG-14630) days with a general mean of 28.42 cm. The top five genotypes that recorded taller plant height are ICG- 14630 (43.40 cm), ICG- 14475 (43.00 cm), ICG- 7190 (42.60 cm), ICG- 8106 (42.00 cm) and ICG- 6022 (40.60 cm).

#### 4.2.2.4 Number of primary branches per plant

Number of primary branches per plant varied from 3.40 (ICG-4998) to 15 (ICG-2511) with a general mean of 5.72. The top five genotypes that recorded more number of primary branches are ICG- 2511 (15.00), ICG-4670 (9.50), ICG- 6993 (9.50), ICG- 332 (8.60) and ICG- 14466 (8.60).

Nineteen genotypes recorded more number of primary branches per plant than the best check TCGS-1330 (7.45).

#### 4.2.2.5 Number of pegs per plant

The range of number of pegs per plant was from 16.20 (ICG-5663) to 112 (ICG-434) with a general mean of 44.97. Forty four genotypes registered more number of pegs per plant than the best check TCGS-1157 (52.10). The top five genotypes that exhibited more number of pegs are ICG- 434 (112.00), ICG- 6892 (86.80), ICG- 3584 (86.00), ICG- 4729 (80.80) and ICG- 11426 (79.99).

#### 4.2.2.6 Number of mature pods per plant

More number of mature pods per plant than the best check TCGS-1157 (24.60) were observed in 24 genotypes. The mean value for number of mature pods per plant ranged from 3.80 (ICG-721) to 35.40 (ICG-6892) with a general mean of 17.78. The top five genotypes that recorded more number of mature pods are ICG- 6892 (35.40), ICG- 434 (35.20), ICG- 7153 (32.60), ICG- 11426 (31.66) and ICG- 3584 (31.20).

#### 4.2.2.7 Number of immature pods per plant

Number of immature pods per plant ranged from 1 to 10.80 with a general mean of 3.90. Less number of immature pods per plant than the best check K-6 (3.40) was recorded by 79 genotypes. Among the genotypes ICG-532, ICG- 297 recorded lowest (1.00) number of immature pods per plant, whereas ICG- 12879 registered highest number of immature pods per plant (10.80). The five genotypes that recorded less number of immature pods are ICG- 297 (1.00), ICG- 532 (1.00), ICG- 6022 (1.03), ICG- 10092 (1.06) and ICG- 1973 (1.20).

**Table 4.7. Grand mean, range, best check and number of germplasm lines superior to best check for 14 characters under inorganic fertilizer management**

| S.No | ICG Number | Range | | Mean | Best check | Number of germplasm lines |
|---|---|---|---|---|---|---|
| | | Min | Max | | | |
| 1 | DF | 24.00 (ICG-8567) | 37.00 (ICG-14008) | 30.73 | $C_2$-Dharani (25.32) | 1.00 |
| 2 | DM | 102.00 (ICG-6888) | 127.00 (ICG-5327) | 117.76 | $C_2$-Dharani (102.50) | 1.00 |
| 3 | PH | 7.80 (ICG-10890) | 43.40 (ICG-14630) | 28.42 | $C_1$-Narayani (37.13) | 12.00 |
| 4 | NPB | 3.40 (ICG-4998) | 15.00 (ICG-2511) | 5.72 | $C_5$- TCGS-1330 (7.45) | 19.00 |
| 5 | NPEGP | 16.20 (ICG-5663) | 112.00 (ICG-434) | 44.97 | $C_4$-TCGS-1157 (52.10) | 44.00 |
| 6 | NMP | 3.80 (ICG-721) | 35.40 (ICG-6892) | 17.78 | $C_4$-TCGS-1157 (24.53) | 24.00 |
| 7 | NIMP | 1.00 (ICG-532) | 10.80 (ICG-12879 | 3.90 | $C_3$-K-6 (3.40) | 79.00 |
| 8 | NPP | 5.26 (ICG-10092) | 40.40 (ICG-6892) | 21.68 | $C_4$-TCGS-1157 (29.58) | 25.00 |
| 9 | 100KW | 13.45 (ICG-10890) | 38.06 (ICG-5662) | 23.76 | $C_5$- TCGS-1330 (34.63) | 2.00 |
| 10 | SP | 26.09 (ICG-6646) | 73.20 (ICG-5195) | 55.92 | $C_2$-Dharani (68.88) | 1.00 |
| 11 | SMK % | 11.06 (ICG-4750) | 78.70 (ICG-14127) | 49.64 | $C_2$-Dharani (64.32) | 23.00 |
| 12 | HI | 6.99 (ICG-721) | 56.92 (ICG-5236) | 33.38 | $C_4$-TCGS-1157 (41.28) | 30.00 |
| 13 | KYP | 1.04 (ICG-721) | 14.95 (ICG-434) | 7.12 | $C_5$- TCGS-1330 (12.85) | 5.00 |
| 14 | PYP | 2.14 (ICG-10092) | 24.25 (ICG-434) | 12.56 | $C_5$- TCGS-1330 (21.16) | 6.00 |

DF : Days to 50% flowering; DM : days to maturity; PH : Plant height (cm); NPB : Number of primary branches per plant (No); NPEGP : Number of pegs per plant (No); NMP : Number of mature pods per plant (No); NIMP : Number of immature pods per plant (No); NPP : Number of pods per plant (No); 100SW : 100 kernel weight (g); SP : Shelling percentage(%); SMK% : Sound mature kernel percentage(%); HI : Harvest index (%); KYP : Kernel yield per plant (g); PYP : Pod yield per plant (g).

#### 4.2.2.8 Number of pods per plant

The range of number of pods per plant was from 5.26 (ICG-10092) to 40.40 (ICG-6892) with a general mean of 21.68. The top five genotypes that recorded more number of pods are ICG- 6892 (40.40), ICG- 434 (38.40), ICG- 11426 (37.66), ICG- 12879 (37.20) and ICG- 7153 (36.60). Twenty five genotypes recorded more total number of pods per plant than the best check TCGS-1157 (29.65).

#### 4.2.2.9 100 kernel weight (g)

For 100 kernel weight mean value ranged from 13.45 g (ICG-10890) to 38.06 g (ICG-5662) with a general mean of 23.76 g. Highest 100 kernel weight than the best check TCGS-1330 (34.63 g) was registered by two genotypes. The top five genotypes that recorded high 100 kernel weight are ICG- 5662 (38.06 g), ICG- 11651 (35.04 g), ICG- 13942 (33.82 g), ICG- 11515 (33.16 g) and ICG- 7243 (32.85 g).

#### 4.2.2.10 Shelling percentage

One genotype recorded higher shelling percentage than the best check dharani (68.88 %). Mean value for shelling percentage ranged from 26.09 % (ICG-6646) to 73.20 % (ICG-5195) with a general mean of 55.92 %. The top five genotypes that recorded high shelling percentage are ICG- 5195 (73.20 %), ICG- 10384 (68.60 %), ICG- 1519 (67.75 %), ICG- 1137 (67.36 %) and ICG- 3584 (67.30 %).

#### 4.2.2.11 Sound mature kernel percentage

For sound mature kernel percentage the mean value ranged from 11.06 % (ICG-4750) to 78.70 % (ICG-14127) with a general mean of 49.64 %. The top five genotypes that recorded high sound mature kernel percentage are ICG- 14127 (78.70 %), ICG- 7963 (78.61 %), ICG- 3240 (77.13 %), ICG- 14482 (76.36 %) and ICG- 118 (74.50 %). Twenty three

**Table 4.8. Summary of top five germplasm lines based on the mean performance for yield and yield contributing characters under inorganic fertilizer management.**

| S. No | Characters | Germplasm lines |
|---|---|---|
| 1 | Days to 50% flowering (Early) | ICG- 8567, ICG- 1399, ICG- 1415, ICG-1519, ICG- 1711 |
| 2 | Days to maturity (Early) | ICG- 6888, ICG- 76, ICG- 332, ICG- 334, ICG- 434 |
| 2 | Plant height (Taller in cm) | ICG- 14630, ICG- 14475, ICG- 7190, ICG- 8106, ICG- 6022 |
| 3 | Number of primary branches per plant | ICG- 2511, ICG- 4670, ICG- 6993, ICG-332, ICG- 14466 |
| | Number of pegs per plant | ICG- 434, ICG- 6892, ICG- 3584, ICG-4729, ICG- 11426 |
| 4 | Number of mature pods per plant | ICG- 6892, ICG- 434, ICG- 7153, ICG-11426, ICG- 3584 |
| 5 | Number of immature pods per plant (Less) | ICG- 297, ICG- 532, ICG- 6022, ICG- 10092, ICG- 1973 |
| 6 | Number of pods per plant | ICG- 6892, ICG- 434, ICG- 11426, ICG-12879, ICG- 7153 |
| 7 | 100 kernel weight (g) | ICG- 5662, ICG- 11651, ICG- 13942, ICG- 11515, ICG- 7243 |
| 8 | Shelling percentage | ICG- 5195, ICG- 10384, ICG- 1519, ICG-1137, ICG- 3584 |
| 9 | Sound mature kernel percentage | ICG- 14127, ICG- 7963, ICG- 3240, ICG-14482, ICG- 118 |
| 10 | Harvest index (%) | ICG- 5236, ICG- 12189, ICG- 4998, ICG-10474, ICG- 13942 |
| 11 | Kernel yield per plant (g) | ICG- 434, ICG- 11651, ICG- 13942, ICG-7153, ICG- 5236 |
| 12 | Pod yield per plant (g) | ICG- 434, ICG- 13942, ICG- 332, ICG-12879, ICG- 11651 |

genotypes recorded highest sound mature kernel percentage than the best check dharani (64.32 %).

#### 4.2.2.12 Harvest index (%)

Harvest index ranged from 6.99 % (ICG-721) to 56.92 % (ICG-5236) with a general mean of 33.38 %. Highest harvest index than the best check TCGS-1157 (41.28 %) was registered by 30 genotypes. The top five genotypes that recorded high harvest index are ICG- 5236 (56.92 %), ICG-12189 (53.76 %), ICG- 4998 (50.58 %), ICG- 10474 (49.37 %) and ICG-13942 (48.66 %).

#### 4.2.2.13 Kernel yield per plant (g)

Mean value ranged from 1.04 g (ICG-721) to 14.95 g (ICG-434) for this trait with a general mean of 7.12 g. Five genotypes viz., ICG- 434 (14.95 g), ICG- 11651 (14.62 g), ICG- 13942 (14.23 g), ICG- 7153 (13.57 g) and ICG- 5236 (13.06 g) recorded higher kernel yield per plant than the best check TCGS-1330 (12.85 g).

#### 4.2.2.14 Pod yield per plant (g)

Six genotypes registered high pod yield per plant than the best check TCGS-1330 (21.16 g). Pod yield per plant ranged from 2.14 g (ICG-10092) to 24.25 g (ICG-434) with a general mean of 12.56 g. The top five genotypes that recorded highest pod yield are ICG- 434 (24.25 g), ICG-13942 (24.03 g), ICG- 332 (23.75 g), ICG- 12879 (23.31 g) and ICG- 11651 (22.86 g).

The results indicated that the top five genotypes presented under each character are worthy of utilization in improvement of the respective character under inorganic fertilizer management.

Under organic fertilizer management the overall general mean performance of 168 germplasm lines and five checks was higher for pod yield than under inorganic fertilizer management. These results were in conformity with the findings of Perenzin and Matteis (2004) in soft wheat varieties in which they reported that yields of organic cultivation were higher than inorganic cultivation. However, rank changes were observed among the genotypes between the two cultivation systems. Finally, they concluded that increasing yield in organic system through breeding would require direct selection within organic systems rather than indirect selection in inorganic system.

The genotype ICG- 13942 showed higher performance for kernel yield and pod yield under both organic and inorganic fertilizer managements. All other genotypes showed differential performance for kernel yield and pod yield under organic and inorganic fertilizer managements suggesting the need for development of cultivars suitable for target environments.

### 4.2.3 Mean performance for Quality traits under Organic Fertilizer Management

The total carbohydrates and protein content estimation gives information about nutritional status of groundnut genotypes which can be used for table purpose. By estimating total free amino acids we can know the physiological and health status of the plants. By estimation of oil content we can know suitability of genotypes for oil industry.

The mean performance for quality traits viz., oil content, protein content, total carbohydrates and total free amino acids of 25 superior genotypes which were selected based on mean performance of kernel yield per plant under organic management is presented in Table 4.9.

**Table 4.9. The mean performance for quality traits of 25 superior germplasm lines under organic fertilizer management**

| ICG Number | | Oil content (%) | Protein content (%) | TCH % | TFA (g/100g) |
|---|---|---|---|---|---|
| 13099 | | 46.30 | 25.70 | 18.72 | 0.39 |
| 13942 | | 46.20 | 26.40 | 9.64 | 0.51 |
| 10384 | | 47.70 | 26.30 | 18.85 | 0.56 |
| 13723 | | 47.40 | 25.90 | 15.18 | 0.33 |
| 2777 | | 46.80 | 25.10 | 11.95 | 0.44 |
| 2925 | | 46.00 | 27.00 | 9.69 | 0.37 |
| 334 | | 48.60 | 24.90 | 18.63 | 0.29 |
| 3992 | | 48.50 | 24.00 | 17.82 | 0.38 |
| 7000 | | 47.70 | 24.60 | 17.54 | 0.24 |
| 11322 | | 46.60 | 25.30 | 13.39 | 0.29 |
| 11426 | | 47.80 | 25.40 | 12.16 | 0.37 |
| 11651 | | 49.30 | 25.60 | 6.31 | 0.12 |
| 9037 | | 45.90 | 25.60 | 8.01 | 0.39 |
| 3053 | | 47.80 | 26.50 | 10.66 | 0.44 |
| 13787 | | 46.90 | 25.60 | 14.03 | 0.43 |
| 3027 | | 47.10 | 26.50 | 10.09 | 0.38 |
| 4670 | | 47.60 | 25.10 | 13.35 | 0.29 |
| 2738 | | 47.90 | 25.20 | 18.68 | 0.35 |
| 10185 | | 46.80 | 25.40 | 8.23 | 0.26 |
| 111 | | 46.30 | 25.20 | 7.68 | 0.22 |
| 332 | | 48.00 | 25.40 | 4.26 | 0.35 |
| 7153 | | 47.30 | 26.50 | 4.04 | 0.42 |
| 11687 | | 48.60 | 24.70 | 15.30 | 0.38 |
| 12921 | | 47.60 | 25.70 | 17.11 | 0.60 |
| 9809 | | 48.80 | 24.80 | 15.01 | 0.38 |
| Narayani | | 47.00 | 25.40 | 18.00 | 0.25 |
| Dharani | | 48.40 | 25.40 | 15.80 | 0.43 |
| K6 | | 47.80 | 25.60 | 17.68 | 0.15 |
| TCGS-1157 | | 47.40 | 26.30 | 12.63 | 0.14 |
| TCGS-1330 | | 47.80 | 26.20 | 12.49 | 0.26 |
| Range | Min | 45.90 | 24.00 | 4.04 | 0.12 |
| | Max | 49.30 | 27.00 | 18.85 | 0.60 |

TCH : Total carbohydrate; TFA : Total free amino acids

#### 4.2.3.1 Oil content (%)

The oil content for 25 genotypes ranged from 45.90 % (ICG- 9037) to 49.30 % (ICG- 11651). The genotypes viz., ICG- 11651, ICG- 9809, ICG- 334, ICG- 11687 and ICG- 3992 recorded higher oil content than the best check Dharani (48.40 %).

#### 4.2.3.2 Protein content (%)

The genotypes ICG- 2925, ICG- 3053, ICG- 3027, ICG- 7153 and ICG- 13942 recorded higher protein content than best check TCGS-1157 (26.30 %). Mean value for protein content ranged from 24 % (ICG- 3992) to 27% (ICG- 2925).

#### 4.2.3.3 Total carbohydrates (%)

Total carbohydrates ranged from 4.40 % (ICG- 7153) to 18.85 % (ICG- 10384). The genotypes ICG- 10384, ICG- 2738, ICG- 334, ICG- 13099 and ICG- 3992 showed high total carbohydrates content than best check Narayani (18.56 %).

#### 4.2.3.4 Total free amino acids (g/ 100g)

Total free amino acids content was higher than the best check Dharani (0.43 g. per 100 g.) in ICG- 12921, ICG- 10384, ICG- 13942, ICG- 2777 and ICG- 3053. Mean value for this trait ranged from 0.12 (ICG- 11651) to 0.60 g per 100 g. (ICG- 12921).

### 4.2.4 Mean performance for Quality characters under Inorganic Fertilizer Management

The mean performance for quality characters viz., oil content, protein content, total carbohydrates and total free amino acids of 25 superior genotypes which were selected based on mean performance of kernel yield per plant under inorganic management is furnished in Table 4.10.

**Table 4.10. The mean performance for quality traits of 25 superior germplasm lines under inorganic fertilizer management**

| ICG Number | | Oil content (%) | Protein content (%) | TCH (%) | TFA (g/100g) |
|---|---|---|---|---|---|
| 434 | | 46.32 | 26.30 | 13.89 | 0.83 |
| 11651 | | 46.73 | 26.50 | 5.98 | 0.42 |
| 13942 | | 46.10 | 26.70 | 17.00 | 0.43 |
| 7153 | | 46.90 | 25.20 | 18.02 | 0.32 |
| 5236 | | 47.50 | 26.80 | 17.28 | 0.41 |
| 15309 | | 48.30 | 25.80 | 17.82 | 0.45 |
| 332 | | 48.50 | 26.40 | 18.62 | 0.41 |
| 12879 | | 47.60 | 26.10 | 18.50 | 0.36 |
| 12276 | | 47.60 | 25.90 | 17.92 | 0.66 |
| 118 | | 47.80 | 25.10 | 8.41 | 0.25 |
| 11855 | | 46.80 | 25.90 | 10.21 | 0.45 |
| 3584 | | 47.70 | 25.00 | 8.54 | 0.20 |
| 4729 | | 47.30 | 25.20 | 12.64 | 0.46 |
| 9905 | | 47.20 | 25.80 | 11.35 | 0.40 |
| 11687 | | 47.10 | 24.10 | 17.68 | 0.31 |
| 14127 | | 47.90 | 24.00 | 8.79 | 0.19 |
| 11515 | | 46.53 | 25.20 | 12.51 | 0.16 |
| 8567 | | 47.40 | 24.00 | 8.15 | 0.32 |
| 13941 | | 47.40 | 25.60 | 9.15 | 0.26 |
| 14118 | | 46.90 | 25.20 | 12.65 | 0.43 |
| 12697 | | 48.20 | 25.60 | 8.88 | 0.29 |
| 14523 | | 47.40 | 25.60 | 15.39 | 0.36 |
| 7963 | | 47.10 | 25.40 | 16.62 | 0.34 |
| 14106 | | 48.36 | 25.30 | 5.21 | 0.36 |
| 15190 | | 48.63 | 25.50 | 10.21 | 0.37 |
| Narayani | | 47.80 | 25.40 | 17.5 | 0.45 |
| Dharani | | 48.00 | 25.80 | 17.21 | 0.30 |
| K-6 | | 47.60 | 25.90 | 17.11 | 0.32 |
| TCGS-1157 | | 47.10 | 26.10 | 13.15 | 0.38 |
| TCGS-1330 | | 46.21 | 25.60 | 18.25 | 0.34 |
| Range | Min | 46.10 | 24.00 | 5.21 | 0.16 |
| | Max | 48.63 | 26.80 | 18.62 | 0.83 |

TCH : Total carbohydrate; TFA: Total free amino acids

#### 4.2.4.1 Oil content (%)

The genotypes viz., ICG- 15190, ICG- 332, ICG- 14106, ICG- 15309 and ICG- 12697 recorded higher oil content than best check Dharani (48.00 %). The oil content for 25 genotypes ranged from 46.10 % (ICG- 13942) to 48.63 % (ICG- 15190).

#### 4.2.4.2 Protein content (%)

The genotypes ICG- 5236, ICG- 13942, ICG- 11651, ICG- 332 and ICG- 434 exhibited high protein content than best check TCGS-1157 (26.10 %). Mean value for protein content ranged from 24 % (ICG- 8567) to 26.8 % (ICG- 5236).

#### 4.2.4.3 Total carbohydrates (%)

Total carbohydrates ranged from 5.21 % (ICG- 14106) to 18.62 % (ICG- 332). The genotypes ICG- 332, ICG- 12879, ICG- 7153, ICG- 12276 and ICG- 15309 showed high total carbohydrates content than best check TCGS-1330 (20.68 %).

#### 4.2.4.4 Total free amino acids (g/ 100g)

Total free amino acids content was higher than the best check Narayani (0.45 g. per 100 g.) in ICG- 434, ICG- 12276, ICG- 4729, ICG- 15309 and ICG- 11855. Mean value for this trait ranged from 0.16 (ICG- 11515) to 1.05 g. per 100 g. (ICG- 434).

Based on above results, the genotypes viz., ICG- 11651, ICG- 9809, ICG- 334, ICG- 11687 and ICG- 3992 were promising for oil content; the genotypes viz., ICG- 2925, ICG- 3053, ICG- 3027, ICG- 7153 and ICG- 13942 were good for protein content; the genotypes viz., ICG- 10384, ICG- 2738, ICG- 334, ICG- 13099 and ICG- 3992 were promising for total carbohydrates; the genotypes viz., ICG- 12921, ICG- 10384, ICG- 13942, ICG- 2777 and ICG- 3053 were better for free amino acids were worthy of utilization in improvement of the respective characters under organic management.

The genotypes viz., ICG- 15190, ICG- 332, ICG- 14106, ICG- 15309 and ICG- 12697 were good for oil content; the genotypes viz., ICG- 5236, ICG- 13942, ICG- 11651, ICG- 332 and ICG- 434 were promising for protein content; the genotypes viz., ICG- 332, ICG- 12879, ICG- 7153, ICG- 12276 and ICG- 15309 were better for total carbohydrates; the genotypes ICG- 434, ICG- 12276, ICG- 4729, ICG- 15309 and ICG- 11855 were promising for free amino acids were best for utilization in improvement of the respective characters under inorganic fertilizer management.

The 168 germplasm lines and five checks grown in organic and inorganic fertilizer managements are presented in Plate 2.

## 4.3 VARIABILITY AND GENETIC PARAMETERS

The success of any breeding programme depends upon the quantum of genetic variability present in the population. Wide range of genetic variability helps in selecting desired genotypes. In genetic studies, characters with high genotypic coefficient of variation indicate the potential for an effective selection. Heritability provides information about the extent of transmission of particular genetic character to the successive generations. Information on heritability estimates along with genetic advance would be more useful in predicting the effectiveness of selecting the best individuals.

This study was undertaken to estimate variability for pod yield and yield contributing traits in groundnut genotypes covering heritability and genetic advance of pod yield components so that it would be possible to establish suitable selection criteria for higher pod yield.

### 4.3.1 Estimation of Variability and Genetic Parameters under Organic Fertilizer Management

The estimates of genetic parameters *viz*., phenotypic and genotypic coefficients of variation, heritability in broad sense, genetic advance and genetic advance as per cent of mean computed for 14 characters involving 173 genotypes under organic and inorganic fertilizer managements were furnished in Tables 4.11 and 4.12, respectively.

#### 4.3.1.1 Variability studies

The range of variation observed for the characters revealed that high variation for number of pegs per plant followed by harvest index, sound mature kernel percentage, shelling percentage and plant height. Whereas, it was least for number of primary branches per plant, number of immature pods per plant, and days to 50 % flowering (Table 4.11). The highest magnitude of genotypic and phenotypic variance was observed for days to maturity and sound mature kernel percentage respectively, while the least estimates were recorded for number of primary branches.

All the characters exhibited higher magnitude of PCV than GCV, which indicated the influence of environment in the expression of these traits. Similar kind of results were reported by Zaman *et al.* (2011), Satish (2014), Vasanthi *et al.* (2015), Jibrin *et al.* (2016) and Kamde *et al.* (2017).

The characters viz., number of immature pods per plant (GCV: 41.64 %; PCV: 49.43 %), kernel yield per plant (GCV : 30.86 %; PCV : 39.89 %), pod yield per plant (GCV : 30.02 %; PCV : 36.35 %), number of mature pods per plant (GCV : 26.62 %; PCV : 32.85 %), number of pegs per plant (GCV : 22.20 %; PCV : 31.71 %), number of pods per plant (GCV : 23.30 %; PCV : 28.73 %), 100 kernel weight (GCV : 22.19 %; PCV : 25.11 %) and plant height (GCV : 20.85 %; PCV : 23.69 %) showed higher estimates of variability indicating enough variation among the genotypes for

**Table 4.11. Estimates of variability and genetic parameters for 14 characters in 168 germplasm lines and five checks under organic fertilizer management**

| S.No. | Character | Variance | | Coefficient of Variation(%) | | Heritability (Broad sense) (%) | Genetic advance (GA) | Genetic advance as percent of mean (%) |
|---|---|---|---|---|---|---|---|---|
| | | Genotypic | Phenotypic | Genotypic | Phenotypic | | | |
| 1. | Days to 50% flowering | 15.27 | 16.36 | 13.21 | 13.67 | 93.34 | 7.78 | 26.28 |
| 2. | Days to maturity | 96.33 | 104.01 | 8.51 | 8.85 | 92.61 | 19.46 | 16.88 |
| 3. | Plant height (cm) | 59.91 | 77.32 | 20.85 | 23.69 | 77.48 | 14.04 | 37.81 |
| 4. | Number of primary branches per plant | 0.43 | 1.07 | 13.22 | 20.94 | 39.87 | 0.85 | 17.20 |
| 5. | Number of pegs per plant | 62.59 | 127.69 | 22.20 | 31.71 | 49.02 | 11.41 | 32.02 |
| 6. | Number of mature pods per plant | 21.57 | 32.84 | 26.62 | 32.85 | 65.68 | 7.75 | 44.44 |
| 7. | Number of immature pods per plant | 1.92 | 2.71 | 41.64 | 49.43 | 70.98 | 2.41 | 72.27 |
| 8. | Number of pods per plant | 23.43 | 35.62 | 23.30 | 28.73 | 65.77 | 8.09 | 38.92 |
| 9. | 100 kernel weight (g) | 44.47 | 56.92 | 22.19 | 25.11 | 78.13 | 12.14 | 40.40 |
| 10. | Shelling percentage | 10.84 | 50.52 | 5.34 | 11.52 | 21.45 | 3.14 | 5.09 |
| 11. | Sound mature kernel percentage | 72.97 | 131.45 | 13.42 | 18.01 | 55.52 | 13.11 | 20.60 |
| 12. | Harvest index (%) | 33.28 | 97.84 | 14.24 | 24.42 | 34.01 | 6.93 | 17.11 |
| 13 | Kernel yield per plant (g) | 7.77 | 12.99 | 30.86 | 39.89 | 59.84 | 4.44 | 49.17 |
| 14 | Pod yield per plant (g) | 18.81 | 27.57 | 30.02 | 36.35 | 68.23 | 7.38 | 51.09 |

these traits. Therefore, simple selection could be effective for further improvement of these characters.

Results of high GCV and PCV for number of immature pods per plant were similar to the reports of John *et al.* (2009). The high variability estimates for pod yield per plant and kernel yield per plant were reported by Parameswarappa *et al.* (2005), John *et al.* (2008), Meta and Monpara (2010), Jonah *et al.* (2012) and Patidar *et al.* (2014). The reports of John *et al.* (2008) and Gupta *et al.* (2015) were similar to the present findings of high variability for number of mature pods per plant and plant height. The high variability estimates noticed for number of pegs per plant was in consonance with results of Korat *et al.* (2009). The high variability estimates registered for number of pods per plant and 100 kernel weight were in conformity with John *et al.* (2009).

The characters viz., harvest index (GCV : 14.24 %; PCV : 24.42 %) and number of primary branches per plant (GCV : 13.22 %; PCV : 20.94 %) exhibited moderate estimates of GCV and high PCV.

The results of Gupta *et al.* (2015) and Bhargavi *et al.* (2016) were similar to the present report of moderate GCV and high PCV estimates for harvest index. The moderate GCV and high PCV estimates for number of primary branches per plant were reported by Sudhir *et al.* (2008).

The GCV and PCV values were found to be moderate for sound mature kernel percentage (GCV : 13.42 %; PCV : 18.01 %) and days to 50% flowering (GCV : 13.21 %; PCV : 13.67 %). Low GCV and moderate PCV values were observed for shelling percentage (GCV : 5.30 %; PCV : 11.37 %).

Moderate estimates of GCV and PCV recorded for days to 50% flowering was in accordance with the results of Patil *et al.* (2014). The low

GCV and moderate PCV values for shelling percentage were in accordance with the reports of Narasimhulu *et al.* (2012).

On the other hand, days to maturity (GCV : 8.51 %; PCV : 8.85 %) exhibited low estimates of coefficient of variation. The low estimates of variability for days to maturity were in agreement with the reports of Patil *et al.* (2014) and Shukla and Rai (2014).

Days to 50% flowering and days to maturity showed low magnitude of differences between GCV and PCV indicating that there is little influence of environment on the expression of these characters.

**4.3.1.2 Heritability**

Under organic fertilizer management, heritability estimates were found to be high for days to 50 % flowering (93.34 %) followed by days to maturity (92.61 %), 100 kernel weight (78.13 %), plant height (77.48 %), number of immature pods per plant (70.98 %), number of pods per plant (65.77 %), pod yield per plant (68.23 %) and number of mature pods per plant(65.68 %) indicating that these characters were least influenced by the environmental effects. Whereas the characters viz., kernel yield per plant (59.84 %) followed by sound mature kernel percentage (55.52 %), number of pegs per plant (49.02 %), number of primary branches per plant (39.87 %) and harvest index (34.01 %) recorded moderate heritability.

Heritability estimates for shelling percentage (21.45 %) were found to be low indicating that the trait was highly influenced by environment.

**4.3.1.3 Genetic advance**

The characters *viz*., days to maturity (19.46 %), plant height (14.04 %), sound mature kernel percentage (13.11 %), 100 kernel weight (12.14 %) and number of pegs per plant (11.41 %) exhibited moderate genetic advance. Whereas the remaining characters viz., number of pods per plant, days to 50% flowering, number of mature pods per plant, pod yield per plant, harvest index, kernel yield per plant, shelling percentage, number of immature pods per plant and number of primary branches per plant recorded lower genetic advance.

### 4.3.1.4 Genetic advance as per cent of mean

Higher genetic advance as per cent of mean was recorded for number of immature pods per plant (72.27 %), pod yield per plant (51.09 %), kernel yield per plant (49.17 %), number of mature pods per plant (44.44 %), number of pods per plant (38.92 %), 100 kernel weight (40.40 %), plant height (37.81 %), number of pegs per plant (32.02 %), days to 50% flowering (26.28 %) and sound mature kernel percentage (20.60 %) indicating the involvement of additive genes and selection will be rewarding for improvement of such traits. On the contrary, moderate genetic advance as per cent of mean was observed for number of primary branches per plant (17.20 %), harvest index (17.11 %) and days to maturity (16.88 %) and low genetic advance as per cent of mean was recorded for shelling percentage (5.09 %). Lower estimates of genetic advance as per cent of mean indicates that these traits are governed by non- additive gene action and recombination breeding may be useful for improvement of such traits

The characters such as days to 50% flowering ($h^2_{bs}$ = 93.34 %, GAM = 26.28 %), 100 seed weight ($h^2_{bs}$ = 78.13 %, GAM = 40.40 %), plant height ($h^2_{bs}$ = 77.48 %, GAM = 37.81 %), number of mature pods per plant ($h^2_{bs}$ = 65.68 %, GAM = 44.44 %), number of immature pods per plant ($h^2_{bs}$ = 70.98 %, GAM = 72.27 %), number of pods per plant ($h^2_{bs}$ = 65.77 %, GAM = 38.92 %) and pod yield per plant ($h^2_{bs}$ = 68.23 %, GAM = 51.09 %) recorded high heritability coupled with high genetic advance as per cent of mean indicating that these traits were mainly under the influence of additive gene action and simple selection may be effective for improvement of these traits.

High heritability coupled with high genetic advance as per cent of mean for days to 50% flowering was in accordance with the results of Sudhir *et al.* (2008). Similar results were reported for plant height, number of mature pods per plant and number of immature pods per plant by John *et al.* (2013), Bhargavi *et al.* (2016) and Zaman *et al.* (2011). High heritability coupled with high genetic advance as per cent of mean for 100 kernel weight was in accordance with the results of Rao (2016) and Bhargavi *et al.* (2016). Similar results were registered for total number of pods per plant and pod yield per plant by Satish (2014).

High heritability coupled with moderate genetic advance as per cent of mean was noticed for days to maturity ($h^2_{bs}$ = 92.61 %, GAM = 16.88 %) indicated the role of both additive and non-additive gene action with preponderance of additive genetic variance and opined that selection would be effective to some extent.

High heritability coupled with moderate genetic advance as per cent of mean recorded for days to maturity was in conformity with Kadam et al. (2007) and Bhargavi *et al.* (2016).

The traits viz., kernel yield per plant ($h^2_{bs}$ = 49.02 %, GAM = 32.02 %), sound mature kernel percentage (($h^2_{bs}$ = 55.52 %, GAM = 20.60 %) and number of pegs per plant ($h^2_{bs}$ = 49.02 %, GAM = 32.02 %) recorded moderate heritability coupled with high genetic advance as per cent of mean which indicated that simple pedigree method of breeding and phenotypic selection would be effective for improvement of these trait.

Moderate heritability coupled with moderate genetic advance as per cent of mean was observed for number of primary branches per plant ($h^2_{bs}$ = 39.87 %, GAM = 17.20 %) and harvest index ($h^2_{bs}$ = 34.01 %, GAM = 17.11 %) indicated that both additive and non-additive gene actions have a role in their inheritance and phenotypic selection would be effective to some extent. Similar results were reported by John *et al.* (2008) for number of primary branches per plant.

Shelling percentage ($h^2_{bs}$ = 21.45 %, GAM = 5.09 %) recorded low heritability coupled with low genetic advance as per cent of mean which indicated that this trait was highly influenced by environmental effects and selection would be ineffective. Similar results were observed by Thakur *et al.* (2011) and vasanthi *et al.* (2015).

### 4.3.2 Estimation of Variability and Genetic Parameters under Inorganic Fertilizer Management

#### 4.3.2.1 Variability studies

Under inorganic fertilizer management the traits such as number of pegs per plant, sound mature kernel percentage, harvest index, total number of pods pert plant and shelling percentage recorded highest range of variation, while least range of variation was observed for number of immature pods per plant, number of primary branches per plant and days to 50 % flowering (Table 4.12). The highest magnitude of genotypic and phenotypic variance was observed for number of pegs per plant, whereas the least estimates of genotypic and phenotypic variance were recorded for number of immature pods per plant.

The estimates of phenotypic coefficient of variation were higher than genotypic coefficient of variation for all the 14 characters indicating the influence of environment in the expression of these traits. Similar kind of observations were also repoted by Zaman *et al.* (2011), Satish (2014), Vasanthi *et al.* (2015), Jibrin *et al.* (2016) and Kamde *et al.* (2017).

The highest estimates of GCV and PCV were registered for number of immature pods per plant (GCV : 50.46 %; PCV : 52.69 %), kernel yield per plant (GCV : 29.73 %; PCV : 42.02 %), number of primary branches per

**Table 4.12.** **Estimates of variability and genetic parameters for 14 characters in 168 germplasm lines and five checks under inorganic fertilizer management**

| S. No. | Character | Variance | | Coefficient of Variation (%) | | Heritability (Broad sense) (%) | Genetic advance (GA) | Genetic advance as percent of mean (%) |
|---|---|---|---|---|---|---|---|---|
| | | Genotypic | Phenotypic | Genotypic | Phenotypic | | | |
| 1. | Days to 50% flowering | 14.78 | 16.41 | 12.51 | 13.18 | 90.05 | 7.51 | 24.45 |
| 2. | Days to maturity | 49.83 | 57.63 | 5.99 | 6.45 | 86.47 | 13.52 | 11.48 |
| 3. | Plant height (cm) | 25.44 | 35.87 | 17.74 | 21.07 | 70.91 | 8.75 | 30.78 |
| 4. | Number of primary branches per plant | 3.90 | 4.67 | 34.53 | 37.79 | 83.49 | 3.71 | 65.00 |
| 5. | Number of pegs per plant | 124.66 | 228.21 | 24.83 | 33.59 | 54.62 | 17.00 | 37.80 |
| 6. | Number of mature pods per plant | 31.48 | 43.53 | 31.56 | 37.11 | 72.32 | 9.83 | 55.29 |
| 7. | Number of immature pods per plant | 3.87 | 4.22 | 50.46 | 52.69 | 91.69 | 3.88 | 99.53 |
| 8. | Number of pods per plant | 38.12 | 52.43 | 28.48 | 33.40 | 72.71 | 10.85 | 50.03 |
| 9. | 100 kernel weight (g) | 15.91 | 24.61 | 16.79 | 20.88 | 64.65 | 6.61 | 27.81 |
| 10. | Shelling percentage | 45.14 | 59.09 | 12.01 | 13.75 | 76.39 | 12.10 | 21.63 |
| 11. | Sound mature kernel percentage | 91.62 | 173.31 | 19.28 | 26.52 | 52.87 | 14.34 | 28.88 |
| 12. | Harvest index (%) | 41.01 | 69.31 | 19.18 | 24.94 | 59.18 | 10.15 | 30.40 |
| 13 | Kernel yield per plant (g) | 4.48 | 8.95 | 29.73 | 42.02 | 50.06 | 3.08 | 43.32 |
| 14 | Pod yield per plant (g) | 11.37 | 21.55 | 26.84 | 36.95 | 52.76 | 5.05 | 40.16 |

plant (GCV : 34.53 %; PCV : 37.79 %), number of mature pods per plant (GCV : 31.56 %; PCV : 37.11 %), pod yield per plant (GCV : 26.84 %; PCV : 36.95 %), number of pegs per plant (GCV : 24.83 %; PCV : 33.59 %), and number of pods per plant (GCV : 28.48 %; PCV : 33.40 %) indicating the presence of ample amount of variation among the genotypes for these traits.

The estimates of high GCV and PCV for number immature pods per plant were in accordance with the reports of John *et al.* (2009). Results of high variability estimates for pod yield per plant and kernel yield per plant were similar to the reports of Parameswarappa *et al.* (2005), John *et al.* (2008), Meta and Monpara (2010), Jonah *et al.* (2012) and Patidar *et al.* (2014). The reports of John *et al.* (2008) and Gupta *et al.* (2015) were similar to the present report of high variability for number of mature pods per plant. The high variability estimates noticed for number of pegs per plant and number of primary branches per plant was in consonance with results of Korat *et al.* (2009) and Parameshwarappa *et al.* (2005) respectively. John *et al.* (2009) reported high variability estimates for number of pods per plant and 100- kernel weight.

The traits viz., sound mature kernel percentage (GCV : 19.28 %; PCV : 26.52 %), harvest index (GCV : 19.18 %; PCV : 24.94 %), plant height (GCV : 17.74 %; PCV : 21.07 %) and 100 kernel weight (GCV : 16.79 %; PCV : 20.88 %) recorded moderate estimates of GCV and high PCV values. The results of Vasanthi *et al.* (2015) and Bhargavi *et al.* (2016) were similar to the present report of moderate GCV and high PCV estimates for 100 kernel weight and harvest index, respectively.

Moderate estimates of GCV and PCV were observed for days to 50 % flowering (GCV : 12.51 %; PCV : 13.18 %) and shelling percentage (GCV : 12.01 %; PCV : 13.75 %). Moderate estimates of GCV and PCV recorded for days to 50 % flowering and shelling percentage were in accordance with the results of Patil *et al.* (2014) and Zaman *et al.* (2011) respectively. On contrary days to maturity (GCV : 5.99 %; PCV : 6.45 %) showed lower estimates of coefficient of variation. The lower estimates of variability for days to maturity were in agreement with the reports of Patil *et al.* (2014) and Shukla and Rai (2014).

**4.3.2.2 Heritability**

Under inorganic fertilizer management, high heritability estimates were registered for number of immature pods per plant (91.69 %) followed by days to 50 % flowering (90.05 %), days to maturity (86.47 %), number of primary branches per plant (83.49 %), shelling percentage (76.39 %), number of pods per plant (72.71 %), number of mature pods per plant (72.32 %), plant height (70.91 %) and 100 kernel weight (64.65 %) which indicated that environment had least influence on the expression of these traits.

While the remaining characters such as harvest index (59.18 %), number of pegs per plant (54.62 %), sound mature kernel percentage (52.87 %), pod yield per plant (52.76 %) and kernel yield per plant (50.06 %) recorded moderate heritability.

**4.3.2.3 Genetic advance**

Moderate estimates of genetic advance were registered for number of pegs per plant (17.00 %) followed by sound mature kernel percentage (14.34 %), days to maturity (13.52 %), shelling percentage (12.10 %), number of pods per plant (10.85 %) and harvest index (10.15 %). While the traits plant height (8.75 %), days to 50% flowering (7.51 %), number of mature pods per plant (9.83 %), 100 kernel weight (6.61 %), number of immature pods per plant (3.88 %), number of primary branches per plant (3.71 %), pod yield per plant (5.05 %) and kernel yield per plant (3.08 %) recorded lower estimates of genetic advance.

#### 4.3.2.4 Genetic advance as per cent of mean

Higher estimates of genetic advance as per cent of mean were noticed for number of immature pods per plant (99.53 %) followed by number of primary branches per plant (65.00 %), number of mature pods per plant (55.29), number of pods per plant (50.03 %), kernel yield per plant (43.32 %), pod yield per plant (40.16 %), number of pegs per plant (37.80 %), plant height (30.78 %) harvest index (30.40 %), sound mature kernel percentage (28.88 %), 100 kernel weight (27.81 %), days to 50% flowering (24.45 %) and shelling percentage (21.63 %) indicated that these traits were governed by additive genes and selection will be rewarding for improvement of such traits. Whereas, days to maturity (11.48 %) showed moderate genetic advance as per cent of mean.

High heritability coupled with high genetic advance as per cent of mean were recorded for number of immature pods per plant ($h^2_{bs}$ = 91.69 %, GAM = 99.53 %) followed by days to 50% flowering ($h^2_{bs}$ = 90.05 %, GAM= 24.45 %), number of primary branches per plant ($h^2_{bs}$ = 83.49 %, GAM = 65 %), shelling percentage ($h^2_{bs}$ = 76.39 %, GAM = 21.63 %), number of pods per plant ($h^2_{bs}$ = 72.71 %, GAM = 50.03 %), number of mature pods per plant ($h^2_{bs}$ = 72.32 %, GAM = 55.29 %), plant height ($h^2_{bs}$ = 70.91 %, GAM = 30.78 %) and 100 kernel weight ($h^2_{bs}$ = 64.65 %, GAM = 27.81 %) suggesting that additive gene action in expression of these traits and selection would be effective for improvement of these traits under inorganic fertilizer management.

Similar results were reported for number of immature pods per plant, plant height, days to 50 % flowering and 100 seed weight by Zaman *et al.* (2011), John *et al.* (2013), Sudhir *et al.* (2008) and Bhargavi *et al.* (2016) respectively. High heritability coupled with high genetic advance as per cent of mean for number of primary branches per plant and shelling percentage

**Table 4.13. Comparison of genetic parameters (GCV, Heritability and GAM) for 14 characters in 168 germplasm lines and five checks in organic and inorganic fertilizer managements**

| | | Organic | | | Inorganic | | | |
|---|---|---|---|---|---|---|---|---|
| | | **Heritability** | | | **Heritability** | | | |
| | | **High** | **Moderate** | **Low** | **High** | **Moderate** | **Low** | |
| **Genetic Advance as per cent of mean** | **High** | PH, NMP, NIMP, NPP, 100KW, PYP | NPEGP, KYP | -- | NPB, NIMP, NMP, NPP | NPEGP, KYP, PYP | -- | **High GCV** |
| | **Moderate** | -- | -- | -- | -- | -- | -- | |
| | **Low** | -- | -- | -- | -- | -- | -- | |
| **Genetic Advance as per cent of mean** | **High** | DF | SMK % | | DF, PH, 100KW, SP | SMK %, HI | -- | **Moderate GCV** |
| | **Moderate** | | NPB, HI | -- | -- | | | |
| | **Low** | -- | -- | -- | -- | -- | -- | |
| **Genetic Advance as per cent of mean** | **High** | -- | -- | -- | -- | -- | -- | **Low GCV** |
| | **Moderate** | DM | | -- | DM | | -- | |
| | **Low** | | -- | SP | | -- | | |

DF : Days to 50% flowering; DM : days to maturity; PH : Plant height (cm); NPB : Number of primary branches per plant (No); NPEGP : Number of pegs per plant (No); NMP : Number of mature pods per plant (No); NIMP : Number of immature pods per plant (No); NPP : Number of pods per plant (No); 100KW : 100 kernel weight (g); SP : Shelling percentage(%); SMK% : Sound mature kernel percentage(%); HI : Harvest index (%); KYP : Kernel yield per plant (g); PYP : Pod yield per plant (g).

was in accordance with the results of Satish (2014) and Narasimhulu *et al.* (2012), respectively.

The characters, harvest index ($h^2_{bs}$ = 59.18 %, GAM = 30.40 %), number of pegs per plant ($h^2_{bs}$ = 54.62 %, GAM = 37.80 %), sound mature kernel percentage ($h^2_{bs}$ = 52.87 %, GAM = 28.88 %), pod yield per plant ($h^2_{bs}$ = 52.76 %, GAM = 40.16 %) and kernel yield per plant ($h^2_{bs}$ = 50.06 %, GAM = 43.32 %) exhibited moderate heritability coupled with high genetic advance as per cent of mean, indicated that improvement of these traits possible by simple pedigree method of breeding and phenotypic selection. Moderate heritability coupled with high genetic advance as per cent of mean recorded for harvest index by Gupta *et al.* (2015).

High heritability coupled with moderate genetic advance as per cent of mean was registered for days to maturity ($h^2_{bs}$ = 86.47 %, GAM = 11.48 %). High heritability coupled with moderate genetic advance as per cent of mean recorded for days to maturity was in conformity with Kadam *et al.* (2007) and Bhargavi *et al.* (2016).

The comparison of variability and genetic parameters for 14 characters in 173 genotypes of groundnut under organic and inorganic fertilizer managements are presented in the Table 4.13**.** The results showed that the traits viz., number of immature pods per plant, number of mature pods per plant, number of pods per plant registered high GCV, heritability and genetic advance as per cent of mean in both the managements. Whereas, number of pegs per plant and kernel yield per plant recorded high GCV, moderate heritability and high genetic advance as per cent of mean; moderate GCV, moderate heritability and high genetic advance as per cent of mean were observed for sound mature kernel percentage; days to 50% flowering exhibited moderate GCV, high heritability and high genetic advance as per cent of mean. Whereas, days to maturity registered low

GCV, high heritability and moderate genetic advance as per cent of mean under both organic and inorganic fertilizer managements.

## 4.4 CHARACTER ASSOCIATION ANALYSIS

The main objective of a plant breeder is to improve yield, which is a complex character and depends upon the expression of a number of component characters. Correlation analysis measures the mutual association between a pair of variables independent of other variables under consideration.

Simple correlation co-efficients were computed in order to assess the degree and direction of relationship present between pod yield and its component characters under both organic and inorganic fertilizer managements and the results are presented in Table 4.14 and 4.15, respectively.

### 4.4.1 Correlation between Pod Yield and its Component Traits under Organic Fertilizer Management

The correlation coefficients between pod yield per plant with days to 50% flowering, days to maturity, plant height, number of primary branches per plant, number of pegs per plant, number of mature pods per plant, number of immature pods per plant, number of pods per plant, 100 kernel weight, shelling percentage, sound mature kernel percentage, harvest index, kernel yield per plant and among themselves under organic fertilizer management practice are presented in Table 4.14.

Under organic fertilizer management practice, pod yield per plant showed highly significant and positive correlation with kernel yield per plant (r = 0.963) followed by number of mature pods per plant (r = 0.832 ), number of pods per plant (r = 0.828), harvest index (r = 0.604), 100 seed weight (r = 0.485), days to maturity (r = 0.447), number of pegs per plant

**Table 4.14. Simple correlation coefficients (r) among pod yield per plant and its components in groundnut under organic fertilizer management**

| Character | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **DF** | **1.000** | 0.445** | -0.228** | 0.120 | -0.034 | 0.205** | 0.006 | 0.200** | 0.330** | -0.039 | -0.035 | 0.124 | 0.239** | 0.276** |
| **DM** | | **1.000** | -0.192* | 0.068 | 0.023 | 0.416** | -0.042 | 0.392** | 0.377** | 0.135 | 0.032 | 0.342** | 0.445** | 0.447** |
| **PH** | | | **1.000** | -0.176* | 0.244** | -0.027 | 0.133 | 0.012 | -0.199** | 0.088 | 0.041 | -0.264** | 0.011 | -0.003 |
| **NPB** | | | | **1.000** | 0.238** | 0.167* | 0.100 | 0.191* | 0.048 | 0.120 | -0.020 | -0.067 | 0.160* | 0.140 |
| **NPEGP** | | | | | **1.000** | 0.572** | 0.208** | 0.614** | -0.019 | 0.230** | -0.086 | -0.037 | 0.459** | 0.464** |
| **NMP** | | | | | | **1.000** | -0.042 | 0.960** | 0.262** | 0.341** | 0.101 | 0.449** | 0.812** | 0.832** |
| **NIMP** | | | | | | | **1.000** | 0.241** | -0.006 | -0.115 | -0.048 | -0.020 | 0.044 | 0.071 |
| **NPP** | | | | | | | | **1.000** | 0.252** | 0.299** | 0.085 | 0.430** | 0.801** | 0.828** |
| **100KW** | | | | | | | | | **1.000** | 0.331** | 0.365** | 0.424** | 0.515** | 0.485** |
| **SP** | | | | | | | | | | **1.000** | 0.346** | 0.237** | 0.563** | 0.340** |
| **SMK%** | | | | | | | | | | | **1.000** | 0.230** | 0.180* | 0.108 |
| **HI** | | | | | | | | | | | | **1.000** | 0.604** | 0.604** |
| **KYP** | | | | | | | | | | | | | **1.000** | 0.963** |
| **PYP** | | | | | | | | | | | | | | **1.000** |

* Significant at 5% level; ** Significant at 1 % level

DF : Days to 50% flowering; DM : days to maturity; PH : Plant height (cm); NPB : Number of primary branches per plant (No); NPEGP : Number of pegs per plant (No); NMP : Number of mature pods per plant (No); NIMP : Number of immature pods per plant (No); NPP : Number of pods per plant (No); 100KW : 100 kernel weight (g); SP: Shelling percentage(%); SMK% : Sound mature kernel percentage(%); HI : Harvest index (%); KYP : Kernel yield per plant (g); PYP : Pod yield per plant (g).

(r = 0.464), days to 50% flowering (r = 0.276) and shelling percentage (r = 0.340).

Significant and positive association of pod yield per plant with harvest index, number of pods per plant and 100 kernel weight was reported by Maunde *et al.* (2015). Significant and positive correlation of pod yield per plant with kernel yield per plant and number of mature pods per plant was registered by Kumar *et al.* (2012) and Jain *et al.* (2016). Significant and positive association for number of pegs per plant, days to 50% flowering and shelling percentage were in accordance with the reports of Mahalakshmi *et al.* (2005), Satish (2014) and Shukla and Rai (2014) respectively.

Pod yield per plant exhibited non-significant positive correlation with number of immature pods per plant (r = 0.071), sound mature kernel percentage (r = 0.108) and number of primary branches per plant (r = 0.140).

Non-significant positive correlation of pod yield per plant with number of immature pods per plant and sound mature kernel percentage was in accordance with the reports of Vasanthi *et al.* (2015) and Patil *et al.* (2006), respectively.

Pod yield per plant showed non-significant negative correlation with plant height (r = -0.003). Similar results of pod yield per plant with plant height were reported by Satish (2014)

### 4.4.2 Inter-correlation among Traits under Organic Management

#### 4.4.2.1 Days to 50 % flowering

Under organic fertilizer management days to 50% flowering showed significant and positive correlation with days to maturity (r = 0.445) followed by 100 kernel weight (r = 0.330), kernel yield per plant (r = 0.239), number of mature pods per plant (r = 0.205) and number of pods per plant (r = 0.200). It exhibited significant and negative correlation with plant height (r = -0.228).

Significant and positive correlation of days to 50% flowering with days to maturity, 100 kernel weight, kernel yield per plant, number of mature pods per plant, number of pods per plant was in accordance with the reports of Kamdi *et al.* (2017), Vasanthi *et al.* (2015), Satish (2014), John *et al.* (2009) and Kumar *et al.* (2012), respectively. Significant and negative association of days to 50% flowering with plant height were registered by Kamdi *et al.* (2017).

**4.4.2.2 Days to maturity**

Days to maturity exhibited significant and positive association with kernel yield per plant (r = 0.445), number of mature pods per plant (r = 0.416), number of pods per plant (r = 0.392), 100 kernel weight (r = 0.377) and harvest index (r = 0.342). It also showed significant negative correlation with plant height (r = -0.192).

Significant and positive association of days to maturity with number of mature pods per plant and 100 kernel weight was reported by Zaman *et al.* (2011) and Pavankumar *et al.* (2014).

**4.4.2.3 Plant height (cm)**

Significant and positive relationship of plant height was observed for number of pegs per plant (r = 0.244). Plant height also exhibited significant negative correlation with harvest index (r = -0.264), 100 kernel weight (r = -0.199) and number of primary branches per plant (r = -0.176).

Significant and positive relationship of plant height with number of pegs per plant was earlier reported by John *et al.* (2009). Similar to the present findings significant and negative correlation of plant height with harvest index, 100 kernel weight and number of primary branches per plant was reported by Vasanthi *et al.* (2015) and Parameshwarappa *et al.* (2005).

#### 4.4.2.4 Number of primary branches per plant

Number of primary branches per plant showed significant positive correlation with number of pegs per plant (r = 0.238), number of pods per plant (r = 0.191), number of mature pods per plant (r = 0.167) and kernel yield per plant (r = 0.160).

Significant and positive correlation of number of primary branches per plant with number of pegs per plant, number of pods per plant and number of mature pods per plant was in accordance with the reports of John *et al.* (2009) and Vasanthi *et al.* (2015), respectively.

#### 4.4.2.5 Number of pegs per plant

Under organic fertilizer management number of pegs per plant exhibited significant and positive relation with number of pods per plant (r = 0.614), number of mature pods per plant (r = 0.572), kernel yield per plant (r = 0.459), number of immature pods per plant (r = 0.208) and shelling percentage (r = 0.230).

Significant and positive association of days to maturity with number of pods per plant, number of mature pods per plant and shelling percentage was reported by John *et al.* (2009) and with number of immature pods per plant by Patil *et al.* (1982).

#### 4.4.2.6 Number of mature pods per plant

Number of mature pods per plant exhibited significant and positive correlation with number of pods per plant(r = 0.960), kernel yield per plant (r = 0.812), harvest index (r = 0.449), 100 kernel weight (r = 0.262) and shelling percentage (r = 0.341).

Significant and positive relationship of number of mature pods per plant with total number of pods per plant, kernel yield per plant and 100 kernel weight was earlier reported by Mukthar *et al.* (2011) and with harvest index and shelling percentage by Pavankumar *et al.* (2014).

#### 4.4.2.7 Number of immature pods per plant

Significant and positive relationship of number of immature pods per plant was observed for number of pods per plant (r = 0.241).

The results of significant and positive relationship of number of immature pods per plant with number of pods per plant were registered by John *et al.* (2009).

#### 4.4.2.8 Number of pods per plant

Under organic fertilizer management number of pods per plant showed significant and positive correlation with kernel yield per plant (r = 0.801), harvest index (r = 0.430), shelling percentage (r = 0.299) and 100 kernel weight (r = 0.252).

Significant and positive association of number of pods per plant with kernel yield per plant and 100 kernel weight was reported by Mukthar *et al.* (2011) and with shelling percentage by John *et al.* (2009).

#### 4.4.2.9 100 kernel weight (g)

Significant and positive association of 100 kernel weight was observed for shelling percentage (r = 0.331), sound mature kernel percentage (r = 0.365), harvest index (r = 0.424) and kernel yield per plant (r = 0.515).

Significant and positive correlation of 100 kernel weight with shelling percentage, harvest index and kernel yield per plant was in accordance with the reports of Mukthar *et al.* (2011), Vasanthi *et al.* (2015) and Rao *et al.* (2014), respectively

### 4.4.2.10 Shelling percentage

Shelling percentage exhibited significant and positive correlation with kernel yield per plant (r = 0.463), sound mature kernel percentage (r = 0.312) and harvest index (r = 0.219).

Significant and positive association of shelling percentage with sound mature kernel percentage and harvest index was reported by Pavankumar *et al.* (2014).

### 4.4.2.11 Sound mature kernel percentage

Sound mature kernel percentage showed significant positive correlation with harvest index (r = 0.230) and kernel yield per plant (r = 0.183).

### 4.4.2.12 Harvest index (%)

Significant and positive association of harvest index was observed for kernel yield per plant (r = 0.637).

Negatively significant association of plant height with shelling percentage and 100- kernel weight suggested that selecting taller plants might adversely affect these traits. Plant height also showed significant negative relation with number of primary branches per plant which indicates that increase in plant height would increase in distance between the branches there by decreasing the number of primary branches per plant.

Number of pegs per plant exhibited significant positive correlation with plant height and number of primary branches per plant which indicated that increase in plant height and number of primary branches per plant would lead to increase in number of pegs per plant.

Significant positive association of number of pegs per plant with number of mature pods per plant, number of immature pods per plant, number of pods per plant, shelling percentage and kernel yield per plant indicated that increase for number of pegs per plant would lead to increase in these traits.

Number of mature pods per plant, number of pods per plant, 100-kernel weight, shelling percentage and harvest index were significantly and positively correlated with each other and also with kernel yield per plant. The results suggest that selection for these traits leads to increase in kernel yield per plant.

The traits viz., days to 50% flowering, days to maturity, number of pegs per plant, number of mature pods per plant, number of pods per plant, 100- kernel weight, shelling percentage, sound mature kernel percentage, harvest index and kernel yield per plant showed significant positive association with pod yield per plant. The results indicated that selection for these traits leads to increased pod yield per plant.

### 4.4.3 Correlation between Pod Yield and its Component Traits under Inorganic Fertilizer Management

The simple correlation coefficients obtained for all the characters under inorganic fertilizer management are furnished in Table 4.15.

Under inorganic fertilizer management pod yield per plant exhibited highly significant and positive relationship with kernel yield per plant (r = 0.955), number of pods per plant (r = 0.796), number of mature pods per plant (r = 0.794), harvest index (r = 0.692), 100 kernel weight (r = 0.545), number of pegs per plant (r = 0.446), shelling percentage (r = 0.277), number of immature pods per plant (r = 0.265), plant height (r = 0.244) and number of primary branches per plant (r= 0.162). Non- significant positive association of pod yield per plant was observed with sound mature kernel

**Table 4.15.** **Simple correlation coefficients (r) among pod yield per plant and its components in groundnut under inorganic fertilizer management**

| Character | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **DF** | **1.000** | 0.420** | -0.250** | 0.307** | -0.097 | -0.289** | 0.182* | -0.210** | -0.067 | -0.398** | -0.187* | -0.292** | -0.264** | -0.170* |
| **DM** | | **1.000** | -0.279** | 0.270** | -0.104 | -0.285** | 0.166* | -0.211** | -0.121 | -0.368** | -0.207** | -0.289** | -0.281** | -0.185* |
| **PH** | | | **1.000** | -0.307** | 0.067 | 0.193* | -0.227** | 0.110 | 0.184* | 0.022 | 0.147 | 0.082 | 0.222** | 0.244** |
| **NPB** | | | | **1.000** | 0.316** | 0.113 | 0.340** | 0.200** | 0.050 | -0.130 | -0.156* | -0.198** | 0.107 | 0.162* |
| **NPEGP** | | | | | **1.000** | 0.650** | 0.332** | 0.684** | 0.033 | 0.198** | -0.091 | 0.056 | 0.454** | 0.446** |
| **NMP** | | | | | | **1.000** | 0.184* | 0.960** | 0.229** | 0.434** | 0.024 | 0.598** | 0.827** | 0.794** |
| **NIMP** | | | | | | | **1.000** | 0.453** | 0.062 | -0.066 | -0.151* | 0.144 | 0.191* | 0.265** |
| **NPP** | | | | | | | | **1.000** | 0.225** | 0.375** | -0.022 | 0.583** | 0.805** | 0.796** |
| **100KW** | | | | | | | | | **1.000** | 0.339** | 0.411** | 0.368** | 0.585** | 0.545** |
| **SP** | | | | | | | | | | **1.000** | 0.416** | 0.385** | 0.530** | 0.277** |
| **SMK%** | | | | | | | | | | | **1.000** | 0.088 | 0.193* | 0.082 |
| **HI** | | | | | | | | | | | | **1.000** | 0.708** | 0.692** |
| **KYP** | | | | | | | | | | | | | **1.000** | 0.955** |
| **PYP** | | | | | | | | | | | | | | **1.000** |

* Significant at 5% level; ** Significant at 1 % level

DF : Days to 50% flowering; DM : days to maturity; PH : Plant height (cm); NPB : Number of primary branches per plant (No); NPEGP : Number of pegs per plant (No); NMP: Number of mature pods per plant (No); NIMP : Number of immature pods per plant (No); NPP : Number of pods per plant (No); 100KW : 100 kernel weight (g); SP: Shelling percentage(%); SMK% : Sound mature kernel percentage(%); HI : Harvest index (%); KYP : Kernel yield per plant (g); PYP : Pod yield per plant (g).

percentage (r = 0.082). Whereas significant negative association was observed for days to maturity (r = -0.185) and days to 50 % flowering (r = -0.170).

The results of significant and positive association of pod yield per plant with harvest index, total number of pods per plant and 100 kernel weight were in conformity with the reports of Maunde *et al.* (2015). Significant and positive correlation of pod yield per plant with kernel yield per plant and number of mature pods per plant was registered by Kumar *et al.* (2012) and Jain *et al.* (2016).The results of significant and positive association for number of pegs per plant, number of primary branches per plant and shelling percentage were in accordance with the reports of Mahalakshmi *et al.* (2005), Vasanthi *et al.* (2015) and Shukla and Rai (2014), respectively. Results of significant and positive correlation of sound mature kernel percentage with pod yield per plant were reported by Patil *et al.* (2006).

### 4.4.4 Inter-correlation among Traits under Inorganic Fertilizer Management

#### 4.4.4.1 Days to 50 % flowering

Days to 50 % flowering exhibited significant positive association with days to maturity (r = 0.420), number of primary branches per plant (r = 0.307) and number of immature pods per plant (r = 0.182). Whereas shelling percentage (r = -0.398), harvest index (r = -0.292), number of mature pods per plant (r = -0.28494), kernel yield per plant (r = -0.264), plant height (r = -0.250), number of pods per plant (r = -0.210) and sound mature kernel percentage (r = -0.187) showed significant and negative correlation with days to 50 % flowering.

Significant and positive association of days to 50 % flowering with number of immature pods per plant and days to maturity was reported by

Mahalakshmi *et al.* (2005) and Kamdi *et al.* (2017), respectively and with sound mature kernel percentage and harvest index by Pavankumar *et al.* (2014). The results of significant and negative association of days to 50 % flowering with plant height were registered by Kamdi *et al.* (2017).

#### 4.4.4.2 Days to maturity

Under inorganic fertilizer management, days to maturity showed significant and positive relationship with number of primary branches per plant (r = 0.270) and number of immature pods per plant (r = 0.166). It exhibited significant negative association with shelling percentage (r = -0.368), kernel yield per plant (r = -0.281), harvest index (r = -0.289), number of mature pods per plant (r = -0.285), plant height (r = -0.277), sound mature kernel percentage (r = -0.207) and number of pods per plant (r = -0.211).

Significant and positive correlation of days to maturity with number of primary branches per plant was in accordance with the reports of Pavankumar *et al.* (2014). Significant and positive association of days to maturity with harvest index was reported by Pavankumar *et al.* (2014).

#### 4.4.4.3 Plant height (cm)

Significant and positive association of plant height was observed with kernel yield per plant (r = 0.222), number of mature pods per plant (r = 0.193) and 100 kernel weight (r = 0.184). It also exhibited significant negative correlation with number of primary branches per plant (r = -0.307) and number of immature pods per plant (r = -0.219).

Significant and positive association of plant height with number of mature pods per plant was reported by Mahalakshmi *et al.* (2005).

#### 4.4.4.4 Number of primary branches per plant

Under inorganic fertilizer management number of immature pods per plant (r = 0.340), number of pegs per plant (r = 0.316) and number of pods per plant (0.200) showed significant and positive correlation with number of primary branches per plant. It also exhibited significant negative association with harvest index (r = -0.198) and sound mature kernel percentage (r = -0.156).

Significant and positive relationship of number of primary branches per plant with number of immature pods per plant and number of pegs per plant was earlier reported by Mahalakshmi *et al.* (2005) and John *et al.* (2009), respectively.

#### 4.4.4.5 Number of pegs per plant

Significant and positive correlation of number of pegs per plant was observed for number of pods per plant (r = 0.684), number of mature pods per plant (r = 0.650), kernel yield per plant (r = 0.454), number of immature pods per plant (r = 0.332) and shelling percentage (r = 0.198).

Significant and positive association of number of pegs per plant with number of pods per plant and number of mature pods per plant was reported by John *et al.* (2009) and with kernel yield per plant, number of immature pods per plant and shelling percentage by Francies and Ramalingam (1997), Patil *et al.* (1982) and John *et al.* (2009) respectively.

#### 4.4.4.6 Number of mature pods per plant

Number of mature pods per plant exhibited significant and positive relationship with number of pods per plant (r = 0.960), kernel yield per plant (r = 0.827), harvest index (r = 0.598), shelling percentage (r = 0.434), 100 kernel weight (r = 0.229) and number of immature pods per plant (r = 0.184).

The results of significant and positive relationship of number of mature pods per plant with number of pods per plant, kernel yield per plant and 100- kernel weight were registered by Mukthar *et al.* (2011) and with harvest index and shelling percentage by Pavankumar *et al.* (2014).

#### 4.4.4.7 Number of immature pods per plant

Under inorganic fertilizer management this trait exhibited significant and positive association with number of pods per plant (r = 0.453) and kernel yield per plant (r = 0.191), whereas significant negative correlation with sound mature kernel percentage (r = -0.151).

Significant and positive correlation of number of immature pods per plant with number of pods per plant was in accordance with the reports of John *et al.* (2009).

#### 4.4.4.8 Number of pods per plant

Significant and positive association of total number of pods per plant was observed for kernel yield per plant (r = 0.805), harvest index (r = 0.583), shelling percentage (r = 0.375) and 100 kernel weight (r = 0.225).

The results of significant positive association of number of pods per plant with kernel yield per plant and 100- kernel weight were similar with the reports of Mukthar *et al.* (2011) and with shelling percentage by John *et al.* (2009).

#### 4.4.4.9 100 kernel weight (g)

Significant and positive association of 100- kernel weight was observed for kernel yield per plant (r = 0.585), sound mature kernel percentage (r = 0.411), harvest index (r = 0.368) and shelling percentage (r = 0.339).

Significant and positive association of 100- kernel weight with kernel yield per plant, harvest index and shelling percentage was reported by Rao *et al.* (2014), Vasanthi *et al.* (2015) and Mukthar *et al.* (2011), respectively.

### 4.4.4.10 Shelling percentage

Shelling percentage exhibited significant and positive correlation with kernel yield per plant (r = 0.530), sound mature kernel percentage (r = 0.416) and harvest index (r = 0.385). Similar results were reported by Pavankumar *et al.* (2014) for sound mature kernel percentage and harvest index.

### 4.4.4.11 Sound mature kernel percentage

Under inorganic fertilizer management this trait showed significant and positive correlation with kernel yield per plant (r = 0.193).

### 4.4.4.12 Harvest index (%)

Harvest index showed significant and positive relationship with kernel yield per plant (r = 0.708).

Number of primary branches per plant and number of immature pods per plant were significantly and positively associated with each other but both of them individually exhibited significant negative correlation with plant height and sound mature kernel percentage. These reports indicated that selection for increased number of primary branches per plant and number of immature pods per plant would lead to decrease in plant height and sound mature kernel percentage.

Significant and negative correlation of number of primary branches per plant with harvest index indicated that increase in primary branches increases dry matter there by decreases harvest index.

### 4.4.5 Comparison of Correlation between Pod yield per plant and its component traits under Organic and Inorganic Fertilizer Managements

Comparison of correlation between pod yield per plant and its component traits under organic and inorganic fertilizer managements is furnished in Table 4.16**.** Critical analysis of results obtained from correlation studies implied that the traits viz., harvest index, 100 kernel weight, kernel yield per plant, number of mature pods per plant, number of pods per plant, shelling percentage and number of pegs per plant recorded significant positive correlation with pod yield per plant, indicating that selection for these traits would result in increase in the pod yield under both organic and inorganic fertilizer managements.

Under organic management pod yield per plant showed significant positive association with days to 50 % flowering and days to maturity whereas, under inorganic fertilizer management these traits exhibited significant negative correlation with pod yield per plant which suggested that late maturing and early maturing varieties were preferable under organic and inorganic fertilizer management, respectively for pod yield improvement.

Days to 50 % flowering recorded significant positive correlation with kernel yield per plant, number of mature pods per plant and total number of pods per plant under organic fertilizer management while under inorganic fertilizer management days to 50 % flowering showed significant negative association with these traits.

Under organic fertilizer management days to maturity exhibited significant positive association with kernel yield per plant, number of mature pods per plant, total number of pods per plant, 100- kernel weight

**Table 4.16. Comparison of correlation between pod yield and its component traits under organic and inorganic fertilizer managements**

| | Organic | Inorganic |
|---|---|---|
| **Pod yield/ plant** | | |
| Significant positive | Harvest index, 100 kernel weight, kernel yield per plant, number of mature pods per plant, number of pods per plant, shelling percentage, number of pegs per plant, days to 50% flowering, days to maturity | Harvest index, 100 kernel weight, kernel yield per plant, number of mature pods per plant, number of pods per plant, shelling percentage, number of pegs per plant, number of primary branches per plant number of immature pods per plant, plant height |
| Significant negative | | Days to 50% flowering, days to maturity |
| **Days to 50 % flowering** | | |
| Significant positive | Days to maturity, 100 kernel weight, kernel yield per plant, number of mature pods per plant, total number of pods per plant | Days to maturity, number of primary branches per plant, ,number of immature pods per plant |
| Significant negative | Plant height | Plant height, shelling percentage, harvest index, number of mature pods per plant, kernel yield per plant, number of pods per plant, sound mature kernel percentage |
| **Days to maturity** | | |
| Significant positive | Kernel yield per plant, number of mature pods per plant, number of pods per plant, 100 kernel weight, harvest index | Number of primary branches per plant, number of immature pods per plant, |
| Significant negative | Plant height | Plant height, shelling percentage, kernel yield per plant, harvest index, number of mature pods per plant, sound mature kernel percentage, number of pods per plant, 100 kernel weight |
| **Plant height** | | |
| Significant positive | Number of pegs per plant, number of immature pods per plant | Kernel yield per plant, number of mature pods per plant, 100 kernel weight |
| Significant negative | Harvest index, 100 kernel weight, number of primary branches per plant | Number of mature pods per plant, number of primary branches per plant |
| **Number of primary branches per plant** | | |
| Significant positive | Number of pegs per plant, number of pods per plant, number of mature pods per plant, kernel yield per plant | Number of pegs per plant, number of immature pods per plant |
| Significant negative | | Harvest index, sound mature kernel percentage |

| | Organic | Inorganic |
|---|---|---|
| **Number of pegs per plant** | | |
| Significant positive | Number of pods per plant, number of mature pods per plant, kernel yield per plant, number of immature pods per plant, shelling percentage | Number of pods per plant, number of mature pods per plant, kernel yield per plant, number of immature pods per plant, shelling percentage |
| **Number of mature pods per plant** | | |
| Significant positive | Number of pods per plant, kernel yield per plant, harvest index, 100 kernel weight, shelling percentage | Number of pods per plant, kernel yield per plant, harvest index, 100 kernel weight, shelling percentage, number of immature pods per plant |
| **Number of immature pods per plant** | | |
| Significant positive | Number of pods per plant | Number of pods per plant, kernel yield per plant |
| Significant negative | | Sound mature kernel percentage |
| **Total number of pods per plant** | | |
| Significant positive | Kernel yield per plant, 100 kernel weight, shelling percentage, harvest index | Kernel yield per plant, 100 kernel weight, shelling percentage, harvest index |
| **100 kernel weight** | | |
| Significant positive | Shelling percentage, sound mature kernel percentage, harvest index, kernel yield per plant | Shelling percentage, sound mature kernel percentage, harvest index, kernel yield per plant |
| **Shelling percentage** | | |
| Significant positive | Kernel yield per plant, sound mature kernel percentage, harvest index | Kernel yield per plant, sound mature kernel percentage, harvest index |
| **Sound mature kernel percentage** | | |
| Significant positive | Harvest index, kernel yield per plant | Kernel yield per plant |
| **Harvest index** | | |
| Significant positive | Kernel yield per plant | Kernel yield per plant |

and harvest index whereas, days to maturity recorded significant negative association with these traits under inorganic fertilizer management.

Plant height showed significant negative association with 100- kernel weight under organic management while under inorganic fertilizer management it recorded significant positive association with 100 seed weight.

## 4.5 PATH COEFFICIENT ANALYSIS

Path coefficient analysis separates the correlation coefficients into components of direct and indirect effects and helps in assessment of the relative importance of each causal factor affecting the pod yield.

Path coefficient analysis of different yield component characters on pod yield based on simple correlations in 173 germplasm lines of groundnut under organic and inorganic fertilizer managements are furnished in Table 4.17 and 4.18, respectively.

### 4.5.1 Direct Effects and Indirect Effects under Organic Fertilizer Management

By using pod yield per plant as dependent variable and nine characters viz., days to 50 % flowering, days to maturity, number of pegs per plant, number of mature pods per plant, number of pods per plant, 100 kernel weight, shelling percentage, harvest index and kernel yield per plant as independent variables path analysis was carried out and the results are furnished in Table 4.17.

#### 4.5.1.1 Days to 50 % flowering

Days to 50% flowering revealed significant and positive correlation with pod yield per plant (0.276 $^{**}$). The direct effect of this trait on pod yield per plant was negative and negligible (-0.001). Its significant and positive

**Table 4.17. Path coefficient analysis for pod yield per plant and its components in groundnut under organic fertilizer management**

| Character | DF | DM | NPEGP | NMP | NPP | 100KW | SP | HI | KYP | r PYP |
|---|---|---|---|---|---|---|---|---|---|---|
| **DF** | **-0.001** | -0.011 | 0.000 | 0.019 | -0.008 | 0.007 | 0.011 | -0.001 | 0.260 | **0.276**** |
| **DM** | -0.001 | **-0.026** | 0.000 | 0.038 | -0.016 | 0.008 | -0.040 | -0.003 | 0.485 | **0.447**** |
| **NPEGP** | 0.000 | -0.001 | **0.004** | 0.053 | -0.024 | 0.000 | -0.068 | 0.000 | 0.500 | **0.464**** |
| **NMP** | 0.000 | -0.011 | 0.002 | **0.092** | -0.038 | 0.005 | -0.101 | -0.004 | 0.886 | **0.832**** |
| **NPP** | 0.000 | -0.010 | 0.003 | 0.088 | **-0.040** | 0.005 | -0.089 | -0.004 | 0.874 | **0.828**** |
| **100KW** | 0.000 | -0.010 | 0.000 | 0.024 | -0.010 | **0.021** | -0.098 | -0.003 | 0.562 | **0.485**** |
| **SP** | 0.000 | -0.003 | 0.001 | 0.031 | -0.012 | 0.007 | **-0.296** | -0.002 | 0.614 | **0.340**** |
| **HI** | 0.000 | -0.009 | 0.000 | 0.041 | -0.017 | 0.009 | -0.070 | **-0.008** | 0.659 | **0.604**** |
| **KYP** | 0.000 | -0.011 | 0.002 | 0.075 | -0.032 | 0.011 | -0.167 | -0.005 | **1.091** | **0.963**** |

Residual Effect : **0.011**

Bold: Direct effects; Normal: Indirect effects. * Significant at 5% level; ** Significant at 1 % level

DF : Days to 50% flowering; DM : days to maturity; NPEGP : Number of pegs per plant (No); NMP : Number of mature pods per plant (No);NPP : Number of pods per plant (No); 100KW : 100 kernel weight (g); SP : Shelling percentage(%);HI : Harvest index (%); KYP : Kernel yield per plant (g); PYP : Pod yield per plant (g).

association with pod yield per plant was due to moderate and positive indirect effect through kernel yield per plant (0.260) followed by its negligible positive indirect effects through number of mature pods per plant (0.019) and shelling percentage (0.011)

Negligible negative direct effect of days to 50% flowering on pod yield per plant was observed by Korat *et al.* (2010). On the contrary, negligible positive direct effect of days to 50% flowering on pod yield per plant was reported by Jain *et al*. (2016).

#### 4.5.1.2 Days to maturity

The direct effect (-0.026) of this trait was negligible and negative on pod yield per plant. This trait exhibited significant positive association ($0.447^{**}$) with pod yield per plant due to its high positive indirect effect through kernel yield per plant (0.485) followed by negligible positive indirect effects through number of mature pods per plant (0.038) and 100 seed weight (0.008).

Negligible and negative direct effect of days to maturity on pod yield per plant was reported by Pavankumar *et al*. (2014). On contrary negligible positive direct effect of days to maturity on pod yield per plant was reported by Jain *et al.* (2016).

#### 4.5.1.3 Number of pegs per plant

Though it showed negligible positive direct effect (0.004), number of pegs per plant exhibited significant positive association ($0.464^{**}$) with pod yield per plant due to its high positive indirect effect through kernel yield per plant (0.500) and negligible positive indirect effects through number of mature pods per plant (0.053).

On contrary to the present findings negligible negative direct effect of number of pegs per plant on pod yield per plant was reported by Francies and Ramalingam (1997).

#### 4.5.1.4 Number of mature pods per plant

The direct effect (0.092) of this trait was negligible and positive on pod yield per plant. This trait showed significant positive correlation ($0.832^{**}$) with pod yield per plant due to its high positive indirect effects through kernel yield per plant (0.886). The indirect effect of this trait via shelling percentage (-0.101) and number pods per plant (-0.038) were low and negative.

On contrary to the present findings negligible negative direct effect of number of mature pods per plant on pod yield per plant was registered by Pavankumar *et al.* (2014).

#### 4.5.1.5 Number of pods per plant

Number of pods per plant showed significant and positive association ($0.828^{**}$) with pod yield per plant. The direct effect (-0.040) of this trait on pod yield per plant was negligible and negative. But the significant and positive relation was due to its high positive indirect effects via kernel yield per plant (0.874) followed by negligible positive indirect effects through number of mature pods per plant (0.088). This trait also showed negligible negative indirect effects through shelling percentage (-0.089) and days to maturity (-0.010).

On contrary to the present findings negligible negative direct effect of number of pods per plant on pod yield per plant was reported by Rao *et al.* (2014).

#### 4.5.1.6 100 kernel weight (g)

100 kernel weight showed significant and positive correlation (0.485$^{**}$) with pod yield per plant due to its negligible positive direct effect (0.021) and high positive indirect effects via kernel yield per plant (0.562) followed by negligible positive indirect effects through number of mature pods per plant (0.024). The indirect effects of this trait via shelling percentage (-0.098) and number of pods per plant (-0.010) were negligible negative.

Negligible positive direct effect recorded for 100 kernel weight on pod yield per plant was in conformity with the results of Pavankumar *et al.* (2014) and Rao *et al.* (2014).

#### 4.5.1.7 Shelling percentage

Inspite of its high negative direct effect (-0.296), shelling percentage exhibited significant positive association (0.340$^{**}$) with pod yield per plant due to its high positive indirect effects through kernel yield per plant (0.614) followed by negligible positive indirect effects via number of mature pods per plant (0.031) and 100 kernel weight (0.007). It also exhibited negligible negative indirect effects via number of pods per plant (-0.012).

The results of high negative direct effect of shelling percentage with pod yield per plant were registered by Kumar *et al.* (2012) and Rao *et al.* (2014).

#### 4.5.1.8 Harvest index (%)

The direct effect of this trait (-0.008) was negligible and negative on pod yield per plant. But this character showed significant positive correlation (0.604$^{**}$) with pod yield per plant due to its high positive indirect effect through kernel yield per plant (0.659) followed by negligible positive indirect effects of number of mature pods per plant (0.041) and 100 kernel weight (0.009). Whereas negligible negative indirect effects were exhibited by number of pods per plant (-0.017) and shelling percentage (-0.070).

The present results where harvest index recorded negligible negative direct effect with pod yield per plant were in accordance with the reports of Venkateswarlu *et al.* (2007).

**4.5.1.9 Kernel yield per plant (g)**

This trait showed significant positive correlation (0.963$^{**}$) with pod yield per plant due its very high positive direct effect (1.091) through kernel yield per plant followed by negligible positive indirect effects via number of mature pods per plant (0.075) and 100 kernel weight (0.011). The indirect effect via shelling percentage (-0.167) was low but negative.

High positive direct effect of kernel yield per plant on pod yield per plant was reported by Jain *et al.* (2017) and Kumar *et al.* (2012).

Under organic fertilizer management the residual effect was 0.011 signifying the consideration of most of the characters contributing to the pod yield per plant in the study.

Under organic fertilizer management the character kernel yield per plant registered very high positive direct effect on pod yield per plant. Whereas, days to 50 % flowering, days to maturity, number of pegs per plant, number of mature pods per plant, number of pods per plant, 100 kernel weight and harvest index exhibited negligible direct effect on pod yield per plant. Shelling percentage showed high negative direct effect on pod yield per plant. The traits viz., number of mature pods per plant, number of pods per plant, harvest index, shelling percentage, 100 kernel weight, number of pegs per plant, days to 50 % flowering and days to maturity displayed high positive indirect effect through kernel yield per plant.

Among the yield contributing characters, kernel yield per plant registered positive direct effect on pod yield per plant. Positive direct effect of this trait on pod yield per plant and significant positive association with pod yield per plant indicated its importance in determining this complex trait. Furthermore, significant positive association of other traits viz., days to 50 % flowering, days to maturity, number of pegs per plant, number of mature pods per plant, number of pods per plant, 100 kernel weight, shelling percentage and harvest index with pod yield per plant was due to positive indirect effects through this trait. Because of this reason kernel yield per plant should be given more importance during selection process in groundnut under organic fertilizer management.

### 4.5.2 Direct Effects and Indirect Effects under Inorganic Fertilizer Management

Path coefficient analysis was carried out by using pod yield per plant as dependent variable and 12 characters viz., days to 50% flowering, days to maturity, plant height, number of primary branches per plant, number of pegs per plant, number of mature pods per plant, number of immature pods per plant, number of pods per plant, 100 kernel weight, shelling percentage, harvest index and kernel yield per plant as independent variables and the results were presented in Table 4.18.

#### 4.5.2.1 Days to 50 % flowering

Significant and negative correlation was observed between days to 50% flowering and pod yield per plant ($-0.170^{*}$). This correlation was due to its negligible negative direct effect (-0.002) followed by high negative indirect effect via number of pods per plant (-0.328) followed by moderate negative indirect effect via kernel yield per plant (-0.282) and negligible negative indirect effect through number of immature pods per plant (-0.075). The indirect effect through number of mature pods per plant (0.408) was

**Table 4.18. Path coefficient analysis for pod yield per plant and its components in groundnut under inorganic management**

| Character | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | HI | KYP | r PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **DF** | **-0.002** | 0.008 | -0.006 | 0.003 | 0.000 | 0.408 | -0.075 | -0.328 | 0.000 | 0.120 | -0.014 | -0.282 | **-0.170*** |
| **DM** | -0.001 | **0.020** | -0.007 | 0.003 | 0.000 | 0.402 | -0.069 | -0.329 | 0.000 | 0.111 | -0.014 | -0.300 | **-0.185*** |
| **PH** | 0.001 | -0.005 | **0.024** | -0.003 | 0.000 | -0.272 | 0.094 | 0.172 | 0.000 | -0.007 | 0.004 | 0.237 | **0.244**** |
| **NPB** | -0.001 | 0.005 | -0.007 | **0.010** | 0.000 | -0.159 | -0.141 | 0.311 | 0.000 | 0.039 | -0.010 | 0.114 | **0.162*** |
| **NPEGP** | 0.000 | -0.002 | 0.002 | 0.003 | **0.000** | -0.916 | -0.138 | 1.067 | 0.000 | -0.060 | 0.003 | 0.486 | **0.446**** |
| **NMP** | 0.001 | -0.006 | 0.005 | 0.001 | 0.000 | **-1.409** | -0.076 | 1.497 | 0.000 | -0.131 | 0.029 | 0.884 | **0.794**** |
| **NIMP** | 0.000 | 0.003 | -0.005 | 0.003 | 0.000 | -0.259 | **-0.415** | 0.707 | 0.000 | 0.020 | 0.007 | 0.204 | **0.265**** |
| **NPP** | 0.000 | -0.004 | 0.003 | 0.002 | 0.000 | -1.352 | -0.188 | **1.560** | 0.000 | -0.113 | 0.028 | 0.860 | **0.796**** |
| **100KW** | 0.000 | -0.002 | 0.004 | 0.001 | 0.000 | -0.323 | -0.026 | 0.352 | **-0.002** | -0.102 | 0.018 | 0.625 | **0.545**** |
| **SP** | 0.001 | -0.007 | 0.001 | -0.001 | 0.000 | -0.612 | 0.027 | 0.585 | -0.001 | **-0.301** | 0.019 | 0.566 | **0.277**** |
| **HI** | 0.001 | -0.006 | 0.002 | -0.002 | 0.000 | -0.842 | -0.060 | 0.910 | -0.001 | -0.116 | **0.049** | 0.757 | **0.692**** |
| **KYP** | 0.001 | -0.006 | 0.005 | 0.001 | 0.000 | -1.165 | -0.079 | 1.255 | -0.001 | -0.160 | 0.034 | **1.069** | **0.955**** |

Residual Effect : **0.013**

Bold: Direct effects; Normal: Indirect effects .* Significant at 5% level; ** Significant at 1 % level

DF : Days to 50% flowering; DM : days to maturity; PH : Plant height (cm); NPB : Number of primary branches per plant (No); NPEGP : Number of pegs per plant (No); NMP : Number of mature pods per plant (No); NIMP : Number of immature pods per plant (No); NPP : Number of pods per plant (No); 100KW : 100 kernel weight (g); SP : Shelling percentage(%); HI : Harvest index (%); KYP : Kernel yield per plant (g); PYP : Pod yield per plant (g).

high and positive followed by low positive indirect effect of shelling percentage (0.120).

Negligible negative direct effect of days to 50 % flowering on pod yield per plant was reported by Korat *et al.* (2010). On contrary, negligible positive direct effect of days to 50 % flowering on pod yield per plant was registered by Jain *et al.* (2017).

**4.5.2.2 Days to maturity**

The direct effect of this trait (0.020) was negligible and positive on pod yield per plant. But it showed significant and negative association ($-0.185^{**}$) with pod yield per plant due to its very high negative indirect effect through number of pods per plant (-0.329), kernel yield per plant (-0.300). It exhibited high positive indirect effect via number of mature pods per plant (0.402) followed by low positive indirect effect through shelling percentage (0.111).

The present findings where in days to maturity recorded negligible positive direct effect with pod yield per plant were in conformity with the reports of Jain *et al.* (2017).

**4.5.2.3 Plant height (cm)**

Plant height showed negligible positive direct effect (0.024) on pod yield per plant. But the significant and positive correlation ($0.244^{**}$) was due to its moderate and positive indirect effects via kernel yield per plant (0.237) followed by low positive indirect effect via number of pods per plant (0.172) and number immature pods per plant (0.094). Whereas number of mature pods per plant (-0.272) showed moderate negative indirect effect.

On the contrary, to the present reports negligible negative direct effect of plant height on pod yield per plant was registered by Jain *et al.* (2016).

### 4.5.2.4 Number of primary branches per plant

There was a significant positive correlation (0.162$^{*}$) between number of primary branches per plant and pod yield per plant. The direct effect (0.010) of this trait on pod yield per plant was negligible and positive. The significant positive association was due to its high positive indirect effects through number of pods per plant (0.311) followed by low positive indirect effect via kernel yield per plant (0.114). This trait showed low negative indirect effect through number of mature pods per plant (-0.159) and number of immature pods per plant (-0.141).

The results are in conformity with the reports of Patil *et al.* (2006).

### 4.5.2.5 Number of pegs per plant

Though this trait exhibited very negligible negative direct effect (-0.000), the significant positive relation (0.446$^{**}$) with pod yield per plant was due to its very high and positive indirect effect via number of pods per plant (1.067) followed by high positive indirect effect via kernel yield per plant (0.486). Whereas it exhibited very high negative indirect effect through number of mature pods per plant (-0.916) and number of immature pods per plant (-0.138).

The results of low negative direct effect of number of pegs per plant on pod yield per plant were registered by Francies and Ramalingam (1997).

### 4.5.2.6 Number of mature pods per plant

Inspite of its very high negative direct effect (-1.409), number of mature pods per plant showed significant positive correlation (0.794$^{**}$) with pod yield per plant due to its very high positive indirect effects through number of pods per plant (1.497) and kernel yield per plant (0.884). It also exhibited low negative indirect effect via shelling percentage (-0.131).

On contrary, very high positive direct effect of number of mature pods per plant on pod yield per plant was reported by Zaman *et al.* (2011) and Kamdi *et al.* (2017).

#### 4.5.2.7 Number of immature pods per plant

Number immature pods per plant showed high negative direct effect (-0.415) with pod yield per plant. But its significant positive association ($0.265^{**}$) with pod yield per plant was due to its high positive indirect effect via number of pods plant (0.707) and kernel yield per plant (0.204). The indirect effect of this trait through number mature pods per plant (-0.259) was moderate and negative.

High negative direct effect for number of immature pods per plant on pod yield per plant was in conformity with the results of Zaman *et al.* (2011). On contrary to the present reports high positive direct effect of number of immature pods per plant on pod yield per plant was registered by Vasanthi *et al.* (2015).

#### 4.5.2.8 Number of pods per plant

Inspite its high negative indirect effets via number of mature pods per plant (-1.352) followed by low negative indirect effect via number of immature pods per plant (-0.188) and shelling percentage (-0.113). This trait exhibited significant and positive relation ($0.796^{**}$) with pod yield per plant was due to its very high positive direct effect (1.560) followed by high positive indirect effect through kernel yield per plant (0.860).

The results of very high positive direct effect for number of pods per plant on pod yield per plant were similar with the reports of Patil *et al.* (2006).

#### 4.5.2.9 100 kernel weight (g)

Though it showed negligible negative direct effect (-0.002), the significant positive association (0.545$^{**}$) with pod yield per plant was due to its high positive indirect effects via kernel yield per plant (0.625) and number of pods per plant (0.352). Whereas, the indirect effects were high and negative via number of mature pods per plant (-0.323) and low negative indirect effect through shelling percentage (-0.102) on pod yield per plant.

However, negligible positive direct effect of 100 kernel weight with pod yield per plant was reported by Pavankumar *et al.* (2014).

#### 4.5.2.10 Shelling percentage

Shelling percentage showed high negative direct effect (-0.301) on pod yield per plant. But the significant and positive association (0.277$^{**}$) was due to its high positive indirect effects via number of pods per plant (0.585) and kernel yield per plant (0.566). Whereas, it exhibited high negative indirect effect via number of mature pods per plant (-0.612) on pod yield per plant.

High negative direct effect of shelling percentage with pod yield per plant was in accordance with the reports of Rao *et al.* (2014) and Kumar *et al.* (2012).

#### 4.5.2.11 Harvest index (%)

There was a significant positive correlation (0.692$^{**}$) between harvest index and pod yield per plant. The direct effect (0.049) of this trait was negligible and positive. The significant and positive relation was due to its very high positive indirect effect via number of pods per plant (0.910) and kernel yield per plant (0.757). The indirect effects via number of mature pods per plant (-0.842) was high negative followed by low negative indirect effect through shelling percentage (-0.116).

On contrary, negligible negative direct effect of harvest index on pod yield per plant was reported by Venkateswarlu *et al.* (2007).

**4.5.2.12 Kernel yield per plant (g)**

The high significant and positive correlation (0.955$^{**}$) between kernel yield per plant and pod yield per plant was due to its very high positive direct effect through kernel yield per plant (1.069) and very high positive indirect effect via number of pods per plant (1.255) followed by negligible positive indirect effect via harvest index (0.034). It also exhibited very high negative indirect effect through number of mature pods per plant (-1.165) followed by low negative indirect effect via shelling percentage (-0.160) on pod yield per plant.

The results of very high positive direct effect for kernel yield per plant with pod yield per plant were reported by Kumar *et al.* (2012), Rao *et al.* (2014) and Jain *et al.* (2017).

Under inorganic fertilizer management the residual effect was 0.013 indicating that most of the traits contributing to the pod yield per plant were considered under study.

Under inorganic fertilizer management the traits number of pods per plant and kernel yield per plant recorded very high positive direct effects; while number of mature pods per plant, number of immature pods per plant and shelling percentage exhibited high negative direct effects on pod yield per plant. The remaining characters viz., days to 50 % flowering, days to maturity, plant height, number of pegs per plant, 100 kernel weight and harvest index registered negligible direct effects on pod yield per plant. The traits viz., number of pegs per plant, number of mature pods per plant, number of pods per plant, 100- kernel weight, shelling percentage and harvest index showed high positive indirect effects on pod yield per plant through kernel yield per plant. Indirect effects of plant height and number of immature pods per plant were moderate and positive through kernel yield per plant whereas number of primary branches per plant exhibited low positive indirect effect through kernel yield per plant.

The high positive direct effects on pod yield per plant were registered by number of pods per plant followed by kernel yield per plant. Positive direct effects of these characters on pod yield per plant and significant positive relation with pod yield per plant displayed their importance in determining this complex trait. Moreover significant positive correlation of plant height, number of pegs per plant, number of primary branches per plant, number of mature pods per plant, number of immature pods per plant, number of pods per plant, 100 kernel weight, shelling percentage and harvest index was due to positive indirect effects via these two traits on pod yield per plant hence, direct selection for these two traits viz., kernel yield per plant and number of pods per plant will be rewarding for yield improvement.

Based on overall path analysis study, it is concluded that kernel yield per plant registered very high positive direct effect under organic management whereas kernel yield per plant and total number of pods per plant exhibited very high positive direct effects under inorganic fertilizer management. These results specified that by keeping the other traits constant selection for kernel yield per plant under organic management and for kernel yield per plant and total number of pods per plant under inorganic fertilizer management will result in an increased pod yield per plant under respective environments.

## 4.6 IDENTIFICATION OF PROMISING GENOTYPES

The genotypes showing better performance for different characters under organic fertilizer management are furnished in Table 4.19. The higher pod yield per plant and kernel yield per plant were registered by ICG-

**Table 4.19. Groundnut germplasm lines showing better performance for different characters under organic fertilizer management**

| Germplasm lines | Characters |
|---|---|
| ICG- 6407 | days to 50% flowering (early), sound mature kernel percentage |
| ICG- 6888 | days to 50% flowering (early), number of immature pods per plant |
| ICG- 13099 | Pod yield per plant, kernel yield per plant, number of pods per plant, number of pegs per plant, number of mature pods per plant, plant height |
| ICG- 10384 | Pod yield per plant, kernel yield per plant, harvest index, number of mature pods per plant |
| ICG- 13723 | Pod yield per plant, kernel yield per plant, number of mature pods per plant, number of pods per plant, |
| ICG- 11687 | Pod yield per plant, number of pods per plant |
| ICG- 13942 | Pod yield per plant, kernel yield per plant, number of mature pods per plant, number of pods per plant, |
| ICG- 2857 | 100 kernel weight, harvest index, shelling percentage |
| ICG- 4729 | Shelling percentage, number of pegs per plant |
| ICG- 6892 | Number of mature pods per plant, number of pods per plant |

13099, ICG- 10384, ICG- 13723, and ICG- 13942. Similarly, ICG- 13099, ICG- 13723 and ICG- 13942 exhibited more number of mature pods per plant and total number of pods per plant. The genotype, ICG- 13099 also registered high plant height and number of pegs per plant. High harvest index and more number of mature pods per plant were recorded by ICG- 10384. The genotype, ICG- 11687 exhibited high pod yield per plant and more number of pods per plant. These results indicated that the genotypes *viz.*, ICG- 13099, ICG- 10384, ICG- 13723, ICG- 13942 and ICG- 11687 appeared to be promising donors for improvement of pod yield and other yield contributing traits under organic fertilizer management.

The genotypes ICG- 6407 and ICG- 6888 were early in flowering and also showed high sound mature kernel percentage and more number of immature pods per plant respectively. While high harvest index and 100 kernel weight were registered by ICG- 2857. The genotype, ICG- 6892 exhibited more number of total pods per plant and mature pods per plant. The genotype, ICG- 4729 registered high shelling percentage and more number of pegs per plant.

Under inorganic fertilizer management the genotypes showing better performance for different characters are presented in Table 4.20. The genotypes viz., ICG- 434, ICG- 13942, ICG- 332, ICG- 12879 and ICG- 11651 recorded higher pod yield per plant. Similarly, higher kernel yield per plant was recorded by ICG- 434, ICG- 11651, ICG- 13942, ICG- 7153 and ICG- 5236. The genotypes viz., ICG- 434, ICG- 12879 and ICG- 7153 exhibited more number of total pods per plant and more number of pegs per plant. Similarly, higher harvest index was registered by ICG- 5236 and ICG- 13942; high 100 kernel weight by ICG- 11651 and ICG- 13942; more number of mature pods per plant by ICG- 6892 and ICG- 7153; more number of primary branches per plant by ICG- 332. While early maturity was recorded by ICG- 332 and ICG- 434. These results indicated that the

**Table 4.20. Groundnut germplasm lines showing better performance for different characters under inorganic fertilizer management**

| Germplasm lines | Characters |
|---|---|
| ICG- 1519 | Days to 50% flowering (early), shelling percentage |
| ICG- 332 | Days to maturity (early), pod yield per plant, number of primary branches per plant, |
| ICG- 434 | Pod yield per plant, kernel yield per plant, number of pods per plant, number of pegs per plant, number of mature pods per plant, days to maturity |
| ICG- 6892 | Number of pods per plant, number of pegs per plant, number of mature pods per plant |
| ICG- 3584 | Number of mature pods per plant, shelling percentage |
| ICG- 11426 | Number of pegs per plant, number of mature pods per plant, number of pods per plant |
| ICG- 7153 | Kernel yield per plant, number of mature pods per plant, number of pods per plant, |
| ICG- 11651 | 100 kernel weight, pod yield per plant, kernel yield per plant |
| ICG- 13942 | Pod yield per plant, 100 kernel weight, kernel yield per plant, harvest index |
| ICG- 5236 | Kernel yield per plant, harvest index |
| ICG- 12879 | Pod yield per plant,, number of pods per plant |

genotypes viz., ICG- 434, ICG- 13942, ICG- 332, ICG- 12879, ICG- 11651, ICG- 5236 and ICG- 7153 appeared to be promising donors for improvement of pod yield and other yield contributing traits under organic management.

The genotype ICG- 1519 was early in flowering and exhibited high shelling percentage. Similarly more number of mature pods per plant and pegs per plant were registered by ICG- 6892, ICG- 11426 and ICG- 3584. High shelling percentage was recorded by ICG- 3584 whereas ICG- 6892, ICG- 11426 recorded more number of pods per plant.

Under organic management the overall general performance of 173 germplasm lines for pod yield per plant was on an average higher when compared with their performance under inorganic fertilizer management. However, rank changes were observed among the genotypes for most of the characters in the two environments. The interrelationships among the characters were also different under organic and inorganic fertilizer managements.

The results indicated that different genotypes showed differential performance in organic and inorganic fertilizer managements. Hence, conduct of trials under organic and inorganic fertilizer managements may help to select the best lines available in the pool of existing germplasm suitable for the target environment. The germplasm lines which showed better performance under organic management can be further used in crossing programme to select best lines suitable for this environment.

# Chapter – V

# Summary&
# Conclusions

## Chapter V

# SUMMARY AND CONCLUSIONS

The present investigation entitled "Evaluation of minicore collection of groundnut under organic and inorganic fertilizer managements'' was carried out in order to study the variability, heritability, genetic advance as per cent of mean, degree and direction of association between yield and its contributing characters and to estimate the direct and indirect contribution of each component character towards yield among 173 groundnut genotypes under organic and inorganic fertilizer managements.

Two separate field experiments were conducted at dryland farm of Sri Venkateswara Agricultural College, Tirupati, Acharya N.G. Ranga Agricultural University during *kharif* 2016 in Augumented design II. The observations were recorded on 14 characters viz., days to 50 % flowering, days to maturity, plant height (cm), number of primary branches per plant, number of pegs per plant, number of mature pods per plant, number of immature pods per plant, total number of pods per plant, 100 seed weight (g), shelling percentage, sound mature kernel percentage, harvest index (%), kernel yield per plant (g) and pod yield per plant (g) under both organic and inorganic fertilizer managements.

The analysis of variance in respect of 14 characters revealed significant differences among the genotypes for all the characters under both organic and inorganic fertilizer managements except for number of primary branches per plant, shelling percentage and harvest index which were non-significant under organic fertilizer management and significant under inorganic fertilizer management indicating the presence of considerable amount of genetic variation for different traits among the genotypes evaluated.

Observation on yield and yield contributing traits under organic and inorganic fertilizer managements clearly showed change in ranking order of the genotypes for most of the characters. Among the genotypes, ICG- 13099, ICG- 10384, ICG- 13723 and ICG- 13942 recorded higher mean performance for yield and its component characters under organic management. Whereas, under inorganic fertilizer management genotypes viz., ICG- 434, ICG- 13942, ICG- 332 and ICG- 11651 showed higher mean performance for pod yield per plant and its contributing traits. Considering both the managements, the genotype ICG- 13942 recorded high *per se* performance for pod yield and its component characters.

The estimates of GCV and PCV were high for the characters viz., number of immature pods per plant, kernel yield per plant, pod yield per plant, number of mature pods per plant, number of pegs per plant, total number of pods per plant, 100-kernel weight and plant height under organic management, while under inorganic fertilizer management number of immature pods per plant, kernel yield per plant, number of primary branches per plant, number of mature pods per plant, pod yield per plant, number of pegs per plant and total number of pods per plant showed high estimates of GCV and PCV which indicated the presence of genetic variability among the genotypes for these traits and less influence of environment. Thus, direct selection for these traits would result in further improvement of pod yield under respective environments.

Moderate GCV and high PCV values were observed for harvest index and number of primary branches per plant under organic management, while the characters viz., sound mature kernel percentage, harvest index, plant height and 100-kernel weight exhibited moderate GCV and high PCV values under inorganic fertilizer management. Moderate estimates of GCV and PCV values were registered for sound mature kernel percentage and days to 50 % flowering under organic management and for days to 50 % flowering and shelling percentage under inorganic fertilizer management, whereas shelling percentage exhibited low GCV and moderate PCV values under organic management. Low estimates of GCV and PCV were recorded for days to maturity under both the fertilizer managements, which indicated little scope for further improvement of these characters through simple selection.

High heritability coupled with high genetic advance as per cent of mean were observed for pod yield per plant under organic managements and for number of primary branches per plant and shelling percentage under inorganic fertilizer management. Whereas high heritability coupled with high genetic advance as per cent of mean were recorded for the characters viz., days to 50 % flowering, 100 seed weight plant height number of mature pods per plant, number of immature pods per plant and total number of pods per plant under both the fertilizer managements

Further, moderate heritability coupled with high genetic advance as per cent of mean observed for number of pegs per plant, kernel yield per plant and sound mature kernel percentage under both the fertilizer managements, while the traits viz., harvest index and pod yield per plant also recorded moderate heritability coupled with high genetic advance as per cent of mean under inorganic fertilizer management. Hence, simple pedigree method of breeding and phenotypic selection would be effective for improvement of these traits.

High heritability coupled with moderate genetic advance as per cent of mean was observed for days to maturity under both the managements indicated the role of both additive and non-additive gene action with preponderance of additive genetic variance and selection would be effective to some extent. Moderate heritability coupled with moderate genetic advance as per cent of mean was recorded for number of primary branches per plant and harvest index under organic management indicating that both additive and non-additive gene actions have a role in their inheritance and phenotypic selection would be effective. Shelling percentage recorded low heritability coupled with low genetic advance as per cent of mean under organic managements indicating that the character is highly influenced by environmental effects and selection would be ineffective for improvement of this trait.

Character association analysis revealed that the characters viz., harvest index, 100 seed weight, number of mature pods per plant, total number of pods per plant, shelling percentage, number of pegs per plant and kernel yield per plant recorded significant positive correlation with pod yield per plant and also among themselves, indicating that simultaneous selection for these characters would result in improvement of pod yield in the genotypes under both organic and inorganic fertilizer managements. Thus, selection criterion if emphasized on the traits that showed significant positive association with pod yield per plant would result in improvement of pod yield under both the managements.

Path analysis was conducted for only those traits which showed significant association with pod yield per plant under both the fertilizer managements. The results revealed that kernel yield per plant under organic management and kernel yield per plant and total number of pods per plant under inorganic fertilizer management recorded high positive direct effect on pod yield per plant.

The other traits *viz*., days to 50 % flowering, days to maturity, number of pegs per plant, number of mature pods per plant, total number of pods per plant, 100 seed weight, shelling percentage and harvest index exhibited significant positive correlation with pod yield due to indirect effects *via* kernel yield per plant under organic fertilizer management.

Whereas, under inorganic fertilizer management the traits *viz*., days to 50 % flowering, days to maturity, plant height, number of primary branches per plant, number of pegs per plant, number of mature pods per plant, number of immature pods per plant, 100-kernel weight, shelling percentage and harvest index exhibited significant positive correlation with pod yield due to indirect effects via kernel yield per plant and total number of pods per plant.

Thus, more importance could be given for kernel yield per plant under organic fertilizer management and for kernel yield per plant and total number of pods per plant under inorganic fertilizer management during selection for pod yield improvement in groundnut.

The results of the present study revealed that the germplasm lines viz., ICG- 13099, ICG- 6407, ICG- 6888, ICG- 10384, ICG- 13723, ICG- 11687, ICG- 13942, ICG- 2857, ICG- 4729 and ICG- 6892 were promising under organic and the germplasm lines viz., ICG- 434, ICG- 1519, ICG- 332, ICG- 6892, ICG- 3584, ICG- 11426, ICG- 7153, ICG- 11651, ICG- 13942, ICG- 5236 and ICG- 12879 were promising under inorganic fertilizer management for yield and its contributing characters. Hence, these lines may be further evaluated for their utility in crossing programmes for the development of varieties suitable for the target environment.

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# Appendices

# Appendix A

## *BEEJAMRUTHAM* PREPARATION

**Materials required:**For 100 kg seeds

- Water 20 liters
- Cow urine 5 liters
- Cow dung 5 kgs
- Calcium (sunnam) 50 g
- Container with 40-50 liters capacity

**Preparation process:**

1. Add 20 liters water in container.
2. Add urine and calcium in water.
3. Tie the cow dung in a cloth and hang it half way into the container.
4. Mix everything very well and let it sit overnight (24 hours).
5. Make sure to stir the mixture clock wise every 8 hours and squeeze the dung each time you stir.

# Appendix B

## *JEEVAMRUTHA* PREPARATION

**Materials required:**

- Water – 200 liters
- Cow dung – 10 Kg (Indigenious Cows, Preferably)
- Cow urine – 5 liters (Indigenious Cows, Preferably)
- Jaggery – 2 Kg
- Flour of any pulse – 2 Kg
- Soil from same land – one handfull.

**Preparation process:**

First of all take 200 litres of water in the drum, add other ingredients to it, mix well and keep the drum under shade covering with wet gunny bag and incubate for 4-5 days. Stir the mixture in clockwise direction once a day at least or at regular intervals of 6-8 hours (thrice a day).

# Appendix C

## *PANCHAGAVYA* PREPARATION

**Materials required:**

Panchagavya consists of nine products viz., cow dung, cow urine, milk, curd, jaggery, ghee, banana, Tender coconut and water.

- Cow dung - 7 kgs
- Cow ghee - 1 kg

Mix the above two ingredients thoroughly both in morning and evening hours and keep it for 3 days

- Cow urine - 10 liters
- Water - 10 liters

After 3 days mix cow urine and water and keep it for 15 days with regular mixing both in morning and evening hours. After 15 days mix the following and *panchagavya* will be ready after 30 days.

- Cow milk - 3 liters
- Cow curd - 2 liters
- Tender coconut water - 3 liters
- Jaggery - 3 kgs
- Well ripened poovan banana – 12 nos.

**Preparation process:**

All the above items can be added to a wide mouthed mud pot, concrete tank or plastic can as per the above order. The container should be kept open under shade. The content is to be stirred twice a day both in morning and evening. The *panchagavya* stock solution will be ready after 30 days (care should be taken not to mix buffalo products and products of local breeds of cow is said to have potency than exotic breeds). It should be kept in the shade and covered with a wire mesh or plastic mosquito net to prevent houseflies from laying eggs and the formation of maggots in the solution. If sugarcane juice is not available add 500 g of jaggery dissolved in 3 liters of water.

## Appendix- D

**Adjusted means with block effect and critical differences of 168 germplasm lines and five checks for 14 characters under organic fertilizer management**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 36 | 26.13 | 101.80 | 33.95 | 4.22 | 44.02 | 10.29 | 5.65 | 15.94 | 20.13 | 54.32 | 55.17 | 20.43 | 3.82 | 8.12 |
| 76 | 28.13 | 101.80 | 33.90 | 4.62 | 35.82 | 15.49 | 3.25 | 18.74 | 22.27 | 60.21 | 73.50 | 34.94 | 5.99 | 10.92 |
| 81 | 29.13 | 118.80 | 33.05 | 5.02 | 38.32 | 22.24 | 4.15 | 26.39 | 32.85 | 60.69 | 65.58 | 40.50 | 11.02 | 18.35 |
| 111 | 32.13 | 118.80 | 40.70 | 4.82 | 50.42 | 25.49 | 2.85 | 28.34 | 24.65 | 57.91 | 29.18 | 49.16 | 14.40 | 24.26 |
| 115 | 28.13 | 101.80 | 36.10 | 4.62 | 30.62 | 13.09 | 2.85 | 15.94 | 24.07 | 61.20 | 68.30 | 41.94 | 8.16 | 14.01 |
| 118 | 31.13 | 101.80 | 36.63 | 5.68 | 38.15 | 15.49 | 6.65 | 22.14 | 23.92 | 60.77 | 62.20 | 34.87 | 8.55 | 14.66 |
| 163 | 35.13 | 123.80 | 18.30 | 4.02 | 71.82 | 30.49 | 3.65 | 34.14 | 29.88 | 56.44 | 58.28 | 40.45 | 13.42 | 23.20 |
| 188 | 33.13 | 118.80 | 28.50 | 3.62 | 38.62 | 25.69 | 2.05 | 27.74 | 34.03 | 56.09 | 79.08 | 52.07 | 12.41 | 21.70 |
| 297 | 29.13 | 112.80 | 39.30 | 4.62 | 36.62 | 15.49 | 4.85 | 20.34 | 36.37 | 50.10 | 64.50 | 42.51 | 7.95 | 15.80 |
| 332 | 28.13 | 118.80 | 47.05 | 5.02 | 53.32 | 27.74 | 6.40 | 34.14 | 36.43 | 49.95 | 76.63 | 54.41 | 14.05 | 26.64 |
| 334 | 27.13 | 112.80 | 56.30 | 6.02 | 44.82 | 22.49 | 5.65 | 28.14 | 28.17 | 72.04 | 49.01 | 35.29 | 16.18 | 22.70 |
| 397 | 30.13 | 101.80 | 34.50 | 4.22 | 59.42 | 18.49 | 3.05 | 21.54 | 25.72 | 57.49 | 66.20 | 33.94 | 8.11 | 14.57 |
| 434 | 27.13 | 109.80 | 44.50 | 5.02 | 58.02 | 14.89 | 3.05 | 17.94 | 27.55 | 60.98 | 73.50 | 23.35 | 7.65 | 13.29 |
| 442 | 26.13 | 109.80 | 44.30 | 4.02 | 42.82 | 13.49 | 3.65 | 17.14 | 19.71 | 70.26 | 56.82 | 26.08 | 5.82 | 9.66 |
| 513 | 33.13 | 126.80 | 37.55 | 4.52 | 41.07 | 19.24 | 7.15 | 26.39 | 42.66 | 51.92 | 64.20 | 36.63 | 9.62 | 18.26 |
| 532 | 28.13 | 126.80 | 23.90 | 4.02 | 30.62 | 18.89 | 3.45 | 22.34 | 28.18 | 57.49 | 69.61 | 47.61 | 9.46 | 16.68 |
| 721 | 36.13 | 126.80 | 31.30 | 4.02 | 34.62 | 18.89 | 2.05 | 20.94 | 25.10 | 43.92 | 62.66 | 37.74 | 6.77 | 15.03 |
| 862 | 34.13 | 126.80 | 19.30 | 7.02 | 41.32 | 19.99 | 4.65 | 24.64 | 24.21 | 59.94 | 61.73 | 51.33 | 6.54 | 11.78 |
| 875 | 35.13 | 126.80 | 28.90 | 5.42 | 39.02 | 23.89 | 3.65 | 27.54 | 33.61 | 58.74 | 62.37 | 57.60 | 13.06 | 21.93 |
| 928 | 35.13 | 126.80 | 37.30 | 6.02 | 51.82 | 24.49 | 4.65 | 29.14 | 27.57 | 53.80 | 51.72 | 39.79 | 10.83 | 19.79 |
| 1137 | 27.13 | 101.80 | 33.30 | 5.35 | 33.75 | 16.09 | 3.98 | 20.07 | 18.71 | 59.89 | 68.90 | 32.62 | 5.52 | 10.25 |
| 1399 | 25.13 | 118.80 | 43.96 | 4.02 | 43.48 | 22.49 | 3.65 | 26.14 | 21.09 | 53.01 | 75.82 | 36.20 | 7.74 | 14.82 |
| 1415 | 26.13 | 118.80 | 37.90 | 4.22 | 31.02 | 20.29 | 3.05 | 23.34 | 22.68 | 57.45 | 79.80 | 51.02 | 8.15 | 14.64 |

**Appendix-D (Contd) . . .**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1519 | 27.13 | 118.80 | 41.60 | 5.02 | 38.15 | 20.82 | 3.65 | 24.47 | 23.31 | 60.66 | 76.57 | 44.09 | 8.41 | 14.47 |
| 1668 | 31.13 | 118.80 | 28.30 | 4.68 | 36.48 | 19.49 | 3.98 | 23.47 | 27.61 | 45.13 | 58.04 | 47.65 | 8.80 | 18.68 |
| 1711 | 25.13 | 118.80 | 29.30 | 4.35 | 36.81 | 21.82 | 4.31 | 26.13 | 23.84 | 61.67 | 76.75 | 52.54 | 8.56 | 14.52 |
| 1973 | 26.13 | 101.80 | 32.30 | 7.02 | 61.82 | 16.49 | 5.65 | 22.14 | 22.44 | 25.91 | 52.73 | 24.24 | 4.90 | 15.95 |
| 2019 | 25.13 | 118.80 | 34.30 | 4.02 | 38.42 | 24.69 | 3.85 | 28.54 | 28.01 | 57.89 | 80.63 | 56.19 | 11.73 | 20.12 |
| 2106 | 24.53 | 118.60 | 34.43 | 3.77 | 35.38 | 24.27 | 1.86 | 26.13 | 19.17 | 69.24 | 75.19 | 51.78 | 12.41 | 18.05 |
| 2511 | 33.53 | 126.60 | 25.93 | 5.07 | 29.28 | 15.17 | 2.06 | 17.23 | 46.18 | 66.00 | 68.71 | 39.06 | 8.11 | 12.45 |
| 2772 | 32.53 | 126.60 | 34.93 | 5.57 | 28.28 | 16.67 | 2.56 | 19.23 | 17.60 | 51.27 | 87.57 | 33.67 | 5.52 | 11.17 |
| 2773 | 30.53 | 126.60 | 32.43 | 4.57 | 27.77 | 18.00 | 1.39 | 19.39 | 27.22 | 69.74 | 76.70 | 52.37 | 10.83 | 15.65 |
| 2777 | 31.53 | 126.60 | 40.43 | 4.23 | 39.11 | 22.67 | 2.39 | 25.06 | 34.40 | 68.72 | 78.32 | 52.88 | 15.81 | 23.14 |
| 2857 | 29.53 | 118.60 | 26.43 | 3.97 | 30.38 | 18.67 | 2.06 | 20.73 | 43.80 | 75.72 | 81.18 | 58.78 | 12.30 | 16.30 |
| 2925 | 34.53 | 126.60 | 23.43 | 4.57 | 45.78 | 19.67 | 5.06 | 24.73 | 31.38 | 74.35 | 51.96 | 51.84 | 15.10 | 20.38 |
| 3027 | 32.53 | 126.60 | 32.09 | 4.57 | 47.78 | 23.67 | 5.06 | 28.73 | 32.04 | 63.61 | 65.23 | 41.32 | 13.63 | 21.63 |
| 3053 | 31.53 | 126.60 | 40.93 | 4.57 | 39.78 | 21.67 | 6.06 | 27.73 | 25.00 | 76.22 | 76.11 | 39.37 | 13.94 | 18.34 |
| 3102 | 29.53 | 109.60 | 51.03 | 4.57 | 31.18 | 8.87 | 3.06 | 11.93 | 23.42 | 64.63 | 59.80 | 31.23 | 3.79 | 6.04 |
| 3240 | 28.53 | 101.60 | 41.93 | 6.07 | 33.78 | 15.67 | 4.26 | 19.93 | 19.64 | 75.13 | 63.97 | 38.27 | 9.42 | 12.60 |
| 3343 | 25.53 | 109.60 | 39.63 | 4.57 | 39.64 | 14.07 | 2.92 | 16.99 | 24.98 | 69.88 | 69.05 | 30.52 | 6.63 | 9.60 |
| 3421 | 24.53 | 101.60 | 49.83 | 3.77 | 26.78 | 8.87 | 1.66 | 10.53 | 25.63 | 63.07 | 73.67 | 26.09 | 3.42 | 5.62 |
| 3584 | 25.53 | 101.60 | 48.43 | 6.57 | 84.78 | 26.67 | 2.06 | 28.73 | 19.91 | 71.10 | 83.01 | 33.12 | 9.76 | 13.83 |
| 3673 | 24.53 | 109.60 | 54.43 | 4.57 | 34.78 | 19.67 | 2.06 | 21.73 | 17.66 | 68.56 | 78.66 | 33.64 | 10.22 | 15.04 |
| 3681 | 24.53 | 97.60 | 41.03 | 3.97 | 26.83 | 10.67 | 2.31 | 12.98 | 20.70 | 57.82 | 71.29 | 36.56 | 5.21 | 9.29 |
| 3746 | 25.53 | 101.60 | 47.43 | 3.57 | 30.78 | 11.67 | 3.06 | 14.73 | 25.74 | 64.31 | 60.49 | 39.26 | 6.03 | 9.56 |
| 3775 | 24.53 | 101.60 | 40.43 | 4.37 | 39.18 | 14.47 | 1.06 | 15.53 | 21.95 | 71.36 | 59.11 | 32.07 | 7.01 | 9.92 |
| 3992 | 34.53 | 126.60 | 34.43 | 7.23 | 49.11 | 22.67 | 5.06 | 27.73 | 28.26 | 68.43 | 63.93 | 45.39 | 14.90 | 21.91 |

**Appendix-D (Contd) . . .**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4156 | 35.53 | 126.60 | 34.63 | 3.97 | 33.78 | 24.87 | 1.26 | 26.13 | 29.84 | 67.31 | 68.73 | 62.49 | 12.06 | 18.06 |
| 4343 | 36.53 | 126.60 | 35.76 | 4.23 | 29.77 | 16.00 | 1.72 | 17.72 | 28.00 | 69.17 | 67.30 | 50.45 | 11.11 | 16.19 |
| 4412 | 34.53 | 126.60 | 37.09 | 4.23 | 45.44 | 15.00 | 4.06 | 19.06 | 28.58 | 70.99 | 72.23 | 44.18 | 11.29 | 16.01 |
| 4527 | 25.53 | 126.60 | 53.76 | 4.90 | 52.77 | 20.67 | 4.39 | 25.06 | 24.12 | 68.13 | 75.36 | 53.65 | 12.42 | 18.37 |
| 4538 | 32.53 | 126.60 | 36.93 | 4.57 | 28.28 | 17.17 | 3.06 | 20.23 | 35.70 | 65.65 | 83.92 | 49.93 | 11.05 | 17.00 |
| 4543 | 24.53 | 109.60 | 38.43 | 3.57 | 30.78 | 11.67 | 5.06 | 16.73 | 20.43 | 76.61 | 74.86 | 48.23 | 6.05 | 7.94 |
| 4598 | 33.53 | 126.60 | 50.09 | 4.23 | 35.77 | 21.00 | 4.39 | 25.39 | 26.65 | 69.64 | 73.53 | 48.64 | 12.36 | 17.87 |
| 4670 | 25.53 | 126.60 | 46.43 | 5.23 | 42.10 | 22.33 | 1.06 | 23.39 | 29.60 | 69.67 | 72.51 | 43.96 | 13.34 | 19.27 |
| 4684 | 24.53 | 101.60 | 49.43 | 6.57 | 58.78 | 18.67 | 5.06 | 23.73 | 15.42 | 75.51 | 70.39 | 32.64 | 11.11 | 14.77 |
| 4729 | 24.73 | 98.00 | 56.09 | 4.25 | 67.38 | 10.99 | 2.88 | 13.87 | 18.60 | 74.51 | 43.17 | 14.52 | 4.95 | 6.71 |
| 4750 | 24.73 | 98.00 | 35.09 | 4.25 | 34.38 | 14.99 | 1.88 | 16.87 | 21.18 | 63.59 | 56.60 | 43.46 | 7.86 | 12.34 |
| 4911 | 24.73 | 98.00 | 58.09 | 4.25 | 42.38 | 19.99 | 5.88 | 25.87 | 17.45 | 61.55 | 66.85 | 36.61 | 7.97 | 12.93 |
| 4955 | 24.73 | 98.00 | 40.09 | 4.25 | 34.38 | 15.99 | 3.88 | 19.87 | 32.15 | 58.62 | 65.65 | 45.29 | 8.34 | 14.19 |
| 4998 | 30.73 | 115.00 | 39.59 | 5.25 | 44.38 | 20.49 | 10.38 | 30.87 | 32.68 | 60.70 | 64.48 | 36.59 | 11.18 | 18.17 |
| 5016 | 30.73 | 115.00 | 46.42 | 5.25 | 33.37 | 22.65 | 2.21 | 24.86 | 24.00 | 55.59 | 53.91 | 33.26 | 7.93 | 14.27 |
| 5195 | 24.73 | 106.00 | 40.09 | 4.85 | 26.98 | 12.79 | 2.28 | 15.07 | 16.57 | 67.09 | 58.55 | 22.51 | 3.06 | 4.81 |
| 5221 | 23.73 | 98.00 | 48.29 | 4.25 | 34.18 | 13.39 | 2.48 | 15.87 | 23.39 | 57.31 | 68.39 | 31.50 | 5.75 | 10.21 |
| 5236 | 24.73 | 98.00 | 29.89 | 5.85 | 22.78 | 9.99 | 3.28 | 13.27 | 32.76 | 68.46 | 78.71 | 33.94 | 5.61 | 8.28 |
| 5286 | 28.73 | 115.00 | 40.49 | 4.45 | 41.78 | 20.59 | 2.88 | 23.47 | 34.45 | 55.04 | 71.23 | 40.25 | 10.71 | 19.22 |
| 5327 | 28.73 | 115.00 | 35.75 | 5.58 | 36.37 | 20.99 | 3.54 | 24.53 | 26.57 | 61.90 | 51.68 | 44.96 | 9.63 | 15.42 |
| 5475 | 24.73 | 98.00 | 52.09 | 4.25 | 54.38 | 17.99 | 4.88 | 22.87 | 24.95 | 58.44 | 62.99 | 36.50 | 8.35 | 14.25 |
| 5494 | 24.73 | 98.00 | 28.09 | 5.25 | 36.38 | 14.99 | 1.88 | 16.87 | 26.25 | 64.28 | 61.27 | 46.91 | 7.71 | 11.98 |
| 5662 | 28.73 | 115.00 | 30.29 | 5.05 | 25.18 | 12.59 | 1.68 | 14.27 | 47.73 | 57.90 | 77.35 | 45.13 | 7.94 | 13.71 |
| 5663 | 28.73 | 115.00 | 43.75 | 4.58 | 30.71 | 19.99 | 3.21 | 23.20 | 35.55 | 62.83 | 77.19 | 37.21 | 11.11 | 17.44 |

**Appendix-D (Contd) . . .**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5745 | 30.73 | 98.00 | 37.42 | 4.58 | 27.04 | 19.32 | 3.88 | 23.20 | 27.11 | 59.83 | 76.48 | 45.46 | 8.66 | 14.41 |
| 5779 | 23.73 | 98.00 | 43.69 | 5.45 | 72.98 | 24.39 | 4.08 | 28.47 | 25.03 | 63.55 | 78.91 | 26.60 | 8.28 | 12.98 |
| 5827 | 33.73 | 115.00 | 54.09 | 5.25 | 45.38 | 19.99 | 1.88 | 21.87 | 32.92 | 64.61 | 60.20 | 19.76 | 8.21 | 12.66 |
| 6022 | 34.73 | 115.00 | 58.09 | 4.25 | 18.38 | 10.99 | 2.88 | 13.87 | 28.40 | 46.34 | 52.31 | 28.25 | 5.97 | 13.13 |
| 6057 | 33.73 | 115.00 | 34.09 | 4.25 | 29.38 | 14.99 | 3.88 | 18.87 | 19.87 | 54.85 | 62.97 | 31.20 | 6.21 | 11.48 |
| 6201 | 24.73 | 98.00 | 61.09 | 4.25 | 26.38 | 13.99 | 3.88 | 17.87 | 23.65 | 61.09 | 74.27 | 50.14 | 10.43 | 16.88 |
| 6263 | 23.73 | 98.00 | 37.09 | 4.25 | 15.18 | 5.99 | 2.68 | 8.67 | 25.35 | 43.04 | 59.90 | 15.94 | 1.02 | 3.34 |
| 6375 | 24.73 | 98.00 | 47.09 | 4.25 | 39.38 | 17.99 | 1.88 | 19.87 | 17.45 | 54.94 | 76.78 | 29.89 | 10.05 | 18.11 |
| 6402 | 23.73 | 115.00 | 36.34 | 4.75 | 26.38 | 20.49 | 2.63 | 23.12 | 12.28 | 48.19 | 53.68 | 29.92 | 3.05 | 6.89 |
| 6407 | 22.73 | 98.00 | 39.09 | 4.65 | 25.58 | 12.39 | 3.48 | 15.87 | 34.15 | 55.89 | 83.08 | 36.44 | 5.37 | 9.83 |
| 6646 | 29.73 | 98.00 | 56.09 | 4.25 | 57.38 | 12.99 | 5.88 | 18.87 | 13.75 | 42.52 | 27.17 | 24.41 | 5.77 | 13.87 |
| 6654 | 28.73 | 115.00 | 36.76 | 5.25 | 28.71 | 18.99 | 3.54 | 22.53 | 27.91 | 59.52 | 77.77 | 42.71 | 8.55 | 14.31 |
| 6766 | 31.73 | 115.00 | 26.09 | 5.25 | 15.38 | 8.99 | 1.88 | 10.87 | 33.26 | 53.60 | 72.68 | 29.05 | 4.16 | 8.12 |
| 6888 | 24.53 | 128.20 | 32.31 | 4.55 | 24.32 | 14.60 | 1.12 | 15.72 | 30.49 | 64.67 | 48.08 | 48.48 | 8.27 | 12.82 |
| 6892 | 25.53 | 128.20 | 32.71 | 7.21 | 44.88 | 30.90 | 2.38 | 33.28 | 20.89 | 56.20 | 31.26 | 22.59 | 7.87 | 13.87 |
| 6993 | 33.53 | 128.20 | 24.01 | 5.55 | 38.45 | 20.93 | 4.72 | 25.65 | 49.97 | 74.55 | 69.42 | 46.07 | 10.74 | 14.63 |
| 7000 | 31.53 | 128.20 | 34.21 | 9.05 | 68.12 | 26.60 | 5.22 | 31.82 | 35.64 | 67.13 | 52.02 | 31.50 | 16.25 | 24.48 |
| 7153 | 32.53 | 128.20 | 29.21 | 5.55 | 43.37 | 25.60 | 2.97 | 28.57 | 37.71 | 69.21 | 58.10 | 55.23 | 14.18 | 20.73 |
| 7181 | 32.53 | 128.20 | 29.96 | 5.55 | 28.62 | 17.10 | 3.22 | 20.32 | 42.00 | 69.87 | 70.33 | 58.14 | 12.28 | 17.78 |
| 7190 | 30.53 | 128.20 | 54.71 | 5.55 | 28.12 | 13.60 | 2.72 | 16.32 | 22.96 | 60.60 | 68.80 | 12.55 | 5.26 | 8.55 |
| 7243 | 34.53 | 103.20 | 32.71 | 7.05 | 36.12 | 23.60 | 4.22 | 27.82 | 40.11 | 64.05 | 71.97 | 54.58 | 13.34 | 20.99 |
| 7906 | 32.53 | 103.20 | 42.51 | 5.35 | 19.92 | 9.40 | 3.52 | 12.92 | 26.30 | 61.99 | 59.86 | 18.72 | 3.73 | 5.87 |
| 7963 | 31.53 | 111.20 | 40.11 | 4.95 | 19.92 | 15.40 | 1.72 | 17.12 | 37.37 | 63.61 | 67.21 | 38.13 | 7.81 | 12.28 |
| 7969 | 31.53 | 103.20 | 31.91 | 4.15 | 29.32 | 19.80 | 3.92 | 23.72 | 40.79 | 56.07 | 69.31 | 42.25 | 6.31 | 11.06 |

**Appendix-D (Contd) . . .**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8106 | 26.53 | 128.20 | 58.21 | 4.55 | 42.12 | 26.60 | 5.22 | 31.82 | 28.22 | 71.39 | 73.89 | 49.30 | 13.60 | 19.30 |
| 8285 | 26.53 | 128.20 | 41.51 | 4.55 | 28.12 | 13.40 | 2.92 | 16.32 | 37.06 | 59.23 | 55.00 | 41.83 | 8.13 | 13.66 |
| 8490 | 25.53 | 128.20 | 39.21 | 5.05 | 38.37 | 19.35 | 3.97 | 23.32 | 35.51 | 63.58 | 45.54 | 42.63 | 11.61 | 18.37 |
| 8517 | 26.53 | 106.20 | 40.21 | 5.55 | 28.62 | 12.60 | 2.72 | 15.32 | 33.82 | 73.71 | 63.91 | 42.82 | 10.70 | 14.73 |
| 8567 | 24.53 | 111.20 | 43.71 | 4.55 | 47.12 | 15.60 | 4.72 | 20.32 | 27.99 | 61.40 | 53.99 | 38.98 | 9.14 | 14.89 |
| 8760 | 27.53 | 128.20 | 46.01 | 6.55 | 27.78 | 16.60 | 4.72 | 21.32 | 30.41 | 62.80 | 37.39 | 46.13 | 9.88 | 15.78 |
| 9037 | 35.53 | 128.20 | 29.71 | 5.85 | 42.44 | 28.26 | 2.38 | 30.64 | 37.02 | 66.60 | 55.33 | 44.57 | 15.46 | 23.46 |
| 9315 | 26.53 | 111.20 | 34.71 | 4.55 | 41.12 | 11.60 | 3.72 | 15.32 | 21.06 | 76.70 | 36.01 | 37.21 | 6.13 | 8.15 |
| 9507 | 26.53 | 103.20 | 38.51 | 5.35 | 40.32 | 14.60 | 4.52 | 19.12 | 29.62 | 65.47 | 61.55 | 34.58 | 7.68 | 11.76 |
| 9666 | 24.53 | 128.20 | 39.71 | 6.05 | 41.62 | 25.10 | 5.22 | 30.32 | 29.94 | 58.29 | 46.62 | 41.79 | 11.49 | 19.74 |
| 9809 | 25.53 | 114.20 | 49.01 | 5.15 | 46.38 | 23.20 | 5.72 | 28.92 | 29.83 | 74.58 | 65.63 | 45.46 | 13.91 | 18.94 |
| 9842 | 33.53 | 128.20 | 35.38 | 4.55 | 27.79 | 15.60 | 2.39 | 17.99 | 33.96 | 60.21 | 48.72 | 49.56 | 8.63 | 14.30 |
| 9905 | 33.53 | 128.20 | 41.71 | 5.55 | 39.12 | 19.60 | 7.72 | 27.32 | 45.49 | 67.37 | 50.83 | 22.01 | 9.84 | 14.72 |
| 9961 | 36.53 | 128.20 | 35.71 | 7.55 | 46.12 | 21.60 | 5.72 | 27.32 | 29.16 | 64.43 | 52.82 | 25.66 | 10.16 | 15.85 |
| 10036 | 36.53 | 128.20 | 36.71 | 5.55 | 27.32 | 15.60 | 2.12 | 17.72 | 30.02 | 74.00 | 47.85 | 36.48 | 11.22 | 15.39 |
| 10092 | 36.53 | 128.20 | 37.91 | 4.55 | 33.12 | 21.40 | 2.72 | 24.12 | 31.90 | 57.29 | 51.54 | 46.82 | 10.71 | 18.69 |
| 10185 | 37.53 | 128.20 | 34.71 | 5.05 | 35.37 | 17.10 | 2.22 | 19.32 | 45.56 | 76.01 | 69.11 | 32.02 | 14.65 | 19.59 |
| 10384 | 33.73 | 129.00 | 26.43 | 4.33 | 36.95 | 26.39 | 1.37 | 27.76 | 42.98 | 67.98 | 68.83 | 58.96 | 16.56 | 24.66 |
| 10474 | 31.73 | 104.00 | 35.83 | 4.13 | 25.09 | 10.39 | 1.57 | 11.96 | 36.54 | 67.89 | 63.10 | 44.56 | 6.96 | 9.60 |
| 10479 | 35.73 | 129.00 | 29.93 | 8.73 | 48.59 | 18.54 | 2.02 | 20.56 | 37.30 | 67.88 | 64.58 | 37.23 | 10.78 | 15.61 |
| 10554 | 35.73 | 121.00 | 30.73 | 4.33 | 33.09 | 17.79 | 2.77 | 20.56 | 22.68 | 43.31 | 47.94 | 46.18 | 4.02 | 9.06 |
| 10566 | 26.73 | 121.00 | 45.43 | 3.73 | 33.09 | 12.79 | 3.77 | 16.56 | 35.47 | 66.61 | 55.20 | 36.18 | 10.57 | 15.62 |
| 10890 | 26.73 | 104.00 | 30.43 | 3.93 | 21.69 | 7.59 | 1.77 | 9.36 | 23.14 | 59.03 | 52.27 | 36.64 | 3.25 | 4.62 |
| 11088 | 34.73 | 115.00 | 31.83 | 3.93 | 22.69 | 11.39 | 1.77 | 13.16 | 26.29 | 54.17 | 30.95 | 38.87 | 6.08 | 10.89 |

**Appendix-D (Contd) . . .**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11109 | 35.73 | 115.00 | 27.43 | 3.73 | 30.09 | 14.29 | 4.27 | 18.56 | 29.22 | 68.31 | 68.40 | 40.30 | 6.84 | 9.34 |
| 11144 | 31.73 | 129.00 | 42.43 | 3.73 | 36.09 | 17.79 | 5.77 | 23.56 | 37.33 | 67.70 | 62.84 | 41.65 | 11.01 | 16.02 |
| 11219 | 27.73 | 129.00 | 32.93 | 3.73 | 27.09 | 14.29 | 3.27 | 17.56 | 43.59 | 63.98 | 60.19 | 38.80 | 9.57 | 14.70 |
| 11249 | 30.73 | 104.00 | 33.03 | 4.73 | 24.69 | 6.59 | 6.97 | 13.56 | 35.18 | 68.53 | 68.18 | 30.67 | 4.57 | 5.77 |
| 11322 | 25.73 | 115.00 | 27.63 | 4.53 | 34.69 | 15.19 | 10.17 | 25.36 | 34.73 | 70.20 | 57.93 | 59.08 | 14.77 | 21.06 |
| 11426 | 25.73 | 115.00 | 27.93 | 5.73 | 56.09 | 26.29 | 2.77 | 29.06 | 34.35 | 73.96 | 34.45 | 42.99 | 14.69 | 19.73 |
| 11457 | 25.73 | 129.00 | 24.73 | 6.03 | 40.59 | 17.39 | 2.37 | 19.76 | 33.09 | 69.51 | 55.72 | 44.33 | 10.89 | 15.35 |
| 11515 | 26.73 | 108.00 | 27.23 | 4.73 | 22.09 | 8.79 | 2.37 | 11.16 | 32.02 | 64.02 | 68.34 | 29.84 | 5.61 | 8.06 |
| 11651 | 26.73 | 121.00 | 32.43 | 3.73 | 26.69 | 20.79 | 1.77 | 22.56 | 37.42 | 73.36 | 68.16 | 52.93 | 14.44 | 19.55 |
| 11687 | 27.73 | 121.00 | 42.23 | 3.93 | 48.69 | 25.79 | 3.37 | 29.16 | 30.83 | 58.18 | 72.18 | 51.78 | 13.14 | 23.07 |
| 11855 | 27.73 | 121.00 | 30.03 | 6.98 | 22.09 | 12.54 | 2.02 | 14.56 | 40.14 | 64.42 | 70.97 | 49.48 | 9.43 | 14.35 |
| 12000 | 34.73 | 129.00 | 29.03 | 4.03 | 34.29 | 19.39 | 4.37 | 23.76 | 31.17 | 61.95 | 57.58 | 34.01 | 8.82 | 13.97 |
| 12189 | 25.73 | 129.00 | 33.93 | 3.98 | 38.59 | 20.54 | 2.27 | 22.81 | 38.87 | 64.28 | 61.67 | 54.38 | 11.70 | 18.17 |
| 12276 | 25.73 | 104.00 | 28.03 | 8.73 | 28.29 | 11.79 | 3.17 | 14.96 | 26.70 | 64.95 | 55.40 | 42.23 | 6.13 | 8.77 |
| 12370 | 34.73 | 108.00 | 31.43 | 7.73 | 34.09 | 17.29 | 1.27 | 18.56 | 38.63 | 68.94 | 62.98 | 33.99 | 9.94 | 14.03 |
| 12625 | 34.73 | 104.00 | 39.43 | 3.73 | 17.17 | 13.79 | 1.27 | 15.06 | 36.27 | 56.07 | 61.25 | 38.18 | 7.45 | 13.08 |
| 12672 | 36.73 | 108.00 | 51.93 | 4.73 | 29.59 | 14.29 | 3.27 | 17.56 | 28.02 | 57.68 | 67.39 | 36.14 | 6.12 | 10.15 |
| 12682 | 27.73 | 108.00 | 53.43 | 4.73 | 37.09 | 9.79 | 1.77 | 11.56 | 33.27 | 69.83 | 68.18 | 30.67 | 7.26 | 9.73 |
| 12697 | 27.73 | 112.00 | 44.43 | 3.73 | 49.09 | 17.79 | 3.77 | 21.56 | 28.43 | 60.83 | 43.28 | 41.26 | 9.45 | 15.39 |
| 12879 | 33.73 | 129.00 | 29.43 | 4.23 | 27.09 | 14.79 | 1.77 | 16.56 | 39.47 | 69.57 | 65.92 | 50.08 | 11.05 | 15.58 |
| 156 | 35.73 | 129.00 | 23.93 | 4.13 | 32.59 | 20.54 | 4.27 | 24.81 | 40.72 | 64.22 | 62.42 | 47.97 | 12.54 | 19.59 |
| 2738 | 32.33 | 120.40 | 36.65 | 3.87 | 33.81 | 23.26 | 2.12 | 25.38 | 36.64 | 77.82 | 77.49 | 55.91 | 13.80 | 17.54 |
| 12921 | 33.33 | 114.40 | 32.45 | 5.27 | 38.61 | 21.66 | 0.92 | 22.58 | 38.82 | 69.54 | 83.56 | 52.41 | 12.99 | 18.67 |
| 12988 | 33.33 | 114.40 | 39.85 | 5.07 | 23.01 | 0.86 | 8.42 | 9.28 | 27.87 | 44.62 | 67.22 | 47.33 | 2.04 | 3.99 |

**Appendix-D (Contd) . . .**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13099 | 35.33 | 128.40 | 64.72 | 4.67 | 66.01 | 34.26 | 4.92 | 39.18 | 44.01 | 68.27 | 67.87 | 49.85 | 18.78 | 28.05 |
| 13603 | 33.33 | 103.40 | 35.85 | 5.87 | 22.21 | 10.46 | 3.12 | 13.58 | 26.25 | 51.25 | 44.59 | 38.13 | 4.13 | 7.65 |
| 13723 | 36.33 | 120.40 | 29.85 | 5.47 | 39.61 | 29.46 | 1.32 | 30.78 | 37.83 | 70.40 | 67.88 | 58.85 | 16.50 | 23.69 |
| 13787 | 35.33 | 120.40 | 28.45 | 4.27 | 35.01 | 24.86 | 1.32 | 26.18 | 36.28 | 65.31 | 67.63 | 50.73 | 14.41 | 22.35 |
| 13858 | 26.33 | 114.40 | 38.05 | 3.87 | 18.61 | 8.86 | 1.72 | 10.58 | 29.57 | 57.91 | 65.22 | 27.81 | 4.32 | 6.91 |
| 13941 | 30.33 | 128.40 | 28.38 | 5.20 | 9.74 | 0.79 | 5.42 | 6.12 | 32.48 | 43.85 | 65.52 | 58.16 | 1.93 | 3.79 |
| 13942 | 32.33 | 128.40 | 28.05 | 5.87 | 37.81 | 29.46 | 0.92 | 30.38 | 38.74 | 76.91 | 62.90 | 55.85 | 17.45 | 22.77 |
| 13982 | 27.33 | 111.40 | 32.25 | 3.87 | 23.41 | 11.26 | 2.72 | 13.98 | 34.67 | 66.46 | 82.70 | 40.38 | 6.41 | 9.14 |
| 14008 | 35.33 | 111.40 | 29.45 | 4.67 | 37.21 | 22.86 | 3.12 | 25.98 | 33.36 | 58.76 | 61.39 | 47.79 | 11.73 | 20.28 |
| 14106 | 36.33 | 114.40 | 34.55 | 5.37 | 27.31 | 18.46 | 0.42 | 18.88 | 29.57 | 56.46 | 61.94 | 39.95 | 9.61 | 17.19 |
| 14118 | 27.33 | 114.40 | 33.65 | 4.87 | 26.01 | 17.76 | 1.52 | 19.28 | 29.39 | 66.93 | 87.87 | 40.70 | 8.08 | 11.71 |
| 14127 | 28.33 | 111.40 | 32.85 | 6.47 | 24.01 | 11.86 | 1.72 | 13.58 | 25.77 | 68.09 | 73.04 | 37.15 | 7.53 | 10.62 |
| 14466 | 34.33 | 111.40 | 33.85 | 7.07 | 14.21 | 7.26 | 6.72 | 13.98 | 32.17 | 54.96 | 69.65 | 25.07 | 4.75 | 8.22 |
| 14475 | 29.33 | 128.40 | 35.45 | 5.27 | 33.21 | 10.46 | 0.72 | 11.18 | 26.06 | 58.32 | 68.59 | 27.31 | 4.26 | 6.74 |
| 14482 | 32.33 | 128.40 | 32.85 | 4.67 | 24.41 | 10.86 | 2.12 | 12.98 | 32.59 | 60.89 | 66.76 | 31.75 | 6.17 | 9.73 |
| 14523 | 31.33 | 111.40 | 35.45 | 5.07 | 33.61 | 15.26 | 1.72 | 16.98 | 30.57 | 67.15 | 61.21 | 31.88 | 5.57 | 7.70 |
| 14630 | 29.33 | 107.40 | 37.05 | 3.87 | 23.31 | 10.06 | 3.22 | 13.28 | 33.46 | 57.99 | 65.43 | 39.91 | 5.29 | 8.69 |
| 14705 | 25.33 | 107.40 | 31.85 | 5.87 | 25.41 | 20.26 | 0.42 | 20.68 | 32.93 | 61.64 | 59.39 | 53.03 | 10.01 | 16.24 |
| 14710 | 26.33 | 107.40 | 36.05 | 3.47 | 21.41 | 10.06 | 1.52 | 11.58 | 22.44 | 56.02 | 29.38 | 34.73 | 4.25 | 7.07 |
| 14985 | 26.33 | 107.40 | 27.45 | 6.67 | 22.61 | 12.66 | 3.72 | 16.38 | 29.54 | 56.14 | 55.87 | 47.62 | 5.99 | 10.38 |
| 15042 | 31.33 | 107.40 | 25.65 | 4.07 | 19.01 | 10.66 | 2.32 | 12.98 | 30.39 | 52.47 | 71.45 | 34.97 | 4.33 | 7.84 |
| 15190 | 33.33 | 128.40 | 29.85 | 5.67 | 30.81 | 19.06 | 1.72 | 20.78 | 37.64 | 60.48 | 67.55 | 55.18 | 9.88 | 16.36 |
| 15287 | 24.33 | 107.40 | 34.65 | 3.87 | 23.01 | 11.86 | 2.32 | 14.18 | 27.53 | 65.68 | 60.32 | 31.86 | 4.53 | 6.23 |
| 15309 | 29.33 | 120.40 | 30.55 | 3.87 | 21.81 | 13.96 | 3.42 | 17.38 | 29.69 | 55.59 | 57.93 | 44.44 | 6.63 | 11.74 |

**Appendix-D (Contd) . . .**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15419 | 32.33 | 120.40 | 38.05 | 3.87 | 14.81 | 7.46 | 0.42 | 7.88 | 26.52 | 53.60 | 23.19 | 29.89 | 3.84 | 6.65 |
| Narayani ($C_1$) | 26.00 | 103.50 | 46.87 | 4.92 | 42.00 | 21.30 | 4.07 | 25.37 | 28.80 | 60.09 | 71.04 | 37.67 | 9.03 | 14.96 |
| Dharani ($C_2$) | 24.33 | 101.50 | 32.45 | 4.50 | 31.86 | 17.89 | 2.57 | 20.46 | 32.38 | 65.76 | 65.97 | 40.91 | 10.47 | 16.05 |
| K-6 ($C_3$) | 25.83 | 106.00 | 40.35 | 4.79 | 40.28 | 20.78 | 3.54 | 24.33 | 29.47 | 54.89 | 56.91 | 43.31 | 9.41 | 17.14 |
| TCGS- 1157 ($C_4$) | 29.00 | 112.33 | 27.42 | 5.90 | 37.07 | 20.98 | 4.50 | 25.48 | 38.09 | 61.91 | 62.69 | 47.83 | 12.69 | 20.75 |
| TCGS- 1330 ($C_5$) | 28.50 | 109.67 | 30.26 | 5.86 | 39.91 | 21.38 | 3.83 | 25.21 | 49.38 | 60.48 | 67.52 | 47.87 | 13.35 | 21.95 |
| Mean | 29.59 | 115.28 | 37.23 | 4.93 | 35.63 | 17.83 | 3.38 | 21.20 | 30.05 | 61.54 | 63.66 | 40.50 | 9.28 | 14.92 |
| Standard Deviation | 4.01 | 10.57 | 8.67 | 1.04 | 11.99 | 3.36 | 0.89 | 3.49 | 7.35 | 6.29 | 12.08 | 10.09 | 2.28 | 2.96 |
| Standard Error | 0.30 | 0.80 | 0.66 | 0.08 | 0.91 | 0.25 | 0.07 | 0.27 | 0.56 | 0.48 | 0.92 | 0.77 | 0.17 | 0.23 |
| C.V. % | 13.56 | 9.17 | 23.29 | 21.05 | 33.64 | 18.83 | 26.33 | 16.47 | 24.44 | 10.23 | 18.98 | 24.92 | 24.61 | 19.84 |

DF : Days to 50% flowering; DM : days to maturity; PH : Plant height (cm); NPB : Number of primary branches per plant (No); NPEGP : Number of pegs per plant (No); NMP : Number of mature pods per plant (No); NIMP : Number of immature pods per plant (No); NPP : Number of pods per plant (No); 100SW : 100 kernel weight (g); SP : Shelling percentage (%); SMK% : Sound mature kernel percentage (%); HI : Harvest index (%); KYP : Kernel yield per plant (g); PYP : Pod yield per plant (g).

## Appendix- E

**Adjusted means with block effect and critical differences of 168 germplasm lines and five checks for 14 characters under inorganic fertilizer management**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 36 | 29.20 | 112.10 | 29.98 | 5.43 | 55.57 | 26.59 | 2.85 | 29.45 | 23.66 | 66.05 | 43.72 | 38.49 | 10.18 | 15.91 |
| 76 | 29.20 | 105.10 | 28.18 | 5.23 | 47.57 | 24.40 | 5.05 | 29.45 | 23.92 | 64.71 | 54.68 | 37.64 | 9.66 | 15.31 |
| 81 | 29.20 | 123.10 | 28.78 | 8.23 | 79.97 | 20.80 | 4.25 | 25.05 | 25.29 | 54.50 | 43.38 | 26.49 | 8.90 | 15.82 |
| 111 | 33.20 | 118.10 | 23.78 | 7.23 | 64.17 | 29.99 | 4.45 | 34.45 | 27.16 | 61.41 | 47.80 | 46.02 | 12.64 | 20.87 |
| 115 | 30.20 | 113.10 | 33.18 | 5.03 | 30.77 | 14.59 | 2.45 | 17.05 | 24.89 | 51.30 | 49.66 | 35.45 | 7.39 | 13.45 |
| 118 | 33.20 | 113.10 | 31.98 | 5.83 | 50.57 | 27.80 | 2.45 | 30.25 | 34.44 | 68.00 | 75.15 | 46.16 | 15.29 | 23.32 |
| 163 | 36.20 | 123.10 | 29.58 | 6.76 | 54.49 | 19.52 | 8.51 | 28.04 | 32.29 | 56.71 | 50.58 | 30.45 | 10.50 | 18.31 |
| 188 | 35.20 | 123.10 | 27.58 | 6.43 | 40.37 | 11.80 | 5.85 | 17.65 | 31.23 | 47.78 | 52.59 | 32.86 | 7.45 | 14.21 |
| 297 | 30.20 | 112.10 | 31.38 | 4.83 | 40.17 | 13.39 | 1.85 | 15.25 | 26.48 | 49.81 | 46.54 | 30.34 | 6.86 | 12.60 |
| 332 | 30.20 | 105.10 | 38.58 | 9.03 | 77.17 | 28.59 | 5.05 | 33.65 | 31.82 | 55.16 | 55.78 | 36.60 | 15.99 | 28.99 |
| 334 | 30.20 | 105.10 | 35.58 | 5.03 | 40.77 | 17.19 | 2.45 | 19.65 | 18.58 | 42.51 | 27.50 | 32.72 | 5.90 | 11.56 |
| 397 | 30.20 | 118.10 | 32.18 | 4.43 | 59.17 | 23.80 | 4.85 | 28.65 | 23.00 | 57.31 | 50.21 | 39.60 | 9.02 | 15.50 |
| 434 | 30.20 | 105.10 | 32.58 | 8.03 | 119.17 | 40.40 | 4.05 | 44.45 | 32.18 | 63.50 | 57.37 | 41.04 | 18.28 | 29.49 |
| 442 | 28.20 | 123.10 | 37.18 | 7.03 | 80.17 | 28.40 | 5.05 | 33.45 | 25.76 | 66.25 | 67.36 | 31.99 | 11.74 | 18.30 |
| 513 | 35.20 | 123.10 | 26.98 | 7.93 | 52.67 | 14.69 | 4.35 | 19.05 | 21.36 | 44.14 | 68.88 | 13.95 | 5.25 | 9.78 |
| 532 | 28.20 | 123.10 | 22.38 | 5.03 | 34.77 | 12.19 | 1.25 | 13.45 | 21.52 | 60.73 | 46.93 | 22.28 | 5.75 | 9.35 |
| 721 | 37.20 | 123.10 | 22.58 | 8.03 | 62.57 | 8.99 | 3.25 | 12.25 | 22.37 | 42.16 | 19.88 | 11.62 | 4.37 | 7.82 |
| 862 | 35.20 | 123.10 | 18.64 | 7.09 | 51.16 | 13.52 | 10.18 | 23.71 | 20.27 | 58.29 | 47.02 | 22.80 | 7.32 | 12.31 |
| 875 | 36.20 | 123.10 | 26.18 | 7.43 | 44.57 | 18.19 | 6.25 | 24.45 | 22.80 | 50.47 | 43.28 | 29.26 | 7.74 | 14.31 |
| 928 | 37.20 | 123.10 | 24.18 | 6.43 | 41.77 | 10.39 | 10.05 | 20.45 | 21.89 | 50.78 | 55.50 | 20.22 | 5.39 | 9.45 |
| 1137 | 28.20 | 105.10 | 34.78 | 5.23 | 59.51 | 29.40 | 4.25 | 33.65 | 26.49 | 69.21 | 71.95 | 41.32 | 12.04 | 18.17 |
| 1399 | 27.20 | 118.10 | 34.73 | 4.93 | 66.92 | 20.69 | 3.85 | 24.55 | 25.26 | 56.55 | 53.35 | 26.47 | 8.51 | 14.71 |
| 1415 | 27.20 | 118.10 | 33.78 | 5.43 | 56.57 | 29.80 | 4.05 | 33.85 | 22.74 | 60.42 | 63.33 | 38.05 | 11.77 | 19.65 |

**Appendix-E (Contd) . . .**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1519 | 27.20 | 112.10 | 32.38 | 6.03 | 60.17 | 26.59 | 4.85 | 31.45 | 26.64 | 69.60 | 63.84 | 39.63 | 11.48 | 17.27 |
| 1668 | 33.20 | 123.10 | 26.98 | 8.63 | 56.57 | 13.99 | 11.25 | 25.25 | 23.14 | 49.91 | 41.02 | 27.30 | 8.16 | 15.29 |
| 1711 | 27.20 | 118.10 | 26.98 | 6.03 | 83.17 | 20.19 | 6.25 | 26.45 | 25.42 | 64.90 | 48.63 | 38.85 | 11.98 | 18.96 |
| 1973 | 27.20 | 105.10 | 25.58 | 7.03 | 67.57 | 25.59 | 2.05 | 27.65 | 21.30 | 61.74 | 29.89 | 30.45 | 8.87 | 14.49 |
| 2019 | 27.20 | 118.10 | 30.58 | 5.23 | 66.77 | 30.19 | 6.85 | 37.05 | 26.53 | 63.65 | 46.30 | 38.01 | 13.10 | 21.05 |
| 2106 | 27.00 | 118.30 | 32.46 | 5.29 | 51.61 | 22.72 | 3.09 | 25.81 | 23.68 | 63.15 | 51.93 | 28.99 | 8.62 | 13.46 |
| 2511 | 36.00 | 123.30 | 24.46 | 5.89 | 32.41 | 10.31 | 2.49 | 12.81 | 18.48 | 53.94 | 45.27 | 26.27 | 3.00 | 5.52 |
| 2772 | 34.00 | 123.30 | 26.26 | 5.49 | 47.81 | 11.31 | 1.09 | 12.41 | 18.88 | 50.94 | 42.60 | 26.25 | 4.15 | 8.22 |
| 2773 | 33.00 | 123.30 | 25.26 | 4.49 | 28.61 | 7.91 | 1.89 | 9.81 | 18.62 | 58.01 | 38.84 | 21.76 | 2.66 | 4.43 |
| 2777 | 34.00 | 105.30 | 25.86 | 7.09 | 39.01 | 12.11 | 2.89 | 15.01 | 21.33 | 59.10 | 47.23 | 26.10 | 4.40 | 7.29 |
| 2857 | 31.00 | 123.30 | 29.26 | 5.89 | 60.81 | 15.11 | 2.89 | 18.01 | 23.88 | 57.54 | 43.51 | 30.25 | 5.95 | 10.25 |
| 2925 | 37.00 | 118.30 | 17.66 | 5.69 | 43.81 | 7.31 | 5.89 | 13.21 | 23.80 | 59.27 | 64.87 | 26.58 | 3.71 | 6.09 |
| 3027 | 35.00 | 123.30 | 31.26 | 6.29 | 47.81 | 9.91 | 1.29 | 11.21 | 26.61 | 55.76 | 46.38 | 28.37 | 4.47 | 7.95 |
| 3053 | 33.00 | 118.30 | 31.36 | 6.84 | 17.56 | 15.71 | -0.41 | 15.31 | 28.02 | 56.23 | 53.68 | 28.28 | 6.72 | 11.91 |
| 3102 | 31.00 | 118.30 | 41.26 | 5.09 | 36.01 | 16.51 | 1.49 | 18.01 | 29.79 | 61.12 | 56.17 | 36.63 | 7.02 | 11.32 |
| 3240 | 27.00 | 105.30 | 32.86 | 4.89 | 30.21 | 15.31 | 2.89 | 18.21 | 30.92 | 63.94 | 75.33 | 37.41 | 7.68 | 11.79 |
| 3343 | 27.00 | 118.30 | 33.66 | 4.09 | 26.21 | 13.91 | 2.69 | 16.61 | 26.68 | 59.05 | 46.58 | 33.98 | 5.73 | 9.57 |
| 3421 | 27.00 | 112.30 | 34.26 | 5.29 | 32.41 | 15.51 | 2.29 | 17.81 | 20.83 | 65.57 | 67.48 | 35.87 | 5.23 | 7.69 |
| 3584 | 27.00 | 105.30 | 35.86 | 4.89 | 77.81 | 29.92 | 1.09 | 31.01 | 21.05 | 67.83 | 34.27 | 37.49 | 10.58 | 15.33 |
| 3673 | 27.00 | 118.30 | 34.26 | 4.89 | 42.81 | 16.32 | 4.49 | 20.81 | 24.68 | 66.24 | 45.90 | 29.68 | 7.29 | 10.73 |
| 3681 | 27.00 | 105.30 | 30.86 | 5.49 | 45.41 | 24.32 | 3.29 | 27.61 | 18.69 | 66.66 | 46.51 | 41.11 | 7.50 | 10.97 |
| 3746 | 27.00 | 118.30 | 32.66 | 4.89 | 19.61 | 10.71 | 1.69 | 12.41 | 24.33 | 55.76 | 58.60 | 38.43 | 6.16 | 11.01 |
| 3775 | 27.00 | 112.30 | 41.26 | 5.49 | 54.81 | 24.11 | 1.89 | 26.01 | 22.74 | 49.20 | 65.76 | 32.26 | 7.10 | 14.63 |
| 3992 | 37.00 | 123.30 | 30.66 | 6.89 | 54.41 | 15.71 | 1.69 | 17.41 | 23.39 | 58.10 | 50.78 | 16.49 | 5.25 | 8.92 |

**Appendix-E (Contd) . . .**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4156 | 37.00 | 123.30 | 21.26 | 6.69 | 12.01 | 4.11 | 0.29 | 4.41 | 15.62 | 48.13 | 33.77 | 14.98 | 0.73 | 1.61 |
| 4343 | 37.00 | 123.30 | 17.66 | 7.89 | 62.61 | 15.91 | 8.89 | 24.81 | 20.39 | 54.40 | 42.22 | 29.84 | 5.85 | 10.75 |
| 4412 | 37.00 | 123.30 | 27.46 | 6.49 | 18.61 | 6.91 | 1.09 | 8.01 | 12.94 | 42.92 | 39.65 | 16.77 | 1.58 | 4.00 |
| 4527 | 37.00 | 123.30 | 30.46 | 4.89 | 44.28 | 16.11 | 2.29 | 18.41 | 18.90 | 56.72 | 51.90 | 31.53 | 5.46 | 9.55 |
| 4538 | 37.00 | 123.30 | 20.46 | 7.89 | 37.01 | 11.71 | 7.89 | 19.61 | 24.62 | 51.15 | 29.25 | 36.93 | 6.55 | 12.92 |
| 4543 | 37.00 | 112.30 | 27.46 | 5.29 | 37.21 | 20.32 | 3.29 | 23.61 | 19.28 | 64.97 | 50.30 | 45.59 | 6.38 | 9.56 |
| 4598 | 37.00 | 123.30 | 26.46 | 6.69 | 35.41 | 13.11 | 4.49 | 17.61 | 19.86 | 55.85 | 38.58 | 29.02 | 5.01 | 8.91 |
| 4670 | 37.00 | 123.30 | 27.11 | 9.59 | 35.56 | 9.46 | 4.09 | 13.56 | 27.68 | 58.84 | 60.40 | 20.17 | 3.87 | 6.42 |
| 4684 | 37.00 | 105.30 | 33.26 | 4.89 | 33.61 | 19.92 | 3.69 | 23.61 | 23.01 | 67.64 | 64.95 | 40.50 | 7.30 | 10.49 |
| 4729 | 37.00 | 102.30 | 27.58 | 5.25 | 87.89 | 33.72 | 4.61 | 38.33 | 25.51 | 60.43 | 60.78 | 41.11 | 11.49 | 19.06 |
| 4750 | 37.00 | 102.30 | 30.98 | 4.25 | 51.09 | 22.32 | 6.21 | 28.53 | 19.50 | 52.00 | 11.02 | 32.53 | 6.18 | 11.97 |
| 4911 | 37.00 | 102.30 | 21.58 | 4.25 | 41.49 | 20.11 | 2.21 | 22.33 | 21.80 | 43.87 | 45.80 | 42.77 | 4.42 | 10.09 |
| 4955 | 37.00 | 109.30 | 29.78 | 5.05 | 36.89 | 15.11 | 2.21 | 17.33 | 24.47 | 59.88 | 47.08 | 34.50 | 4.90 | 8.42 |
| 4998 | 37.00 | 120.30 | 21.58 | 3.25 | 36.09 | 12.91 | 4.61 | 17.53 | 25.67 | 42.90 | 45.56 | 52.78 | 4.07 | 9.50 |
| 5016 | 37.00 | 120.30 | 27.33 | 7.35 | 60.59 | 20.47 | 6.61 | 27.08 | 23.24 | 48.34 | 41.70 | 42.83 | 8.74 | 17.98 |
| 5195 | 37.00 | 109.30 | 28.38 | 4.25 | 62.69 | 31.92 | 3.81 | 35.73 | 23.94 | 72.09 | 44.60 | 45.08 | 9.44 | 13.34 |
| 5221 | 37.00 | 115.30 | 37.58 | 4.05 | 39.49 | 17.11 | 1.41 | 18.53 | 23.11 | 51.25 | 39.07 | 45.71 | 7.65 | 14.94 |
| 5236 | 37.00 | 115.30 | 21.98 | 6.85 | 56.69 | 32.72 | 5.21 | 37.93 | 31.35 | 62.88 | 53.18 | 59.12 | 13.27 | 21.14 |
| 5286 | 37.00 | 123.30 | 24.98 | 5.85 | 48.29 | 10.91 | 2.01 | 12.93 | 25.31 | 49.52 | 59.24 | 22.62 | 3.82 | 7.86 |
| 5327 | 37.00 | 123.30 | 28.58 | 4.45 | 35.89 | 12.71 | 2.21 | 14.93 | 26.16 | 60.14 | 61.03 | 29.67 | 4.32 | 7.44 |
| 5475 | 37.00 | 109.30 | 28.98 | 4.05 | 44.29 | 16.32 | 1.81 | 18.13 | 28.51 | 59.93 | 34.49 | 39.83 | 6.32 | 10.74 |
| 5494 | 37.00 | 115.30 | 24.18 | 4.25 | 39.69 | 12.51 | 1.81 | 14.33 | 24.10 | 64.36 | 67.43 | 23.94 | 4.76 | 7.68 |
| 5662 | 37.00 | 115.30 | 26.38 | 6.05 | 42.09 | 17.32 | 3.41 | 20.73 | 39.65 | 46.45 | 62.60 | 31.02 | 6.26 | 13.45 |
| 5663 | 37.00 | 115.30 | 23.78 | 4.85 | 23.29 | 11.31 | 1.01 | 12.33 | 30.41 | 59.23 | 63.13 | 33.55 | 4.50 | 7.84 |

**Appendix-E (Contd) . . .**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5745 | 37.00 | 109.30 | 35.98 | 5.05 | 86.29 | 17.91 | 2.81 | 20.73 | 28.26 | 58.87 | 45.97 | 23.72 | 6.97 | 12.00 |
| 5779 | 37.00 | 102.30 | 26.71 | 4.05 | 34.89 | 12.91 | 2.21 | 15.13 | 22.90 | 47.71 | 60.47 | 22.49 | 3.73 | 7.94 |
| 5827 | 37.00 | 120.30 | 28.18 | 4.25 | 34.09 | 12.31 | 1.21 | 13.53 | 24.30 | 47.30 | 46.97 | 29.09 | 3.72 | 7.98 |
| 6022 | 37.00 | 120.30 | 39.18 | 4.25 | 33.69 | 13.11 | 0.41 | 13.53 | 23.47 | 35.03 | 53.07 | 29.86 | 4.07 | 11.41 |
| 6057 | 37.00 | 120.30 | 27.18 | 5.45 | 37.29 | 13.71 | 4.21 | 17.93 | 26.19 | 43.72 | 47.23 | 26.99 | 4.42 | 10.12 |
| 6201 | 37.00 | 115.30 | 35.58 | 4.45 | 35.49 | 14.11 | 1.21 | 15.33 | 19.06 | 44.59 | 36.30 | 29.59 | 4.09 | 9.22 |
| 6263 | 37.00 | 115.30 | 29.78 | 5.85 | 45.29 | 19.72 | 1.21 | 20.93 | 17.06 | 47.56 | 39.90 | 29.61 | 3.69 | 7.88 |
| 6375 | 37.00 | 120.30 | 25.98 | 4.65 | 55.69 | 21.51 | 4.21 | 25.73 | 18.12 | 63.58 | 51.92 | 36.37 | 5.56 | 9.00 |
| 6402 | 37.00 | 120.30 | 21.38 | 6.65 | 84.09 | 29.72 | 3.81 | 33.53 | 15.46 | 40.01 | 32.35 | 27.75 | 3.73 | 9.29 |
| 6407 | 37.00 | 109.30 | 20.78 | 5.25 | 42.49 | 20.51 | 2.61 | 23.13 | 26.07 | 53.15 | 52.64 | 39.42 | 8.05 | 15.18 |
| 6646 | 37.00 | 120.30 | 26.58 | 3.85 | 38.29 | 11.11 | 5.41 | 16.53 | 18.30 | 24.98 | 33.93 | 35.90 | 2.30 | 8.74 |
| 6654 | 37.00 | 120.30 | 24.58 | 4.25 | 54.09 | 22.51 | 1.61 | 24.13 | 22.98 | 56.54 | 50.68 | 39.37 | 6.50 | 11.64 |
| 6766 | 37.00 | 120.30 | 28.98 | 7.25 | 33.49 | 8.51 | 1.21 | 9.73 | 21.54 | 32.35 | 14.57 | 13.52 | 1.99 | 6.05 |
| 6888 | 37.00 | 106.90 | 33.20 | 3.11 | 28.68 | 8.99 | 3.38 | 12.37 | 18.25 | 49.56 | 42.85 | 30.31 | 4.42 | 8.90 |
| 6892 | 37.00 | 124.90 | 24.40 | 7.51 | 79.88 | 32.79 | 4.18 | 36.97 | 18.55 | 53.41 | 22.92 | 26.86 | 8.22 | 15.41 |
| 6993 | 37.00 | 124.90 | 20.80 | 8.61 | 33.08 | 17.89 | 4.18 | 22.07 | 17.75 | 60.34 | 16.61 | 29.85 | 6.51 | 10.65 |
| 7000 | 37.00 | 124.90 | 26.20 | 3.91 | 18.68 | 10.39 | 0.58 | 10.97 | 16.99 | 55.15 | 46.10 | 14.00 | 3.17 | 5.60 |
| 7153 | 37.00 | 119.90 | 26.80 | 4.91 | 62.28 | 29.98 | 3.18 | 33.17 | 27.91 | 62.22 | 45.00 | 42.03 | 13.25 | 21.27 |
| 7181 | 37.00 | 119.90 | 27.20 | 4.71 | 22.48 | 16.18 | 1.38 | 17.57 | 29.56 | 60.14 | 51.83 | 40.79 | 8.69 | 14.36 |
| 7190 | 37.00 | 113.90 | 41.40 | 4.91 | 30.08 | 12.19 | 3.18 | 15.37 | 22.66 | 52.09 | 63.75 | 20.31 | 4.01 | 7.62 |
| 7243 | 37.00 | 119.90 | 27.40 | 4.31 | 18.08 | 10.39 | 0.58 | 10.97 | 33.49 | 62.49 | 63.68 | 27.62 | 7.14 | 11.27 |
| 7906 | 37.00 | 113.90 | 35.80 | 4.11 | 52.88 | 24.18 | 1.98 | 26.17 | 25.56 | 60.52 | 59.00 | 31.81 | 9.44 | 15.52 |
| 7963 | 37.00 | 113.90 | 27.40 | 3.91 | 42.28 | 20.78 | 3.98 | 24.77 | 29.96 | 65.45 | 81.16 | 36.03 | 9.87 | 14.94 |
| 7969 | 37.00 | 119.90 | 33.20 | 4.71 | 44.88 | 18.18 | 4.38 | 22.57 | 27.79 | 55.74 | 31.14 | 34.64 | 8.11 | 14.52 |

**Appendix-E (Contd) . . .**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8106 | 37.00 | 119.90 | 40.80 | 3.51 | 18.08 | 15.18 | 0.38 | 15.57 | 23.11 | 67.83 | 54.77 | 30.33 | 7.55 | 10.92 |
| 8285 | 37.00 | 124.90 | 29.40 | 6.71 | 27.08 | 13.19 | 0.78 | 13.97 | 28.05 | 53.70 | 74.48 | 31.30 | 5.95 | 11.03 |
| 8490 | 37.00 | 124.90 | 33.80 | 4.51 | 51.28 | 20.39 | 6.78 | 27.17 | 23.03 | 49.96 | 14.79 | 39.52 | 7.93 | 15.96 |
| 8517 | 37.00 | 119.90 | 28.20 | 3.11 | 29.68 | 15.99 | 1.15 | 17.14 | 26.31 | 57.53 | 48.96 | 34.83 | 8.60 | 14.90 |
| 8567 | 37.00 | 113.90 | 28.60 | 4.11 | 52.48 | 25.59 | 3.38 | 28.97 | 23.57 | 67.61 | 72.37 | 42.26 | 10.15 | 14.85 |
| 8760 | 37.00 | 119.90 | 19.60 | 4.51 | 18.08 | 12.39 | 2.18 | 14.57 | 22.66 | 60.92 | 44.23 | 31.37 | 6.83 | 11.07 |
| 9037 | 37.00 | 124.90 | 23.40 | 4.31 | 29.28 | 7.59 | 1.58 | 9.17 | 22.55 | 55.40 | 67.37 | 23.16 | 3.29 | 5.79 |
| 9315 | 37.00 | 113.90 | 19.00 | 4.11 | 36.68 | 12.78 | 1.98 | 14.77 | 22.11 | 65.63 | 64.11 | 31.27 | 5.82 | 8.65 |
| 9507 | 37.00 | 119.90 | 19.20 | 3.71 | 30.28 | 12.59 | 2.58 | 15.17 | 22.71 | 57.80 | 66.72 | 28.75 | 5.01 | 8.53 |
| 9666 | 37.00 | 119.90 | 22.60 | 3.71 | 38.28 | 18.99 | 1.58 | 20.57 | 24.63 | 61.12 | 41.88 | 30.12 | 5.96 | 9.59 |
| 9809 | 37.00 | 124.90 | 23.20 | 5.31 | 49.08 | 19.99 | 3.98 | 23.97 | 21.60 | 51.98 | 57.88 | 32.13 | 7.65 | 14.75 |
| 9842 | 37.00 | 124.90 | 21.40 | 3.51 | 40.08 | 17.78 | 4.78 | 22.57 | 19.82 | 60.91 | 56.65 | 32.57 | 6.87 | 11.14 |
| 9905 | 37.00 | 124.90 | 17.40 | 6.11 | 50.48 | 22.78 | 7.18 | 29.97 | 20.76 | 51.89 | 41.88 | 42.96 | 10.79 | 20.92 |
| 9961 | 37.00 | 124.90 | 30.20 | 5.51 | 42.68 | 21.59 | 4.58 | 26.17 | 23.07 | 46.01 | 40.99 | 26.98 | 5.69 | 12.47 |
| 10036 | 37.00 | 124.90 | 30.20 | 2.91 | 32.28 | 11.99 | 2.18 | 14.17 | 19.15 | 48.56 | 38.43 | 32.21 | 5.56 | 11.49 |
| 10092 | 37.00 | 113.90 | 27.40 | 3.11 | 13.28 | 1.59 | 0.91 | 2.50 | 18.15 | 52.66 | 57.50 | 17.89 | 0.79 | 1.32 |
| 10185 | 37.00 | 124.90 | 28.60 | 4.31 | 26.88 | 9.19 | 3.38 | 12.57 | 25.97 | 57.17 | 46.53 | 21.65 | 5.16 | 8.90 |
| 10384 | 37.00 | 114.30 | 24.90 | 6.05 | 48.05 | 20.79 | 3.85 | 24.65 | 22.21 | 65.51 | 52.00 | 39.72 | 7.77 | 12.30 |
| 10474 | 37.00 | 114.30 | 22.70 | 6.25 | 43.45 | 18.80 | 4.45 | 23.25 | 19.62 | 56.05 | 55.21 | 45.89 | 7.21 | 13.06 |
| 10479 | 37.00 | 125.30 | 29.70 | 7.05 | 51.05 | 12.19 | 2.85 | 15.05 | 14.33 | 39.23 | 31.02 | 16.58 | 3.26 | 8.27 |
| 10554 | 37.00 | 114.30 | 27.50 | 5.85 | 56.05 | 24.79 | 4.45 | 29.25 | 16.20 | 45.89 | 32.32 | 38.33 | 6.44 | 13.86 |
| 10566 | 37.00 | 114.30 | 38.10 | 5.25 | 47.85 | 18.19 | 4.05 | 22.25 | 23.63 | 46.68 | 42.72 | 38.17 | 8.03 | 16.86 |
| 10890 | 37.00 | 114.30 | 27.90 | 4.65 | 39.65 | 13.60 | 4.85 | 18.45 | 11.23 | 59.59 | 51.61 | 36.98 | 3.44 | 6.40 |
| 11088 | 37.00 | 125.30 | 33.70 | 5.25 | 53.05 | 21.79 | 5.25 | 27.05 | 14.39 | 40.46 | 36.16 | 37.74 | 7.74 | 18.37 |

**Appendix-E (Contd) . . .**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11109 | 37.00 | 125.30 | 28.30 | 6.25 | 54.05 | 22.39 | 6.05 | 28.45 | 19.09 | 54.15 | 42.08 | 33.69 | 7.01 | 13.09 |
| 11144 | 37.00 | 114.30 | 34.10 | 7.25 | 54.45 | 26.19 | 4.85 | 31.05 | 19.00 | 56.91 | 49.67 | 36.28 | 9.96 | 17.48 |
| 11219 | 37.00 | 125.30 | 30.50 | 5.45 | 44.25 | 14.39 | 3.65 | 18.05 | 21.27 | 48.93 | 41.81 | 22.96 | 5.47 | 11.28 |
| 11249 | 37.00 | 107.30 | 33.30 | 5.85 | 56.65 | 26.19 | 1.25 | 27.45 | 19.94 | 55.60 | 35.90 | 33.61 | 8.62 | 15.55 |
| 11322 | 37.00 | 120.30 | 27.30 | 6.85 | 43.05 | 22.19 | 5.45 | 27.65 | 27.49 | 59.65 | 50.61 | 35.15 | 9.76 | 16.47 |
| 11426 | 37.00 | 125.30 | 29.10 | 7.98 | 89.64 | 34.65 | 6.65 | 41.31 | 16.12 | 44.86 | 14.88 | 30.19 | 8.74 | 18.92 |
| 11457 | 37.00 | 120.30 | 31.50 | 6.25 | 44.65 | 15.39 | 4.25 | 19.65 | 21.17 | 49.18 | 68.89 | 17.00 | 6.66 | 13.51 |
| 11515 | 37.00 | 120.30 | 32.30 | 5.85 | 48.05 | 21.59 | 3.25 | 24.85 | 30.94 | 54.35 | 59.08 | 39.35 | 11.10 | 20.17 |
| 11651 | 37.00 | 120.30 | 31.50 | 5.05 | 48.65 | 29.19 | 4.45 | 33.65 | 32.82 | 60.86 | 55.56 | 43.96 | 15.07 | 24.49 |
| 11687 | 37.00 | 114.30 | 31.30 | 5.45 | 75.45 | 31.99 | 4.65 | 36.65 | 23.14 | 63.99 | 57.03 | 38.25 | 11.31 | 17.82 |
| 11855 | 37.00 | 120.30 | 23.70 | 7.45 | 54.65 | 25.99 | 5.85 | 31.85 | 28.62 | 53.14 | 46.19 | 40.70 | 12.01 | 22.19 |
| 12000 | 37.00 | 120.30 | 27.30 | 7.65 | 60.45 | 23.99 | 4.65 | 28.65 | 22.03 | 56.20 | 46.18 | 21.60 | 8.84 | 15.78 |
| 12189 | 37.00 | 120.30 | 28.50 | 5.25 | 41.25 | 16.80 | 5.25 | 22.05 | 25.93 | 55.66 | 39.67 | 50.28 | 8.47 | 15.28 |
| 12276 | 37.00 | 120.30 | 23.30 | 7.85 | 51.65 | 26.99 | 5.85 | 32.85 | 28.99 | 56.92 | 69.19 | 43.07 | 12.83 | 22.26 |
| 12370 | 37.00 | 125.30 | 25.50 | 7.25 | 54.85 | 22.79 | 6.25 | 29.05 | 22.57 | 52.63 | 61.80 | 26.26 | 7.61 | 14.48 |
| 12625 | 37.00 | 125.30 | 34.30 | 4.65 | 46.25 | 19.59 | 3.05 | 22.65 | 22.44 | 45.26 | 41.95 | 33.88 | 6.74 | 14.64 |
| 12672 | 37.00 | 125.30 | 26.10 | 8.45 | 84.25 | 24.79 | 8.45 | 33.25 | 27.10 | 42.71 | 51.51 | 27.68 | 7.86 | 17.81 |
| 12682 | 37.00 | 107.30 | 30.90 | 5.65 | 50.05 | 16.59 | 5.45 | 22.05 | 21.03 | 54.24 | 67.09 | 25.30 | 5.26 | 10.02 |
| 12697 | 37.00 | 107.30 | 28.30 | 5.85 | 71.65 | 26.59 | 2.65 | 29.25 | 23.83 | 63.49 | 49.40 | 34.44 | 10.67 | 16.98 |
| 12879 | 37.00 | 125.30 | 22.70 | 8.85 | 64.85 | 29.39 | 11.45 | 40.85 | 25.43 | 50.84 | 30.68 | 44.90 | 13.02 | 24.94 |
| 156 | 37.00 | 107.30 | 25.30 | 6.65 | 51.65 | 24.79 | 10.85 | 35.65 | 26.39 | 47.74 | 37.35 | 42.20 | 9.91 | 20.24 |
| 2738 | 37.00 | 116.10 | 30.90 | 4.89 | 43.01 | 14.40 | 5.21 | 19.61 | 23.48 | 66.18 | 50.33 | 36.25 | 5.62 | 7.81 |
| 12921 | 37.00 | 109.10 | 19.70 | 4.89 | 18.48 | 10.87 | 1.01 | 11.88 | 22.69 | 56.14 | 43.65 | 37.03 | 3.85 | 6.98 |
| 12988 | 37.00 | 116.10 | 29.90 | 5.09 | 44.61 | 16.20 | 4.41 | 20.61 | 19.82 | 65.78 | 66.24 | 40.27 | 5.51 | 7.72 |

**Appendix-E (Contd) . . .**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13099 | 37.00 | 127.10 | 20.30 | 7.09 | 40.01 | 15.80 | 5.81 | 21.61 | 21.93 | 53.63 | 52.43 | 37.85 | 5.11 | 9.96 |
| 13603 | 37.00 | 116.10 | 24.30 | 5.49 | 27.41 | 11.80 | 4.41 | 16.21 | 23.79 | 60.41 | 60.42 | 39.68 | 4.23 | 6.74 |
| 13723 | 37.00 | 127.10 | 26.90 | 5.29 | 28.61 | 9.40 | 5.01 | 14.41 | 18.19 | 61.77 | 42.19 | 34.05 | 4.23 | 6.47 |
| 13787 | 37.00 | 127.10 | 22.90 | 6.09 | 32.01 | 10.60 | 9.01 | 19.61 | 19.27 | 47.04 | 40.16 | 32.16 | 2.68 | 6.86 |
| 13858 | 37.00 | 127.10 | 20.70 | 7.89 | 21.21 | 6.00 | 2.61 | 8.61 | 17.07 | 58.77 | 39.45 | 28.76 | 3.93 | 6.56 |
| 13941 | 37.00 | 127.10 | 20.90 | 7.49 | 25.81 | 11.00 | 4.81 | 15.81 | 23.62 | 55.56 | 46.10 | 44.91 | 7.53 | 13.86 |
| 13942 | 37.00 | 127.10 | 21.30 | 6.09 | 34.61 | 21.60 | 4.01 | 25.61 | 32.23 | 60.26 | 51.00 | 48.35 | 11.33 | 18.76 |
| 13982 | 37.00 | 122.10 | 25.70 | 4.49 | 26.41 | 13.80 | 3.01 | 16.81 | 27.15 | 65.01 | 58.30 | 42.47 | 6.83 | 9.94 |
| 14008 | 37.00 | 127.10 | 27.90 | 6.69 | 43.01 | 12.80 | 7.21 | 20.01 | 18.62 | 47.73 | 39.62 | 25.59 | 3.95 | 9.40 |
| 14106 | 37.00 | 116.10 | 33.10 | 5.89 | 44.21 | 20.60 | 2.21 | 22.81 | 18.66 | 56.62 | 42.58 | 37.13 | 7.21 | 12.92 |
| 14118 | 37.00 | 116.10 | 32.50 | 5.29 | 52.01 | 21.60 | 7.21 | 28.81 | 25.18 | 62.12 | 66.87 | 39.33 | 7.52 | 11.79 |
| 14127 | 37.00 | 109.10 | 36.70 | 5.69 | 34.01 | 15.40 | 4.21 | 19.61 | 20.65 | 52.75 | 76.57 | 43.60 | 7.85 | 15.52 |
| 14466 | 37.00 | 122.10 | 33.10 | 8.49 | 55.61 | 13.80 | 8.21 | 22.01 | 30.93 | 57.20 | 46.77 | 29.23 | 6.67 | 11.77 |
| 14475 | 37.00 | 122.10 | 40.70 | 7.29 | 52.21 | 12.20 | 10.61 | 22.81 | 27.42 | 60.93 | 57.60 | 28.18 | 5.94 | 9.49 |
| 14482 | 37.00 | 122.10 | 31.90 | 6.49 | 36.01 | 6.40 | 2.61 | 9.01 | 27.03 | 58.71 | 74.23 | 25.46 | 3.53 | 5.88 |
| 14523 | 37.00 | 109.10 | 36.90 | 6.29 | 39.21 | 16.80 | 3.81 | 20.61 | 22.72 | 64.16 | 51.01 | 40.02 | 7.30 | 10.89 |
| 14630 | 37.00 | 109.10 | 41.10 | 5.09 | 41.81 | 7.40 | 4.81 | 12.21 | 24.12 | 54.54 | 46.42 | 32.39 | 5.36 | 10.17 |
| 14705 | 37.00 | 122.10 | 27.70 | 5.29 | 16.61 | 8.20 | 5.01 | 13.21 | 26.85 | 59.87 | 40.53 | 44.89 | 4.53 | 7.36 |
| 14710 | 37.00 | 122.10 | 32.10 | 4.29 | 12.21 | 6.40 | 3.61 | 10.01 | 22.32 | 54.43 | 62.21 | 37.03 | 3.55 | 6.81 |
| 14985 | 37.00 | 122.10 | 18.70 | 4.69 | 18.41 | 7.40 | 4.01 | 11.41 | 27.63 | 59.01 | 49.25 | 36.54 | 3.97 | 6.58 |
| 15042 | 37.00 | 122.10 | 21.90 | 4.49 | 31.21 | 12.20 | 5.01 | 17.21 | 26.95 | 56.60 | 48.43 | 42.37 | 6.95 | 12.46 |
| 15190 | 37.00 | 127.10 | 25.10 | 6.69 | 32.01 | 16.80 | 3.81 | 20.61 | 27.42 | 58.26 | 41.36 | 38.50 | 7.01 | 12.05 |
| 15287 | 37.00 | 122.10 | 31.10 | 4.29 | 20.81 | 10.60 | 2.41 | 13.01 | 24.32 | 62.98 | 66.48 | 34.17 | 4.49 | 6.66 |
| 15309 | 37.00 | 122.10 | 34.70 | 5.89 | 42.81 | 18.60 | 1.81 | 20.41 | 22.02 | 59.48 | 50.78 | 37.49 | 9.80 | 16.46 |

**Appendix-E (Contd) . . .**

| ICG Number | DF | DM | PH | NPB | NPEGP | NMP | NIMP | NPP | 100KW | SP | SMK% | HI | KYP | PYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15419 | 37.00 | 122.10 | 29.90 | 3.89 | 18.61 | 4.20 | 2.21 | 6.41 | 26.50 | 48.05 | 56.74 | 32.69 | 3.47 | 8.28 |
| Narayani ($C_1$) | 37.00 | 105.33 | 37.13 | 4.88 | 41.60 | 23.20 | 3.47 | 26.67 | 27.37 | 57.49 | 60.99 | 40.21 | 9.35 | 17.70 |
| Dharani ($C_2$) | 37.00 | 102.50 | 31.20 | 4.97 | 40.97 | 17.58 | 3.83 | 21.12 | 30.42 | 70.18 | 64.32 | 40.52 | 9.88 | 14.34 |
| K-6 ($C_3$) | 37.00 | 106.33 | 31.20 | 5.47 | 42.40 | 19.17 | 3.40 | 22.40 | 26.10 | 58.50 | 48.27 | 34.62 | 9.28 | 16.09 |
| TCGS- 1157 ($C_4$) | 37.00 | 113.00 | 23.27 | 6.47 | 52.10 | 24.60 | 5.05 | 30.13 | 27.18 | 59.31 | 45.34 | 41.28 | 11.10 | 18.60 |
| TCGS- 1330 ($C_5$) | 37.00 | 110.33 | 25.08 | 7.45 | 49.38 | 23.82 | 3.60 | 27.72 | 34.63 | 57.13 | 52.46 | 40.17 | 12.85 | 23.50 |
| Mean | 37.00 | 117.71 | 28.60 | 5.66 | 44.97 | 18.29 | 3.89 | 22.19 | 23.76 | 55.93 | 49.64 | 33.38 | 7.13 | 13.17 |
| Standard Deviation | 37.00 | 6.79 | 5.39 | 1.37 | 17.26 | 3.47 | 0.59 | 3.78 | 4.51 | 7.79 | 12.90 | 8.26 | 1.99 | 3.18 |
| Standard Error | 37.00 | 0.52 | 0.41 | 0.10 | 1.31 | 0.26 | 0.04 | 0.29 | 0.34 | 0.59 | 0.98 | 0.63 | 0.15 | 0.24 |
| C.V. % | 37.00 | 5.77 | 18.86 | 24.15 | 38.39 | 18.97 | 15.20 | 17.05 | 19.00 | 13.94 | 25.99 | 24.73 | 28.02 | 24.22 |

DF : Days to 50% flowering; DM : days to maturity; PH : Plant height (cm); NPB : Number of primary branches per plant (No); NPEGP : Number of pegs per plant (No); NMP : Number of mature pods per plant (No); NIMP : Number of immature pods per plant (No); NPP : Number of pods per plant (No); HSW : 100- kernel weight (g); SP : Shelling percentage(%); SMK% : Sound mature kernel percentage(%); HI : Harvest index (%); KYP : Kernel yield per plant (g); PYP : Pod yield per plant (g).