GENETIC ANALYSIS OF YIELD AND YIELD ATTRIBUTES IN F_3 GENERATION OF 5 x 5 PARTIAL DIALLEL SET OF CROSSES IN PUMPKIN (*Cucurbita moschata* Duch ex. Poir)

By

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CERTIFICATE

This is to certify that **Ms. K. UMA MAHESWARI**, has satisfactorily prosecuted the course of research and that the thesis entitled **"GENETIC ANALYSIS OF YIELD AND YIELD ATTRIBUTES IN F_3 GENERATION OF 5 X 5 PARTIAL DIALLEL SET OF CROSSES IN PUMPKIN (*Cucurbita moschata* Duch ex. Poir)"** 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 the thesis or part thereof has not been previously submitted by her for a degree of any University.

Date :

Place : Tirupati

(Dr. K. HARIBABU)
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DECLARATION

I, **Ms. K. UMA MAHESWARI** hereby declare that the thesis entitled "**GENETIC ANALYSIS OF YIELD AND YIELD ATTRIBUTES IN F_3 GENERATION OF 5 x 5 PARTIAL DIALLEL SET OF CROSSES IN PUMPKIN (*Cucurbita moschata* Duch ex. Poir)**" submitted to Acharya N.G. Ranga Agricultural University, Hyderabad for the degree of **Master of Science in Agriculture** is the result of original research work done by me. I also declare that the material contained in this thesis has not been published earlier.

Date :

(K. UMA MAHESWARI)

CERTIFICATE

This is to certify that the thesis entitled **"GENETIC ANALYSIS OF YIELD AND YIELD ATTRIBUTES IN F_3 GENERATION OF 5 x 5 PARTIAL DIALLEL SET OF CROSSES IN PUMPKIN (*Cucurbita moschata* Duch ex. Poir)"** submitted in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE IN AGRICULTURE** of the Acharya N.G.Ranga Agricultural University, Hyderabad is a record of the bonafide research work carried out by **K. UMA MAHESWARI** under our guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee.

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

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ABSTRACT

The present investigation was carried involving five parents and their ten F_3 cross combinations of Pumpkin (*Cucurbita moschata* Duch. ex. Poir) grown under field conditions at Horticultural Garden, Sri Venkateswara Agricultural College, Tirupati. The data recorded for fruit yield and its fourteen component characters were analysed for genetic parameters viz., variability, heritability and genetic advance as per cent of mean, combining ability, nature of gene action, character association, path analysis, segregation pattern of some important traits and transgressive segregants.

Analysis of variance revealed existence of significant genotypic differences for all the characters studied. The genotype CM-12 showed high mean performance for number of fruits per vine and yield per vine. High genetic advance as per cent of mean was revealed for fruit yield and number of

fruits per vine in both parents and crosses indicating that these traits can be improved by simple selection method.

Combining ability analysis revealed significant gca and sca mean squares for all the characters indicating the importance of both additive and non-additive gene action for these characters. The estimates of component variance revealed predominance of non-additive gene action for all characters. Mean performance and gca effects of parental lines over all the characters, enabled to identify the best combiners *viz.,* CM-12, CM-64 and CM-14, when *per se* performance and sca effects were considered over all the characters including fruit yield the genotypes CM-12 and CM-64 and the crosses CM-45 x CM-12, CM-45 x CM-64 and CM-12 x CM-64 were best promising entries for yield.

Correlation studies revealed significant positive association of number of branches per vine and fruit weight with fruit yield. It suggested that selection for these characters would ultimately help to bring considerable improvement in yield. Path coefficient analysis revealed that number of branches per vine, hundred seed weight, fruit length and fruit flesh thickness had high positive direct effects on yield. Moreover the indirect effect of most of the characters through fruit weight, number of fruits per vine, and fruit girth were positive, hence importance should be given to these characters in a selection programme to identify superior lines with genetic potentiality for high fruit yield.

Segregation pattern showed that the crosses CM-45 x CM-12 for fruit yield per vine, CM-12 x TPT-local for sex ratio, CM-12 x CM-64 for number of branches per vine and fruit length and CM-14 x CM-12 for number of fruits per vine and fruit weight showed high proportion of segregants which can be utilized to obtain high yielding genotypes in future generations. Total Transgressive segregants and Significantly Transgressive Segregants were observed to be more in the cross CM-14 x CM-12 for number of fruits per vine and fruit weight, and CM-45 x CM-12 for yield per vine.

LIST OF ABBREVIATIONS

et al.	:	and others
%	:	Per cent
CD	:	Critical difference
cm	:	Centimeter
g	:	Gram
GA	:	Genetic Advance
gca	:	General Combining Ability
GCV	:	Genotypic Coefficient of Variation
h^2(b)	:	Heritability (broad sense)
kg	:	Kilogram
m	:	metre
No	:	Number
PCV	:	Phenotypic Coefficient of Variation
r	:	Correlation Coefficient
sca	:	Specific Combining Ability
SEd	:	Standard Error of difference
TTS	:	Total transgressive segregants
STS	:	Significantly transgressive segregants
viz.,	:	Namely

CHAPTER - 1

INTRODUCTION

Cucurbitaceous crops is the largest group of vegetables grown in India and through out the world. Pumpkin (*Cucurbita moschata* Duch ex. Poir) is one of the important cultivated cucurbits originated from Central Mexico and has a place of high value, due to its long shelf life, high productivity, excellent response to forcing, high nutritive value especially carotene content. Fruits of pumpkin can be used as vegetable both in immature and mature stage. Mature fruits can be used in preparing sweets, jams and also can be candied or fermented to prepare a beverage. Fruit flesh is delicious when stewed, boiled or baked. According to Bailey (1929), pumpkins are the marvels of the vegetable world due to their many unusual and extravagant characters.

Pumpkin being monoecious and cross pollinated crop, offers a wide range of variability for several qualitative and quantitative characters. But very little attention has been paid for its genetical improvement. This might be due to inadequate assemblage of genetically distant genotypes.

The breeding strategy to be adopted for improvement of a crop depends primarily on the nature of gene action involved in the expression of quantitative traits of economic importance. Diallel analysis has been used as a popular experimental method to assess the combining ability of the parents and the crosses for different characters and making further selections in the segregating generations. In addition, a thorough knowledge on genetic parameters like mean variability, heritability and genetic advance as per cent of mean and gene action will provide a systematic breeding strategy to improve yield potential of genotypes. Estimates of genetic variability, heritability and genetic advance are of immense value in identifying the superior genotypes.

Fruit yield being a complex character, is influenced by several genetic factors interacting with environment. A clear understanding of the association of plant characters with yield is necessary for successful crop improvement programme. Correlation coefficient reveal magnitude and direction of association which directly or indirectly influences yield. Both character association and path analysis help in formulating an effective breeding strategy to develop productive genotypes.

Breeding approach should be suggested to pool the desirable genes from the selected plants in the early segregating generations. Further, due to intercrossing, new population with high frequencies of rare recombinants add to the existing variability. The present investigation was therefore, planned to evaluate the performance of F_3 generation with a view to establish the relative superiority of the intermated progenies, if any, over the conventionally bred progenies, in terms of mean performance, release of genetic variability, shift in character association and impact on direct and indirect effects among different quantitative characters and also with fruit yield.

Keeping all the above in view, the present study was undertaken with the following objectives :

1. To estimate variability, heritability and genetic advance as per cent of mean in five parental and 10 F_3 generation progeneis for fruit yield and its components.
2. To estimate the combining ability effects and nature and magnitude of gene action for yield and its attributes.
3. To study the correlations among the yield attributing characters in parents and F_3 generation progenies.

4. To identify the characters which are directly and indirectly influencing the yield based on path coefficient analysis in five parental and 10 F_3 progenies.
5. To study the segregation pattern for yield and important yield contributing characters.
6. To study the mean performance of parents along with F_3 progenies.

CHAPTER - IV

RESULTS

A study on genetic analysis of yield and yield attributes was undertaken in pumpkin using a partial diallel set of crosses involving five genotypes of pumpkin. The results obtained from both parents and F_3 crosses for certain characters are presented under the following heads.

4.1 MEAN PERFORMANCE

4.2 VARIABILITY, HERITABILITY AND GENETIC ADVANCE

4.3 COMBINING ABILITY

4.4 CHARACTER ASSOCIATION

4.5 PATH COEFFICIENT ANALYSIS

4.6 SEGREGATION PATTERN.

4.7 TRANSGRESSIVE SEGREGANTS.

4.1 MEAN PERFORMANCE

Analysis of variance was done for fifteen characters *viz.,* vine length, branches per vine, nodes at which first male and female flowers appeared, number of days taken for male and female flowers opening, sex ratio, fruits per vine, average fruit weight, fruit length, fruit girth, fruit flesh thickness, yield per vine, seeds per fruit and hundred seed weight. The treatmental differences among the parents and F_3s were found significant for all characters. Mean performance for 5 parents and 10 F_3s in presented in Table 2.

4.1.1. Vine Length (m)

Among the parents the vine length ranged from 5.76 m (CM-12) to 9.74 m (CM-14). Three parents out of five *viz.,* CM-12 (5.76 m), TPT-local (7.11 m) and CM-64 (7.49 m) recorded the shorter vine length compared to mean vine length of the parents (7.62 m).

Among the F_3s TPT-local x CM-64 showed the highest vine length (9.83 m) followed by CM-12 x CM-64 (8.88 m) CM-45 x CM-64 (8.81 m) and CM-45 x TPT-local (8.78 m). While CM-12 x TPT-local recorded the lowest vine length (6.93 m). Out of the ten crosses four F_3 crosses (CM-45 x TPT-local, CM-45 x CM-64, CM-12 x CM-64 and TPT-local x CM-64) recorded higher vine length than their mean vine length (8.031 m) (Table 2).

4.1.2. Branches per vine

Among the parents number of branches per vine ranged from 7.43 (CM-45) to 11.47 (CM-12). Out of five parents namely CM-45 (7.43), TPT-local (7.6) and CM-14 (8.23) recorded less number of branches per vine compared to mean branches per vine (8.73). Among the parents CM-12 (11.47) and CM-64 (8.9) recorded more number of branches per vine than the mean of branches per vine.

Out of ten F_3 crosses CM-45 x CM-12 (10.73), CM-45 x TPT-local (10.07), CM-14 x CM-12 (10.50), CM-14 x CM-64 (10.27) and CM-12 x CM-64 (11.23) recorded more number of branches per vine than their mean of branches per vine (9.89).

4.1.3 Node at which first male flower appeared

The node at which first male flower appeared was varied from 5.13 (TPT-local) to 6.3 (CM-45). The parental means showed a value of 5.76. Three parents CM-12 (5.63), TPT-local (5.13) and CM-64 (5.57) recorded the lower number of node for first male flower appearance than the mean value of parents (5.76). Two parents *viz.,* CM-45 (6.30) and CM-14 (6.17) showed the higher node for first male flower appearance than the mean value. Among the F_3 crosses CM-45 x CM-12 (5.13) recorded the lowest number of node at which first male flower appeared, whereas the highest node number was noticed with CM-12 x TPT-local (6.20). Four F_3 crosses *viz.,* CM-45 x CM-12, CM-45 x CM-64, CM-14 x CM-64 and TPT-local x CM-64 displayed lower node number of first male flower appearance as compared to their mean value (5.38).

4.1.4. Node at which first female flower appeared

Among the parents the node at which first female flower appeared ranged from 17.4 (CM-12) to 18.67 (TPT-local). The mean value of parents for this trait was 17.98. Three parents *viz.,* CM-45, CM-14 and CM-12 showed lower node of first female flower appearance than the mean value of parents (17.98).

Among the F_3 crosses the number of first female flowering node appearance ranged from 17.4 (CM-14 x CM-64) to 19.57 (CM-12 x CM-64). Four F_3 crosses *viz.,* CM-45 x CM-64, CM-14 x TPT-local, CM-14 x CM-64 and CM-12 x TPT-local exhibited the lower node number as compared to mean of crosses (18.55).

4.1.5 Days to male flower opening

Among the parents TPT-local (54.3) showed the lowest number of days to first male flower opening and CM-45 (58.03) showed the highest number of days for first female flower opening. Three parents *viz.,* CM-12, TPT-local and CM-64 showed lesser number of days than the mean value (56.36).

Among F_3 crosses number of days taken for first male flower opening ranged from 55.73 (TPT-local x CM-64) to 56.87 (CM-45 x CM-12). Three F_3 crosses *viz.,* CM-14 x TPT-local, CM-12 x CM-64 and TPT-local x CM-64 showed lesser number of days taken for first male flower opening compared to the mean value of crosses (56.4).

4.1.6 Days to female flower opening

Among the parents CM-12 showed the lowest days (61.47) and CM-45 showed the highest number of days to first female flower opening. Three parents *viz.,* CM-14 (63.13), CM-12 (61.47) and TPT-local (62.83) showed lesser days taken for first female flower opening compared to the mean of parents (63.28).

Days taken to first female flowering registered a mean value of 63.13 among crosses. CM-12 x CM-64 showed the lowest number of days (61.33) and CM-45 x CM-14 showed the highest number of days (64.57) for first female flowering. Five F_3 crosses *viz.,* CM-45 x CM-64, CM-14 x TPT-local, CM-14 x CM-64, CM-12 x TPT-local and CM-12 x CM-64 exhibited higher number of days to first female flower opening as compared to their mean value (63.13).

4.1.7 Sex ratio

Among the parents sex ratio ranged from 0.10 (TPT-local) to 0.14 (CM-45). The parents *viz.,* TPT-local (0.1) and CM-64 (0.11) showed less sex ratio than their mean value (0.12).

Among F_3 crosses sex ratio varied from 0.11 (CM-45 x CM-64) to 0.39 (TPT-local x CM-64). Nine F_3 crosses *viz.,* CM-45 x CM-14, CM-45 x CM-12, CM-45 x TPT-local, CM-45 x CM-64, CM-14 x CM-12, CM-14 x TPT-local, CM-14 x CM-64, CM-12 x TPT-local and CM-12 x CM-64 recorded the lower sex ratio than their mean value (0.15) whereas TPT-local x CM-64 showed higher sex ratio than their mean value (0.15).

4.1.8 Number of fruits per vine

Among the parents number of fruits per vine was the highest in CM-12 (2.33) and the lowest in CM-45 (1.40). The parental mean registered a value of 1.83. Two parents *viz.,* CM-14 and CM-12, showed higher value than the mean value of parents (1.83). Among F_3 crosses number of fruits per vine ranged from 1.53 (CM-14 x TPT-local) to 2.40 (CM-14 x CM-12). Four F_3 crosses *viz.,* CM-14 x CM-12, CM-14 x CM-64, CM-12 x CM-64 and TPT-local x CM-64 recorded higher number of fruits per vine compared to their mean value (1.76).

4.1.9 Average fruit weight (kg)

Average fruit weight among the parents ranged from 2.54 kg (CM-45) to 3.58 kg (CM-12). The parental mean registered a value of 3.23 kg. Two parents among five *viz.,* CM-12 (3.58 kg) and CM-64 (3.26 kg) recorded higher average fruit weight than their mean value (3.23 kg).

Among the hybrids average fruit weight ranged from 3.23 kg (CM-45 x TPT-local) to 3.89 kg (CM-12 x CM-64). Four F_3 crosses *viz.,* CM-45 x CM-64, CM-14 x CM-12, CM-14 x CM-64 and CM-12 x CM-64, recorded higher fruit weight than their mean value (3.54 kg).

4.1.10 Fruit length

Among the parents fruit length ranged from 20.15 cm (TPT-local) to 26.73 cm (CM-64). The parents *viz.,* CM-14 and CM-64 recorded higher fruit length compared to their mean value (23.62 cm).

Among the crosses fruit length varied from 22.3 cm (CM-14 x TPT-local) to 28.51 cm (CM-12 x CM-64). Six F_3 crosses *viz.,* CM-45 x CM-14, CM-45 x CM-64, CM-14 x CM-64, CM-12x TPT-local, CM-12 x CM-64 and TPT-local x CM-64 showed higher value of fruit length compared to their mean value (24.95 cm).

4.1.11 Fruit girth (cm)

Among the parents fruit girth ranged from 22.37 cm (CM-64) to 25.75 cm (CM-12). Parents registered a mean value of 22.81 cm. Among the parents CM-12 (25.75) cm showed the higher fruit girth than their mean value (22.81 cm).

Among the crosses fruit girth ranged from 22.8 cm (CM-45 x CM-64) to 27.00 cm (CM-14 x CM-12). Five F_3 crosses *viz.,* CM-45 x CM-14, CM-45 x CM-12, CM-45 x TPT-local, CM-14 x CM-12 and CM-14 x TPT-local recorded higher fruit girth compared to their mean value (24.81 cm).

4.1.12 Fruit flesh thickness (cm)

The highest fruit flesh thickness was registered (3.92 cm) in CM-12 while the lowest fruit flesh thickness was recorded (3.09 cm) by CM-45 among parents. The other parents *viz.,* CM-12 (3.92 cm) and CM-64 (3.55 cm) registered higher fruit flesh thickness compared to their mean value (3.47 cm).

Among the crosses fruit flesh thickness ranged from 3.24 cm (TPT-local x CM-64) to 4.07 cm (CM-45 x TPT-local). Four F_3 crosses *viz.,* CM-45 x CM-14, CM-45 x CM-12, CM-45 x TPT-local and CM-14 x CM-64 recorded higher fruit flesh thickness compared to their mean value (3.54 cm).

4.1.13 Yield per vine (kg)

Yield per vine ranged from 5.6 kg (CM-45) to 10.66 kg (CM-12). Among the parents CM-12 (10.66 kg) and CM-64 (9.4 kg) registered higher yield per vine compared to their mean value (7.78 kg).

Among the crosses yield per vine ranged from 8.34 kg (CM-45 x TPT-local) to 12.62 kg (CM-45 x CM-12). Four F_3 crosses *viz.,* CM-45 x CM-14, CM-45 x CM-12, CM-45 x CM-64 and CM-12 x CM-64 recorded higher yield per vine compared to their mean value (9.56 kg).

4.1.14 Number of seeds per fruit

Among the parents number of seeds per fruit varied from 296.1 (CM-45) to 555.00 (CM-12). Among parents *viz.,* CM-12, TPT-local and CM-64 registered higher number of seeds per fruit than their mean value (469.94).

Among the crosses number of seeds per fruit ranged from 424.27 (CM-45 x TPT-local) to 740.17 (CM-45 x CM-14). Four F_3 crosses *viz.,* CM-45 x CM-14, CM-14 x CM-12, CM-14 x CM-64 and CM-12 x CM-64 recorded higher number of seeds per fruit than their mean value (595.34).

4.1.15 Hundred seed weight (g)

Among the parents hundred seed weight ranged from 16.37 g (CM-45) to 21.47 g (CM-12). Out of five, two parents CM-14 and CM-12 recorded higher hundred seed weight than the mean value of parents (19.32 g).

Among the crosses hundred seed weight varied from 18.43 g (CM-45 x TPT-local) to 22.57 g (CM-45 x CM-65). Five F_3 crosses *viz.,* CM-45 x CM-64, CM-14 x CM-12, CM-14 x TPT-local, CM-14 x CM-64 and CM-12 x CM-64 recorded higher hundred seed weight compared to their mean value of crosses (21.08 g).

4.2. GENETIC PARAMETERS

The results on phenotypic and genotypic variance, phenotypic and genotypic coefficients of variation, heritability and genetic advance for fifteen characters are presented in Table 3.

GCV and PCV were considered low when they were less than 10 per cent, medium at 10-20 per cent and high at more than 20 per cent. Heritability was considered low when it was less than 20 per cent, medium at 20-50 per cent and high at more than 50 per cent (Stansfield, 1969).

4.2.1 Variability

The character number of seeds per fruit recorded the maximum values for both genotypic and phenotypic variances (11,289.030 and 12,115.447) respectively) followed by fruit length (4.483 and 4.897), fruit girth (4.050 and 4.288), yield per vine (3.710 and 3.839). Whereas hundred seed weight (2.471 and 3.290), days to male flower opening (1.711 and 1.909), number of branches per vine (1.466 and 1.683), vine length (1.283 and 1.338) showed fairly low genotypic and phenotypic variances. Days to female flower opening (0.786 and 1.209), number of fruits per vine (0.662 and 0.089), node at which first female flower appeared (0.374 and 0.523), node at which first male flower appeared (0.225 and 0.247), flesh thickness (0.063 and 0.069) and sex ratio (0.001 and 0.0185) had lower values for genotypic and phenotypic variances.

In general the phenotypic coefficients of variation were higher than genotypic coefficients of variation indicating that the variation due to the influence of environment. The phenotypic and genotypic coefficients of variation were highest for sex ratio (23.00 and 98.82) followed by yield per vine (21.48 and 21.85). Number of seeds per fruit (19.19 and 19.88), number of fruits per vine (14.47 and 16.78), vine length (14.35 and 14.65), number of branches per vine (12.74 and 13.65), fruit weight (10.64 and 10.79) displayed moderate values. Fruit length (8.64 and 9.03), node at which first male flower appeared (8.64 and 9.02), fruit girth (8.29 and 8.53), node at which first female flower appeared (3.33 and 3.94), days to first male flowering (2.32 and 2.45) and days to first female flowering (1.49 and 1.74) recorded lower values for genotypic and phenotypic coefficients of variation.

4.2.2 Heritability

The heritability estimates of broad sense were maximum for fruit weight (97.2%) followed by yield per vine (96.6%), vine length (95.9%), fruit girth (94.4%) number of seeds per fruit (93.2%), fruit flesh thickness (91.8%), fruit length (91.4%), number of node at which first male flower appeared (91.0%), days taken to male flowering (89.5%), branches per vine (87.1%), hundred seed weight (75.0%), number of fruits per vine (74.3 %), days to female flowering (73.5%) and number of node at which first female flower appeared (71.6%) whereas minimum heritability in board sense was recorded in sex ratio (5.4%).

4.2.3 Genetic Advance

Number of seeds per fruit (211.38) displayed higher value for genetic advance whereas all the remaining characters registered lower values.

Genetic advance as per cent of mean was highest for yield per vine (43.493%), followed by number of seeds per fruit (38.169%), vine length (29.005%), number of fruits per vine (25.872%), number of branches per vine (24.515%), fruit weight (21.705%). Whereas moderately high values were recorded for fruit length (17.016%), node at which first male flower appeared (16.881%), fruit girth (16.601%), sex ratio (14.492%), fruit flesh thickness (14.209%) and hundred seed weight (13.663%). While node at which first female flower appeared (5.827%), days to first male flowering (4.522) and days to first female flowering (2.643) registered lower values for genetic advance as per cent of mean.

4.3 COMBINING ABILITY ANALYSIS

In order to identify the best combiners and parents and to earmark superior F_3 hybrids in pumpkin, combining ability analysis was carried out with five parents and ten F_3s. The variation among the parents and crosses was partitioned into those due to general combining ability (gca) and specific combining ability (sca) and are furnished in Table 4,5 and 6 respectively.

4.3.1 Analysis of Variance

The analysis of variance was significant for both gca and sca for all characters except sex ratio. The magnitude to mean sum of squares due to gca was higher than sca for the characters *viz.,* number of branches per vine, days to first male flowering, days to first female flowering, number of fruits per vine, fruit weight, fruit length, fruit girth, yield per vine, number of seeds per fruit and hundred seed weight. Higher mean sum of squares due to sca were observed when compared to gca in case of vine length, node at which first male flower appeared, node at which first female flower appeared, sex ratio and fruit flesh thickness.

The estimates of component variances suggested that the estimates of specific combining ability variance components were larger than general combining ability variance components for all the characters under study. The variance ratio of gca to sca was highest for days to male flower opening (0.15004) and lowest for fruit weight (0.14736).

4.3.2 General combining ability effects

The estimates of gca effects of the parental lines for different character are presented in Table 5.

4.3.2.1 Vine length

The gca effects for vine length ranged from -0.65 (CM-12) to 0.35 (CM-64). Two parents *viz.,* CM-12 and TPT-local recorded significant and negative gca effects. Highly significant and positive effects were observed in the parents *viz.,* CM-45 and CM-64 (Table 5). The parents CM-14 showed non-significant positive gca effects for vine length.

4.3.2.2. Branches per vine

The minimum and maximum gca effects of -0.59 and 1.01 were observed for branches per vine in the parents TPT-local and CM-64 respectively. Highly significant and negative effects were observed in CM-45, CM-14 and TPT-local. Two parents namely CM-12 and CM-64 showed highly significant and positive gca effects for branches per vine.

4.3.2.3. Node at which first male flower appeared

For this trait gca effects ranged from -0.26 (CM-64) to 0.19 (CM-14). Non-significant and negative gca effects were observed for two parents namely TPT-local and CM-64. Whereas non-significant positive gca effects were expressed for three parents namely CM-45, CM-14 and CM-12.

4.3.2.4. Node at which first female flower appeared

The range of gca effects for this trait varied from -0.15 (CM-14) to 0.13 (TPT-local). Highly significant and negative gca effects expressed in parent CM-64. Moderately significant and negative gca effect was expressed in parent CM-14. Highly significant and positive gca effects were expressed in two parents namely CM-45 and CM-12. Moderately significant and positive gca effect was expressed in parent TPT-local (Table 5).

4.3.2.5 Days to first male flower opening

The minimum and maximum gca effects were showed in the parents TPT-local (-0.73) and CM-14 (1.00) respectively for days to first male flower opening. Highly significant and negative gca effects were observed in CM-12, TPT-local and CM-64. While, highly significant and positive gca effects were observed in two parents namely CM-45 and CM-12.

4.3.2.6 Days to first female flower opening

The gca effects for this attribute ranged from -0.74 (CM-12) to 0.86 (CM-45). Highly significant and negative gca effects were expressed by three parents namely CM-12, TPT-local and CM-64. At the same time highly significant and positive gca effects were expressed by two parents namely CM-45 and CM-14 (Table 5).

4.3.2.7 Sex ratio

Estimates of gca effects for sex ratio ranged from -0.02 (CM-14) to 0.02 (TPT-local and CM-64). Highly significant and negative gca effects were expressed by CM-45. Whereas moderately significant and negative gca effects were expressed by CM-14 and CM-12. But moderately significant and positive gca effects were noticed in two parents namely TPT-local and CM-64.

4.3.2.8 Number of fruits per vine

The gca effects for this attribute ranged from -0.17 (CM-45) to 0.20 (CM-12). Highly significant and negative gca effects were expressed by three parents namely CM-45, TPT-local and CM-64. While highly significant and positive gca effects were expressed by two parents namely CM-14 and CM-12 (Table 5).

4.3.2.9 Fruit weight

Maximum and minimum values of gca effects for fruit weight were recorded in CM-12 (0.19) and CM-45 (-0.24) respectively. Three parents *viz.,* CM-45, TPT-local and CM-64 recorded highly significant and negative gca effects whereas two parents namely CM-14 and CM-12 recorded highly significant positive gca effects for fruit weight.

4.3.2.10 Fruit length

The gca effects for this attribute ranged from -1.46 (TPT-local) to 1.9 (CM-64). Two parents CM-45 and TPT-local showed highly significant gca effects in negative direction whereas three parents namely CM-14, CM-12 and CM-64 expressed highly significant gca effects in positive direction for fruit length.

4.3.2.11 Fruit girth

Estimates of gca effects for fruit girth showed a range of -1.12 (CM-64) to 1.17 (CM-12). Two parents *viz.,* CM-45 and CM-64 displayed highly significant and negative gca effects. On contrary, three parents namely CM-14, CM-12, TPT-local displayed highly significant gca effects in positive direction for fruit girth.

4.3.2.12 Fruit flesh thickness

Among all the genotypes minimum gca effect was recorded for fruit flesh thickness in CM-64 (-0.04) while the maximum effect in CM-12 (0.10). The parent CM-12 displayed non-significant and positive gca effect. While remaining four genotypes *viz.,* CM-45, CM-14, TPT-local and CM-64 expressed non-significant gca effects in negative direction for fruit flesh thickness.

4.3.2.13 Yield per vine

The gca effects due to yield per vine ranged from -1.02 (TPT-local) to 1.28 (CM-12). Two parents *viz.,* CM-12 and CM-64 displayed non significant gca effects in positive direction. On contrary, three parents *viz.,* CM-45, CM-14 and TPT-local showed non-significant and negative gca effects for yield per vine.

4.3.2.14 Number of seeds per fruit

The range of gca effects for number of seeds per fruit ranged from -65.55 (CM-45) to 34.18 (CM-12). Two parents *viz.,* CM-45 and TPT-local expressed highly significant and negative gca effects. Whereas three parents namely CM-14, CM-12 and CM-64 showed highly significant and positive gca effects for number of seeds per fruit.

4.3.2.15 Hundred seed weight

Among all the genotypes minimum gca effect was recorded for hundred seed weight in CM-45 (-0.97) and maximum was recorded in CM-12 (0.74). Three genotypes namely CM-14, CM-12 and CM-64 displayed highly significant and positive gca effects. Whereas two genotypes namely CM-45 and TPT-local expressed highly significant and negative gca effects for hundred seed weight.

4.3.3 Specific combining ability effects

Estimates of sca effects for certain characters are presented in Table 6.

4.3.3.1 Vine length

The range of sca effects for vine length was recorded from -1.40 (CM-14 x TPT-local) to 1.73 (TPT-local x CM-64). Six F_3 crosses (CM-45 x CM-12, CM-45 x TPT-local, CM-45 x CM-64, CM-14 x CM-12, CM-12 x CM-64 and TPT-local x CM-64) recorded highly significant and positive sca effects, whereas remaining four F_3 crosses (CM-45 x CM-14, CM-14 x TPT-local, CM-14 x CM-64, CM-12 x TPT-local) showed highly significant and negative sca effects for vine length.

4.3.3.2 Branches per vine

The sca effects for branches per vine ranged from -1.22 (CM-12 x TPT-local) to 1.56 (CM-45 x TPT-local). Among 10 F_3 crosses only two crosses (CM-45 x CM-14 and CM-12 x TPT-local) showed highly negative significant sca effects while the other seven F_3 crosses (CM-45 x CM-12, CM-45 x TPT-local, CM-45 x CM-64, CM-14 x CM-12, CM-14 x TPT-local, CM-14 x CM-64, CM-12 x CM-64 and TPT-local x CM-64) showed highly significant positive sca effects for number of branches per vine (Table 6).

4.3.3.3 Node at which first male flower appeared

The magnitude of sca effects for this trait ranged from -0.75 (CM-45 x CM-64) to 0.09 (CM-12 x CM-64). Highly significant and positive sca effects were expressed by three F_3 crosses (CM-45 x TPT-local, CM-12 x TPT-local and CM-12 x CM-64). Whereas highly significant and negative sca effects were expressed by remaining six F_3 crosses (CM-45 x CM-14, CM-45 x CM-12, CM-45 x CM-64, CM-14 x CM-12, CM-14 x CM-64, TPT-local x CM-64). But only one cross i.e. CM-14 x TPT-local expressed zero sca effect indicating out that there was no difference between the performance of this cross and its parents.

4.3.3.4 Node at which first female flower appeared

The sca effects for this attribute ranged from -0.70 (CM-12 x TPT-local) to 0.84 (CM-45 x CM-12). Highly significant and positive sca effects observed in seven F_3 crosses (CM-45 x CM-14, CM-45 x CM-12, CM-45 x TPT-local, CM-14 x CM-12, CM-14 x TPT-local, CM-12 x CM-64, and TPT-local x CM-64). Whereas highly significant and negative sca effects were recorded in remaining three crosses (CM-45 x CM-64, CM-14 x CM-64 and CM-12 x TPT-local) for node at which first female flower appeared.

4.3.3.5 Days to first male flower opening

The sca effects for days to first male flower opening varied from -1.48 (CM-45 x CM-14) to 1.26 (CM-12 x TPT-local). Among the ten F_3 crosses four crosses (CM-45 x CM-14, CM-14 x CM-12, CM-14 x TPT-local and CM-14 x CM-64) showed highly significant sca effects in negative direction and remaining six F_3 crosses (CM-45 x CM-12, CM-45 x TPT-local, CM-45 x CM-64, CM-12 x TPT-local, CM-12 x CM-64 and TPT-local x CM-64) displayed highly significant sca effects in positive direction.

4.3.3.6 Days to first female flower opening

Among ten F_3 crosses the minimum sca effect for this trait was observed in CM-12 x CM-64 (-1.00) while maximum sca was recorded in CM-14 x CM-12 (0.92). Highly significant and positive sca effects were observed in crosses *viz.,* CM-45 x CM-14, CM-45 x CM-12, CM-14 x CM-12, CM-12 x TPT-local and TPT-local x CM-64. On contrary highly significant sca effects in negative direction were observed in CM-45 x TPT-local, CM-45 x CM-64, CM-14 x TPT-local, CM-14 x CM-64 and CM-12 x CM-64 for days to first female flower opening.

4.3.3.7 Sex ratio

The maximum and minimum sca effects for sex ratio recorded in TPT-local x CM-64 (0.21) and CM-45 x TPT-local, CM-45 x CM-64 (0.03) respectively. Significant and positive sca effects were recorded in four F_3s *viz.,* CM-45 x CM-14, CM-45 x CM-12, CM-14 x CM-12 and TPT-local x CM-64. Whereas remaining six F_3 crosses *viz.,* CM-45 x TPT-local, CM-45 x CM-64, CM-14 x TPT-local, CM-14 x CM-64, CM-12 x TPT-local and CM-12 x CM-64 displayed non-significant and negative sca effects for sex ratio (Table 6).

4.3.3.8 Number of fruits per vine

The sca effects for number of fruits per vine varied from -0.33 (CM-12 x TPT-local) to 0.33 (CM-14 x CM-12). Among ten F_3 crosses four F_3 crosses (CM-45 x CM-14, CM-45 x CM-12, CM-14 x CM-64 and CM-12 x CM-64) expressed moderately significant and negative sca effects. Whereas two F_3 crosses (CM-14 x TPT-local and CM-12 x TPT-local) displayed non-significant and negative sca effects. Among remaining four F_3 crosses two crosses (CM-45 x TPT-local and CM-45 x CM-64) showed moderately significant and positive sca effects, on contrary two crosses (CM-14 x CM-12 and TPT-local x CM-64) expressed non-significant and positive sca effects for number of fruits per vine.

4.3.3.9 Fruit weight

The magnitude of sca effects for fruit weight ranged from -0.20 (CM-12 x TPT-local) to 0.49 (CM-45 x CM-64). Only two crosses among ten F_3 crosses (CM-12 x TPT-local and TPT-local x CM-64) showed highly significant and negative sca effects. While remaining eight F_3 crosses (CM-45 x CM-14, CM-45 x CM-12, CM-45 x TPT-local, CM-14 x CM-64, CM-14 x CM-12, CM-14 x TPT-local, CM-45 x CM-64 and CM-12 x CM-64) displayed highly significant sca effects in positive direction for fruit weight.

4.3.3.10 Fruit length

The sca effects for fruit length varied from -1.45 (CM-45 x CM-12) to 1.95 (CM-12 x TPT-local). Highly significant and positive sca effects were recorded in six F_3 crosses *viz.,* CM-45 x CM-14, CM-45 x TPT-local, CM-14 x CM-12, CM-12 x TPT-local, CM-12 x CM-64 and TPT-local x CM-64. On contrary remaining four crosses *viz.,* CM-45 x CM-12, CM-45 x CM-64, CM-14 x TPT-local and CM-14 x CM-64 showed highly significant and negative sca effects for fruit length (Table 6).

4.3.3.11 Fruit girth

The sca effects for fruit girth ranged from -1.36 (CM-12 x CM-64) to 2.71 (CM-45 x CM-12). The F_3 crosses CM-45 x CM-14, CM-45 x CM-12, CM-45 x TPT-local, CM-45 x CM-64, CM-14 x CM-12, CM-14 x TPT-local, CM-14 x CM-64, TPT-local x CM-64 exhibited highly significant and positive sca effects. Whereas only two F_3 crosses (CM-12 x TPT-local and CM-12 x CM-64) had shown highly significant and negative sca effects for fruit girth.

4.3.3.12 Fruit flesh thickness

The sca effects for this trait ranged from -0.27 (CM-12 x CM-64) to 0.57 (CM-45 x TPT-local). Out of ten F_3 crosses, five crosses (CM-45 x CM-14, CM-45 x CM-12, CM-45 x TPT-local, CM-45 x CM-64 and CM-14 x CM-64) displayed highly significant and positive sca effects. Whereas the F_3 crosses CM-14 x CM-12, CM-14 x TPT-local, CM-12 x TPT-local, CM-12 x CM-64 and TPT-local x CM-64 expressed highly significant and negative sca effects for fruit flesh thickness.

4.3.3.13 Yield per vine

Maximum sca effect was observed in the cross CM-45 x CM-12 (2.48) and minimum sca was observed for yield per vine in the cross CM-14 x CM-12 (-0.86). Seven F_3 crosses *viz.,* CM-45 x CM-14, CM-45 x CM-12, CM-45 x TPT-local, CM-45 x CM-64, CM-14 x TPT-local, CM-12 x CM-64 and TPT-local x CM-64 showed highly significant and positive sca effects while remaining three F_3 crosses (CM-14 x CM-12, CM-14 x CM-64 and

CM-12 x TPT-local) displayed highly significant and negative sca effects for yield per vine (Table 6).

4.3.3.14 Number of seeds per fruit

The magnitude of sca effects for number of seeds per fruit ranged from -50.94 (CM-45 x TPT-local) to 223.29 (CM-45 x CM-14). Highly significant and positive sca effects were recorded in all F_3 crosses (CM-45 x CM-14, CM-45 x CM-12, CM-45 x CM-64, CM-14 x CM-12, CM-45 x TPT-local, CM-45 x CM-64, CM-12 x TPT-local, CM-12 x CM-64 and TPT-local x CM-64) except in cross CM-45 x TPT-local which recorded highly significant and negative sca effect for number of seeds per fruit.

4.3.3.15 Hundred seed weight

The sca effect for hundred seed weight expressed maximum in cross CM-45 x CM-64 (2.81) and minimum in cross CM-45 x TPT-local (-0.40). Highly significant and positive sca effects were recorded in crosses CM-45 x CM-14, CM-45 x CM-12, CM-45 x CM-64, CM-14 x TPT-local, CM-14 x CM-64, CM-12 x CM-64 and TPT-local x CM-64. Whereas highly significant and negative sca effects were expressed in crosses CM-45 x TPT-local, CM-14 x CM-12 and CM-12 x TPT-local for hundred seed weight (Table 6).

4.4 CHARACTER ASSOCIATION

Phenotypic and genotypic correlation coefficients between yield and various yield components and interrelation among the attributes were computed and presented in Table 7 and 8. In general it was observed that genotypic correlations are higher than corresponding phenotypic correlations.

4.4.1 Phenotypic Correlation

4.4.1.1 Yield per vine

Fruit yield per vine (r = 0.707**) recorded highly significant and positive association with number of branches per vine. While fruit weight recorded moderately significant positive association (r = 0.571*) with fruit yield. However, node at which first female flower appeared, number of fruits per vine, fruit length, fruit girth, fruit flesh thickness, number of seeds per fruit and hundred seed weight showed non-significant and positive association with fruit yield. Vine length, node at which first male flower appeared, days to male flower opening, days to female flower opening and sex ratio expressed non-significant and negative association with fruit yield (Table 7).

4.4.1.2 Hundred seed weight

Hundred seed weight exhibited significant positive association with fruit weight and number of seeds per fruit. While, branches per vine

(r = 0.518*) recorded moderately significant positive association with hundred seed weight. Whereas vine length, node at which first female flower appeared, number of fruits per vine, fruit length, fruit girth, fruit flesh thickness expressed non-significant positive association with hundred seed weight. While node at which first male flower appeared, days to first male flower opening and days to first female flower opening showed non-significant but negative association with hundred seed weight.

4.4.1.3 Number of seeds per fruit

Number of seeds per fruit exhibited highly significant and positive association (r = 0.704**) with fruit weight. It exhibited non-significant and positive association with branches per vine, node at which first female flower appeared, sex ratio, number of fruits per vine, fruit length, fruit girth, fruit flesh thickness but non-significant and negative association was recorded with vine length, node at which first male flower appeared, days to first male flower opening and days to first female flower opening.

4.4.1.4 Fruit flesh thickness

Fruit flesh thickness exhibited moderately significant and positive association (r = 0.527*) with fruit girth. It had non-significant and positive association with branches per vine, number of fruits per vine and fruit weight.

While non-significant but negative association with vine length, node at which first male flower appeared, node at which first female flower appeared, days to first male flower opening, days to first female flower opening, sex ratio and fruit length (Table 7).

4.4.1.5 Fruit girth

Fruit girth exhibited moderately significant positive association with branches per vine (r =0.514*). It exhibited non-significant and positive association with node at which first female flower appeared, number of fruits per vine and fruit weight. While it expressed non-significant but negative association with vine length, node at which first male flower appeared, days to first male flower opening, days to first female flower opening, sex ratio and fruit length.

4.4.1.6 Fruit length

Fruit length exhibited non-significant and positive association with vine length, branches per vine, node at which first female flower appeared, days to first male flower opening, sex ratio, number of fruits per vine and fruit weight, while it exhibited non-significant and negative association with node at which first male flower appeared and days to first female flower opening.

4.4.1.7 Fruit weight

Fruit weight exhibited highly significant and positive association (r=0.726**) with number of branches per vine, while it had showed moderately significant and positive association with number of fruits per vine (r = 0.520*). It had exhibited moderately significant and negative association with node at which first male flower appeared and days to first female flower opening. It displayed a non-significant and positive association with node at which first female flower appeared. While non-significant and negative association with vine length, days to first male flower opening and sex ratio.

4.4.1.8 Number of fruits per vine

Number of fruits per vine exhibited non-significant and positive association with branches per vine and node at which first male flower appeared, while it had exhibited non-significant and negative association with vine length, node at which first female flower appeared, days to first male flower opening, days to first female flower opening and sex ratio.

4.4.1.9 Sex ratio

Sex ratio exhibited non-significant and positive association with vine length, branches per vine and node at which first female flower appeared, while non-significant and negative association with node at which first male flower appeared, days to first male flower opening and days to first female flower opening.

4.4.1.10 Days to first female flower opening

Days to first female flower opening exhibited a non-significant and positive association with vine length, node at which first male flower appeared, and days to first female flower opening. It exhibited non-significant and negative association with branches per vine only.

4.4.1.11 Days to first male flower opening

Days to first male flower opening exhibited non-significant and positive association with vine length and node at which first male flower appeared, while a non-significant and negative association was appeared with branches per vine and node at which first female flower appeared.

4.4.1.12 Node at which first female flower appeared

Node at which first female flower appeared recorded non-significant and positive association with vine length and branches per vine, while, non-significant and negative association with node at which first male flower appeared.

4.4.1.13 Node at which first male flower appeared

Node at which first male flower exhibited a non-significant and negative association with vine length and branches per vine.

4.4.1.14 Branches per vine

Branches per vine exhibited non-significant and negative association with vine length.

4.4.2 Genotypic Correlation

4.4.2.1 Yield per vine

Yield per vine exhibited a highly significant and positive association with branches per vine (r = 0.771**) and hundred seed weight (r = 0.650**). It displayed moderately significant and positive association with fruit weight, (r = 0.593*), number of seeds per fruit (r= 0.528*), while moderately significant and negative association (r = -0.515) with node at which first male flower appeared. It had expressed a non-significant and positive association with node at which first female flower appeared, number of fruits per vine, fruit length, fruit girth and fruit thickness. While non-significant and negative association with vine length, days to first male flower opening, days to first female flower opening and sex ratio (Table 8).

4.4.2.2 Hundred seed weight

Hundred seed weight exhibited highly significant and positive association (r=0.887**) with fruit weight, number of seeds per fruit (r=0.836**) and branches per vine (r = 0.702**). It showed moderately significant and positive association with number of fruits per vine while moderately significant association with days to first female flower opening in negative direction. It displayed a non-significant and positive association with vine length, node at which first female flower appeared, days to first male flower opening, fruit length, fruit girth and fruit flesh thickness. While it expressed a non-significant and negative association with node at which first male flower appeared and sex ratio.

4.4.2.3. Number of seeds per fruit

It exhibited highly significant and positive association (r = 0.753**) with fruit weight. It had displayed a non-significant and positive association with branches per vine, node at which first female flower appeared, number of fruits per vine, fruit length, fruit girth and fruit flesh thickness. On contrary it had exhibited a non-significant and negative association with vine length, node at which first male flower appeared, days to male flower opening, days to female flower opening and sex ratio.

4.4.2.4 Fruit flesh thickness

Fruit flesh thickness exhibited a highly significant and negative association (r = 0.813**) with sex ratio. It displayed moderately significant and positive association with branches per vine (r = 0.531*) and fruit girth (r = 0.560*), while moderately significant and negative association with days to first female flower opening. It expressed non-significant and positive association with number of fruits per vine and fruit weight. On contrary non-significant and negative association with vine length, node at which first male flower appeared, node at which first female flower appeared, days to first male flower opening, days to first female flower opening and sex ratio (Table 8).

4.4.2.5 Fruit girth

Fruit girth showed moderately significant and positive association with branches per vine. It displayed non-significant and positive association with node at which first male flower appeared, number of fruits per vine and fruit weight, while, non-significant and negative association with vine length, node at which first male flower appeared, days to first male flower opening, days to first female flower opening, sex ratio and fruit length.

4.4.2.6 Fruit length

Fruit length had exhibited moderately significant and positive association with sex ratio (r = 0.544*). It exhibited non-significant and positive association with vine length, branches per vine, node at which first female flower appeared, days to first male flower opening, fruits per vine and fruit weight, on contrary it had showed non-significant and negative association with node at which first male flower appeared and days to first female flower opening.

4.4.2.7 Fruit weight

Fruit weight expressed highly significant and positive association with number of branches per vine (r = 0.793**) while highly significant and negative association with days to first female flower opening (r = -0.626**). It displayed moderately significant and positive association with number of fruits per vine (r=0.610*), while moderately significant and negative association with node at which first male flower appeared (r= -0.555*). It showed non-significant and positive association with node at which first male flower appeared, on contrary it expressed non-significant and negative association with vine length, days to first male flower opening and sex ratio.

4.4.2.8 Number of fruits per vine

Number of fruits per vine displayed moderately significant and positive association with number of branches per vine. While it had showed a non-significant and negative association with vine length, node at which first male flower appeared, node at which first female flower appeared, days to first male flower opening, days to first female flower opening and sex ratio.

4.4.2.9 Sex ratio

Sex ratio expressed highly significant and positive association with vine length (r = 1.072**). While highly significant and negative correlation with node at which first male flower appeared (r = -0.728**). It showed a non-significant and positive association with node at which first female flower appeared and days to first female flower opening while it displayed non-significant and negative association with number of branches per vine and days to first male flower opening.

4.4.2.10 Days to first female flower opening

This trait exhibited moderately significant and negative association with number of branches per vine (r = -0.613*). While it expressed non-significant and positive association with vine length, node at which first male flower appeared, node at which first female flower appeared and days to first male flower opening.

4.4.2.11 Days to first male flower opening

This trait had expressed moderately significant and positive association with vine length (r = 0.517*). It displayed non-significant and positive association with node at which first male flower appeared, while, non-significant and negative association with node at which first female flower appeared.

4.4.2.12 Node at which first female flower appeared

Node at which first female flower appeared had exhibited non-significant and positive association with number of branches per vine, while non-significant and negative association with vine length and node at which first male flower appeared.

4.4.2.13 Node at which first male flower appeared

This trait displayed non-significant and negative association with vine length and number of branches per vine.

4.4.2.14 Number of branches per vine

Number of branches per vine exhibited non-significant and negative association with vine length.

4.5 PATH COEFFICIENT ANALYSIS

In order to understand the nature and magnitude and the extent of true contribution of the major component traits to yield per vine, their phenotypic and genotypic correlations were partitioned in to their corresponding direct and indirect effects through path coefficient analysis and the results are furnished in Table 9 & 10.

4.5.1 Phenotypic path analysis

Number of branches per vine exerted the highest positive direct effect (P =0.505) on yield per vine (r =0.771**). This trait had indirect contribution to yield through hundred seed weight (P = 0.194), fruit flesh thickness (P = 0.126), fruit length (P=0.091), node at which first male flower appeared (P = 0.087) and number of seeds per fruit (P = 0.049) (Table 9).

Hundred seed weight exerted the next highest and direct effect (P=0.375) on fruit yield. It had indirect contribution to yield through branches per vine (P = 0.261), fruit length (P =0.105) node at which first male flower appeared (P=0.091), number of seeds per fruit (P = 0.088) and fruit flesh thickness (P =0.032).

Fruit length displayed positive and direct effect (P = 0.292) on fruit yield through the indirect contribution of number of branches per vine (P = 0.157), hundred seed weight (P =0.134), number of seeds per fruit (P =0.046), node at which first male flower appeared (P = 0.025) and fruit girth (P=0.014).

Fruit flesh thickness had positive and direct effect (P = 0.268) on yield through its indirect contribution *via* branches per vine (P = 0.238), vine length (P=0.052), hundred seed weight (P=0.045) and node at which first male flower appeared (P = 0.033).

Node at which first male flower appeared showed positive and direct effect (P=0.231) on yield through its indirect contribution *via* fruit weight (P=0.196), vine length (P=0.027), number of fruits per vine (P=0.015), days to first female flower opening (P =0.015).

Node at which first female flower appeared showed positive and direct effect (P=0.147) on yield through its indirect contribution *via* number of branches per vine (P=0.114), node at which first male flower appeared (P=0.068), hundred seed weight (P=0.037), number of seeds per fruit (P=0.033) and fruit length (P=0.020).

Besides the direct effect of number of seeds per fruit (P=0.124) its indirect effects through hundred seed weight (P=0.265), number of branches per vine (P=0.199), fruit length (P=0.109), node at which first male flower appeared (P =0.076) and node at which first female flower appeared (P =0.039) resulted in moderately significant and positive correlation with yield per vine (r = 0.508*).

Besides the direct effect of days to female flower opening (P = 0.081), its indirect negative effects through number of branches per vine (P = -0.257), hundred seed weight (P= -0.176), vine length (P= -0.080), fruit flesh thickness (P = -0.056) and number of seeds per fruit (P= -0.037) nullified that effect and resulted in non-significant and negative association with yield per vine (r = -0.261).

In case of fruit girth, though the direct effect was negative (P = -0.049), but its association with yield per vine was found to be non-significant and positive (P =0.389) due to its positive indirect effects through number of branches per vine (P = 0.260), hundred seed weight (P = 0.156), fruit flesh thickness (P=0.141), fruit length (P =0.082) and vine length (P=0.052).

Vine length exerted negative direct effect (P=-0.162) and indirect effects through fruit flesh thickness (P=-0.087), number of branches per vine (P=-0.056), number of seeds per fruit (P=-0.017) and days to first male flower opening (P=-0.009) resulting in non-significant and negative effect on yield per vine (r=-0.066).

In case of number of fruits per vine though the direct effect was negative (P =-0.147), but its association with yield per vine was found to be positive and non-significant (r=0.133) due to its positive indirect effects through hundred seed weight (P=0.145), number of branches per vine (P=0.223), fruit flesh thickness (P=0.073), number of seeds per fruit (P=0.026) and node at which first male flower appeared (P=0.023).

In case of fruit weight though the direct effect was negative (P=-0.372), but its association with yield per vine was found to be positive and moderately significant (r=0.571*) due to its positive indirect effects *via* number of branches per vine (P=0.367), hundred seed weight (P=0.295), fruit length

(P=0.170), node at which first male flower appeared (P=0.122) and number of seeds per fruit (P=0.088).

4.6.2 Genotypic path analysis

Besides the direct effect of number of branches per vine (P=1.879) its indirect effects through number of seeds per fruit (P=0.563) and node at which first male flower appeared (P=0.051) resulted in highly significant and positive correlation with yield per vine (r=0.771**) (Table 10).

Number of seeds per fruit showed positive direct effect (P=1.211) on yield per vine which exhibited non-significant and positive value (r=0.528). It had showed indirect and positive contribution to yield via number of branches per vine (P=0.874) and node at which first male flower appeared (P=0.045).

Besides the direct effect of days to first female flower opening (P=0.274) its indirect negative effects through number of branches per vine (P= -1.153), number of seeds per fruit (P=-0.525), hundred seed weight (P=-0. 230) and node at which first male flower appeared (P=-0.025) nullified that effect and resulted in non-significant and negative association with yield per vine (r=-0.381).

Besides the direct effect of vine length (P=0.219) its indirect negative effects through fruit length (P=-0.193), number of seeds per fruit (P=-0.192), number of branches per vine (P=-0.167) and node at which first female flower appeared (P=-0.109) nullified that effect and resulted in non-significant and negative association with yield per vine (r=-0.069).

Besides the direct effect of days to male flower opening (P = 0.113), its indirect negative effects through number of branches per vine (P=-0.470), number of seeds per fruit (P=-0.404), node at which first male flower appeared (P=-0.054) and fruit length (P=-0.045) nullified that effect resulted in non-significant and negative association with yield per vine (r =-0.263). In case of fruit flesh thickness though the direct effect was negative (P = 0.084) but its association with yield per vine was found to be non-significant and positive (r=0.427) due to its positive indirect effects through number of branches per vine (P= 0.999), fruit length (P=0.131), number of seeds per fruit (P = 0.046), node at which first female flower appeared (P =0.026) and node at which first male flower appeared (P=0.016).

Node at which first male flower appeared exerted negative direct effect (P=-0.119) and indirect effects through fruit weight (P=-0.506), hundred seed weight (P=-0.283), fruit girth (P=-0.265), number of fruits per vine (P=-0.198) and days to first female flower opening (P=0.057) resulted in moderately significant and negative effect on yield per vine (r=-0.515*).

In case of node at which first male flower appeared the direct effect was negative (P=-0.299) but its association with yield per vine was found to be non-significant and positive (r=0.382) due to its indirect effects through number of branches per vine (P=0.459), number of seeds per fruit (P=0.458), vine length (P=0.080) and hundred seed weight (P=0.049).

In case of number of fruits per vine though the direct effect was negative (P=-0.344) its association with yield per vine was found to be non-significant and positive (r=0.199) due to its positive indirect effects through number of branches per vine (P=1.079), number of seeds per fruit (P=0.392), node at which first female flower appeared (P=0.028) and node at which first male flower appeared (P=0.008) (Table 10).

In case of hundred seed weight though the direct effect was negative (P=-0.404) but its association with yield per vine was found to be highly significant and positive (r=0.650**) due to its positive indirect effects via number of branches per vine (P=1.319), number of seeds per fruit (P=1.012) and node at which first male flower appeared (P=0.059).

In case of fruit length though the direct effect was negative (P=-0.445) but its association with yield per vine was found to be non-significant and positive (r=0.390) due to its positive indirect effects via number of branches per vine (P=0.577), number of seeds per fruit (P=0.502), fruit girth (P=0.135) and vine length (P=0.095).

In case of fruit girth though the direct effect was negative (P=-0.451) but its association with yield per vine was found to be non-significant and positive (r=0.418) due to its positive indirect effects through number of branches per vine (P=1.102), number of seeds per fruit (P=0.483), fruit length (P=0.133) and node at which first male flower appeared (P=0.013).

In case of fruit weight though the direct effect was negative (P=0.638) but its association with yield per vine was found to be moderately significant and positive (r=0.593*) due to its positive indirect effects through number of branches per vine (P=1.490), number of seeds per fruit (P=0.911) and node at which first male flower appeared (P=0.066).

4.6 SEGREGATION PATTERN

Segregation pattern for F_3 population for sex ratio, number of branches per vine, number of fruits per vine, fruit weight, fruit length and yield per vine were depicted graphically. Appropriate class intervals were chosen to group F_3 population for each of the six attributes and percentage of plants falling in each class interval was indicated (Tables 11,12, 13,14, 15 and 16).

4.6.1 Sex ratio

Only one F_3 cross (CM-12 x TPT-local) out of 10 F_3 crosses exceeded the general mean (0.137) of all hybrid populations for this trait. The parental means of these crosses were 0.1171 and 0.1041 respectively. The F_3 mean occupied a class interval of 0.121-0.15. The mean of parents occupied a class interval of 0.121-0.15. The selected F_3 mean of the population in CM-12 x TPT-local was exceeded by 8.08 per cent (Table 11).

In the cross combination CM-12 x CM-64, the F_3 mean was 0.1280 and the parental means were 0.1174 and 0.3352 respectively. The F_3 mean was in the class interval of 0.121-0.15. The parental means also occupied the class interval of 0.121-0.15. The selected F_3 mean was exceeded by 9.62 per cent of the population in CM-12 x CM-64 as illustrated in Fig. 3.

4.6.2. Number of branches per vine

As many as six out of 10 F_3 crosses surpassed the overall mean (9.504). The highest number of branches per vine was observed for CM-12 x CM-64

(11.24) which lies with in the class interval of 9.1-12. The parents recorded the mean values of 11.47 and 8.9 branches, respectively. The mean of the parents occupied with in the class interval of 9.1-12. About 28.1 per cent of the CM-45 x CM-64 progenies recorded higher values than F_3 mean.

In the cross combination CM-45 x CM-12, the F_3 population recorded a mean value of 10.73 for number of branches per vine which lies in the class interval of 9.1-12. About 15.1 per cent of CM-45 x CM-12 population recorded higher values than the mean value Fig. 4.

In the cross combination CM-14 x CM-12, the F_3 population recorded a mean value of 10.5 branches, which lies in the class interval of 9.1-12. About 17.83 per cent of CM-14 x CM-12 population recorded higher values than the mean value (Table 12).

4.6.3 Number of fruits per vine

Among 10 F_3 crosses, two F_3s exceeded the overall general mean value (1.778 kg). The cross CM-14 x CM-12 recorded the highest mean yield of 2.4 kg with parental means of 1.97 and 2.33 kg respectively. The means of both parents occupied the class interval of 1.1-2 kg. The mean of

F_3 populations occupied the class interval 2.1-3 kg and 29.08 per cent of CM-14 x CM-12 population exceeds the mean value (Table 13).

In the cross combination TPT-local x CM-64, the F_3 mean was recorded as 1.80 kg, while the parental mean yields were found to be 1.73 and 1.70 kg, respectively. The mean of F_3 and parents lie in the class interval of 1.1-2 kg. The selected F_3 mean was exceeded by 61.23 per cent of TPT-local x CM-64 population Fig. 5.

4.6.4 Fruit weight

Five out of ten F_3 crosses exceeded the general mean (3.41 kg) of all hybrid populations. The highest mean fruit weight was recorded by CM-14 x CM-12 (4.03 kg) and parental means were 3.61 and 3.58 kg respectively. Parental means occupied a class interval of 3.1-4 kg while the F_3 mean occupied a class interval of 4.1-5 kg. The selected F_3 mean was exceeded by 6.5 per cent of CM-14 x CM-12 population (Table 14).

In the cross CM-12 x CM-64, the F_3 population exhibited a mean of 3.89 kg, while, the parental means were 3.18 and 3.23 kg respectively. Both the parental means and F_3 mean occupied the class interval of 3.1-4 kg. The selected F_3 mean was exceeded by 20.00 per cent of CM-12 x CM-64 population.

The cross combination CM-45 x CM-64 recorded the mean yield of 3.79 kg which occupied the class interval of 3.1-4 kg. The parental means occupied the class interval of 3.1-4 kg. The selected F_3 mean was exceeded by 2.46 per cent of CM-45 x CM-64 population.

In cross combination CM-14 x CM-64 recorded the mean performance of 3.76 kg which occupied the class interval of 3.1-4 kg. The parental means were 3.16 and 3.23 kg respectively which occupied the class interval of 3.1-4 kg. The selected F_3 mean was exceeded by 18.12 per cent of population. exceeded by 18.12 per cent of the population Fig. 6.

4.6.5 Fruit Length

Seven out of ten F_3 crosses exceeded the overall mean value (23.501 cm) of all hybrid populations. The highest mean fruit length was recorded by CM-12 x CM-64 (28.44 cm) and parental means were 23.23 and 26.73 cm respectively. Both the parental means and F_3 means occupied the same class interval of 22.6-30 cm. The selected F_3 mean was exceeded by 20.43 per cent of CM-12 x CM-64 population (Table 15).

In the cross TPT-local x CM-64, the F_3 population recorded a mean value of 26.59 cm. The parental means were 20.15 and 26.73 cm respectively. Both the parental means and F_3 means occupied the class interval of 22.6-30.1 cm. The selected F_3 mean was exceeded by 19.92 per cent of TPT-local x CM-64 population.

In the cross combination CM-14 x CM-64, the F_3 population recorded a mean value of 26.00 cm, which lies in the class interval of 22.5-30 cm. The parental means were 24.56 and 26.73 cm respectively and lie in the class interval of 22.6-30 cm. The selected F_3 mean was exceeded by 16.55 per cent of CM-14 x CM-64 population Fig. 7

4.6.6 Yield per vine

Among 10 F_3 crosses, five F_3 crosses exceeded the overall general mean value (8.96 kg). The cross CM-45 x CM-12 recorded the highest mean yield per vine of 12.62 kg with parental means of 5.60 and 10.66 kg respectively. The means of parents lie in the class interval of 6.1-9 kg and 9.1-12 kg respectively, while mean of F_3 occupied a class interval of 12.1-15 kg. The selected F_3 mean was exceeded by 5.1 per cent of CM-45 x CM-12 population (Table 16).

In the cross CM-12 x CM-64, the mean of F_3 population was 11.26 kg while the parental means were 10.66 and 9.4 kg respectively. Both the parental and F_3 mean occupied the same class interval of 9.1-12 kg. The selected F_3 mean was exceeded by 3.04 per cent of CM-12 x CM-64 population.

In the cross CM-45 x CM-64, the F_3 mean was 10.96 kg while, the parental means were 5.60 and 9.40 kg respectively occupied the class intervals 3.1-6 and 6.1-9 kg respectively. The mean of F_3 population occupied the class interval of 9.1-12 kg. The selected F_3 mean was exceeded by 8.03 per cent of CM-45 x CM-64 population.

In the cross combination CM-45 x CM-14 recorded the mean yield per vine of 9.97 kg which occupied the class interval of 9.1-12 kg. The parental means were 5.60 and 6.67 kg respectively and occupied 3.1-6 and 6.1-9 kg respectively. The selected F_3 mean was exceeded by 7.0 per cent of the CM-45 x CM-14 population Fig. 8.

4.7 TRANSGRESSIVE SEGREGANTS

The transgressive segregants for yield and its components in the F_3 generation for ten crosses were presented in Table 17.

The total transgressive segregants for number of fruits per vine ranged from 38.16 to 49.32 per cent while significantly transgressive segregants ranged from 39.34 to 50.37 per cent. The cross CM-14 x CM-12 showed more percentage of total transgressive segregants and significantly transgressive segregants.

The total transgressive segregants for fruit weight ranged from 38.13 to 50.33 while the significantly transgressive segregants ranged from 36.39 to 49.92. The cross CM-45 x CM-12 showed more percentage of total transgressive segregants and significantly transgressive segregants.

The total transgressive segregants for yield per vine ranged from 39.38 to 49.67 and the significantly transgressive segregants ranged from 33.14 to 48.13. The cross CM-14 x CM-12 depicted more percentage of total transgressive segregants and significantly transgressive segregants.

Table 2 : Mean performance of 5 parents and 10 F_3 crosses for 15 characters in Pumpkin

Entries	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Vine length (m)	Branches per vine	Node at which first Male flower appeared	Node at which first Female flower appeared	Days to male flower appearance	Days to female flower appearance	Sex Ratio	Fruits per vine	Fruit weight (kg)	Fruit length (cm)	Fruit girth (cm)	Fruit flesh thickness (cm)	Yield per Vine (kg)	Number of Seeds per fruit	Hundred seed weight (g)
Parents															
CM-45	8.01	7.43	6.30	17.77	58.03	65.17	0.14	1.40	2.54	23.43	20.69	3.09	5.60	296.1	16.37
CM-14	9.74	8.23	6.17	17.87	59.77	63.13	0.12	1.97	3.16	24.56	22.70	3.41	6.67	465.37	21.0
CM-12	5.76	11.47	5.63	17.40	54.83	61.47	0.12	2.33	3.58	23.23	25.75	3.92	10.66	555.00	21.47
TPT-local	7.11	7.60	5.13	18.67	54.30	62.83	0.10	1.73	3.18	20.15	22.54	3.40	6.59	535.30	18.77
CM -64	7.49	8.90	5.57	18.17	54.87	63.83	0.11	1.70	3.26	26.73	22.37	3.55	9.40	497.93	18.97
Hybrids															
CM-45 x CM-14	7.72	8.73	5.67	18.77	56.53	64.57	0.12	1.67	3.30	25.36	24.98	3.55	9.97	740.17	21.30
CM-45 x CM-12	7.58	10.73	5.13	19.23	56.87	63.63	0.12	1.67	3.40	22.50	27.72	3.78	12.62	537.20	21.17
CM-45 x TPT-2	8.78	10.07	5.60	18.80	56.50	63.57	0.12	1.70	3.23	22.57	25.77	4.07	8.34	424.27	18.43
CM-45 x CM-64	8.81	9.80	4.57	18.00	56.80	63.03	0.11	1.67	3.79	25.78	22.80	3.50	10.96	569.33	22.57
CM -14 x CM-12	7.89	10.50	5.53	18.80	56.50	63.50	0.12	2.40	4.03	24.83	27.00	3.40	8.53	643.33	21.90
CM-14 x TPT-local	6.58	9.27	5.63	18.43	55.90	62.87	0.12	1.53	3.38	22.30	26.89	3.45	7.26	591.80	21.10
CM-14 x CM -64	7.31	10.27	5.20	17.40	56.83	62.87	0.12	1.77	3.76	26.00	23.50	3.67	8.73	617.33	21.53
CM-12 xTPT-local	6.93	8.70	6.20	17.80	56.50	62.50	0.14	1.57	3.28	25.03	24.62	3.47	9.01	583.77	20.33
CM-12 x CM- 64	8.88	11.23	5.40	19.57	55.87	61.33	0.13	1.77	3.89	28.51	22.97	3.30	11.27	686.97	21.8
TPT-local xCM-64	9.83	9.63	4.90	18.73	55.73	63.47	0.39	1.80	3.35	26.59	23.85	3.24	8.91	561.23	20.70
Mean of Parents	7.62	8.73	5.76	17.98	56.36	63.28	0.12	1.83	3.23	23.62	22.81	3.47	7.78	469.94	19.32
Mean of F_3s	8.03	9.89	5.38	18.55	56.40	63.13	0.15	1.76	3.54	24.95	24.81	3.54	9.56	595.34	21.08
SEd	0.19	0.38	0.12	0.31	0.36	0.46	0.11	0.12	0.05	0.53	0.40	0.06	0.29	23.40	0.73
Cd at P = 0.05	0.39	0.78	0.24	0.63	0.74	0.94	0.23	0.25	0.10	1.08	0.82	0.12	0.59	47. 92	1.48
CD at P =0.01	0.52	1.05	0.33	0.85	0.99	1.27	0.30	0.33	0.14	1.46	1.11	0.17	0.80	64.65	2.02

Table 3 : **Mean, Variance, Coefficients of variation, heritability (broadsense) and Genetic advance and Genetic advance as per cent of mean for 15 characters in F_3 generation of 5 x 5 partial diallel of pumpkin.**

S. No.	Character	General Mean	Variance		Coefficient of variation		Habitability Broad sense (%)	Genetic advance	Genetic advance as per cent of mean (%)
			Genotypic (r_g)	Phenotypic (r_p)	Genotypic (%)	Phenotypic (%)			
1.	Vine length (m)	7.895	1.283	1.338	14.35	14.65	95.90	2.29	29.005
2.	Branches per vine	9.504	1.466	1.683	12.74	13.65	87.10	2.33	24.515
3.	Node at which first male flower appeared	5.509	0.225	0.247	8.61	9.02	91.00	0.93	16.881
4.	Node at which first female flower appeared	18.360	0.374	0.523	3.33	3.94	71.60	1.07	5.827
5.	Days to first male flower opening	56.389	1.711	1.909	2.32	2.45	89.50	2.55	4.522
6.	Days to first female flower opening	63.184	0.886	1.209	1.49	1.74	73.50	1.67	2.643
7.	Sex ratio	0.138	0.001	0.0185	23.00	98.82	5.40	0.02	14.492
8.	Fruits per vine	1.778	0.662	0.089	14.47	16.78	74.30	0.46	25.872
9.	Fruit weight (kg)	3.4093	0.132	0.135	10.64	10.79	97.20	0.74	21.705
10.	Fruit length (cm)	24.5051	4.483	4.897	8.64	9.03	91.40	4.17	17.016
11.	Fruit girth (cm)	24.276	4.050	4.288	8.29	8.53	94.40	4.03	16.601
12.	Fruit Flesh thickness (cm)	3.519	0.063	0.069	7.15	7.46	91.80	0.50	14.209
13.	Yield per vine (kg)	8.967	3.710	3.839	21.48	21.85	96.60	3.90	43.493
14.	Number of seeds per fruit	553.673	11289.030	12115.447	19.19	19.88	93.20	211.38	38.169
15.	Hundred seed weight (g)	20.493	2.471	3.290	7.67	8.85	75.00	2.80	13.663

Table 4 : Analysis of variance for combining ability in a 5 x 5 partial diallel of pumpkin

S. No.	Character	Mean sum of squares					
		gca df = 4	sca df = 10	Error df = 28	σ^2_{gi}	σ^2_{Sij}	$\sigma^2_{gi} / \sigma^2_{Sij}$
1.	Vine length (m)	1.16950**	1.35420**	0.01811	0.00206	0.01379	0.14930
2.	Branches per vine	2.90917**	0.99008**	0.07217	0.00825	0.05499	0.15002
3.	Node at which first male flower appeared	0.20925**	0.24151**	0.00737	0.00084	0.00561	0.14954
4.	Node at which first female flower appeared	0.07100	0.56450**	0.04943	0.00564	0.03766	0.15000
5.	Days to first male flower opening	4.07780**	0.85009**	0.06606	0.00755	0.05032	0.15004
6.	Days to first female flower opening	2.35690**	0.45562*	0.10699	0.01228	0.08152	0.15063
7.	Sex ratio	0.00251	0.00588	0.00581	0.00066	0.00443	0.15011
8.	Fruits per vine	0.14889**	0.04373**	0.00761	0.00087	0.00580	0.14989
9.	Fruit weight (kg)	0.21500**	0.10009**	0.00125	0.00014	0.00095	0.14736
10.	Fruit length (cm)	10.64890**	2.20640**	0.14002	0.01600	0.10668	0.15000
11.	Fruit girth (cm)	5.04650**	3.76590**	0.07952	0.00908	0.06058	0.15001
12.	Fruit Flesh thickness (cm)	0.02169**	0.08254**	0.00189	0.00216	0.00144	0.15000
13.	Yield per vine (kg)	6.80800**	2.53175**	0.04317	0.00493	0.03289	0.14998
14.	Number of seeds per fruit	11725.58500**	11500.40300**	274.00760	31.31516	208.76770	0.15000
15.	Hundred seed weight (g)	4.36770**	2.09240**	0.27371	0.03128	0.20854	0.14999

* Significant at P = 0.05%

** Significant at P = 0.01%

Table 5 : General combining ability effects of 5 parents for 15 characters in pumpkin

Entries	1 Vine length (m)	2 Branches per vine	3 Node at which first Male flower appeared	4 Node at which first Female flower appeared	5 Days to male flower appearance	6 Days to female flower appearance	7 Sex Ratio	8 Fruits per vine	9 Fruit weight (kg)	10 Fruit length (cm)	11 Fruit girth (cm)	12 Fruit flesh thickness (cm)	13 Yield per Vine (kg)	14 Number of Seeds per fruit	15 Hundred seed weight (g)
Parents															
CM-45	0.22**	-0.40**	0.07	0.02**	0.63**	0.86**	-0.01**	-0.17**	-0.24**	-0.57**	-0.43**	-0.01	-0.10	-65.55**	-0.97**
CM-14	0.33	-0.26**	0.19	-0.15*	1.00**	0.14**	-0.02*	0.09**	0.05**	0.08**	0.30**	-0.03	-0.85	28.76**	0.70**
CM-12	-0.65**	1.01**	0.07	0.01**	-0.42**	-0.74**	-0.01*	0.20**	0.19**	0.04**	1.17**	0.10	1.28	34.18**	0.74**
TPT-local	-0.15**	-0.59**	-0.06	0.13*	-0.73**	-0.15**	0.02*	-0.09**	-0.12**	-1.46**	0.08**	-0.01	-1.02	-12.91**	-0.69**
CM-64	0.35**	0.24**	-0.26	-0.02**	-0.48**	-0.11**	0.02*	-0.04**	0.12**	1.90**	-1.12**	-0.04	0.69	15.53**	0.22**
S.E (gi)	0.045	0.091	0.290	0.075	0.087	0.111	0.026	0.030	0.120	0.127	0.095	0.015	0.702	5.596	0.177
C.D at P =0.05	0.092	0.186	0.593	0.154	0.178	0.227	0.053	0.061	0.246	0.260	0.195	0.307	1.438	11.461	0.362
C.D at P =0.01	0.124	0.251	0.801	0.207	0.240	0.307	0.718	0.082	0.331	0.351	0.262	0.414	1.940	15.462	0.489

* Significant at P = 0.05%

** Significant at P = 0.01%

Table 6 : Specific combining ability effects of 10 F_3 hybrid progenies in pumpkin.

Characters F_3's	1 Vine length (m)	2 Branches per vine	3 Node at which first Male flower app-eared	4 Node at which first Female flower ap-peared	5 Days to male flower appea-rance	6 Days to female flower appea-rance	7 Sex Ratio	8 Fruits per vine	9 Fruit weight (kg)	10 Fruit length (cm)	11 Fruit girth (cm)	12 Fruit flesh thick-ness (cm)	13 Yield per Vine (kg)	14 Number of Seeds per fruit	15 Hun-dred seed weight (g)
1.CM-45 x CM-14	-0.63**	-0.11**	-0.10**	0.53**	-1.48**	0.38**	0.01	-0.03*	0.08**	1.34**	0.83**	0.07**	1.96**	223.29**	1.08**
2. CM-45 x CM-12	0.12**	0.62**	-0.52**	0.84**	0.26**	0.33**	0.00	-0.14*	0.04**	-1.48**	2.71**	0.17**	2.48**	14.90**	0.90**
3. CM-45 x TPT-local	0.81**	1.56**	0.08**	0.28**	0.21**	-0.33**	-0.03	0.18*	0.18**	0.09**	1.84**	0.57**	0.49**	-50.94**	-0.40**
4. CM-45 x CM-64	0.35**	0.46**	-0.75**	-0.37**	0.26**	-0.91**	-0.03	0.09*	0.49**	-0.06**	0.07**	0.03*	1.40**	65.69**	2.81**
5. CM-14 x CM-12	0.41**	0.24**	-0.23**	0.58**	-0.47**	0.92**	0.01	0.33	0.38**	0.20**	1.26**	-0.18**	-0.86**	26.72**	-0.03**
6. CM-14 x TPT-local	-1.40**	0.61**	0.00**	0.09**	-0.76**	-0.31**	-0.02	-0.25	0.05**	-0.82**	2.24**	-0.02**	0.16**	22.20**	0.60**
7. CM-14 x CM-64	-1.16**	0.77**	-0.23**	-0.80**	-0.07**	-0.35**	-0.02	-0.06*	0.18**	-0.49**	0.04**	0.23**	-0.07**	19.37**	0.12**
8. CM-12 x TPT-local	-0.17**	-1.22**	0.69**	-0.70**	1.26**	0.21**	-0.01	-0.33	-0.20**	1.95**	-0.90**	-0.14**	-0.22**	8.83**	-0.20**
9. CM-12 x CM-64	1.29**	0.47**	0.09**	1.22**	0.38**	-1.00**	-0.02	-0.17*	0.17**	2.06**	-1.36**	-0.27**	0.33**	83.59**	0.34**
10. TPT-local x CM-64	1.73**	0.48**	-0.28**	0.26**	0.55**	0.54**	0.21	0.15*	-0.06**	1.65**	0.61**	-0.22**	0.26**	4.94**	0.68**
S.E (Sij)	0.117	0.233	0.743	0.193	0.223	0.283	0.661	0.756	0.306	0.324	0.244	0.376	0.180	14.340	0.453
C.D at P = 0.05	0.240	0.477	1.522	0.395	0.457	0.580	1.354	1.548	0.627	0.664	0.500	0.770	0.369	29.368	0.928
C.D at P = 0.01	0.323	0.644	2.053	0.533	0.616	0.781	1.826	2.089	0.845	0.895	0.674	1.039	0.497	39.621	1.252

* Significant at P = 0.05%

** Significant at P = 0.01%

Table 8 : Genotypic correlation coefficients among 15 characters in a 5 x 5 partial diallel of pumpkin

S. No.	Characters	Branches per vine	Node at which first Male flower appeared	Node at which first Female flower appeared	Days to male flower appearance	Days to female flower appearance	Sex Ratio	Fruits per vine	Fruit weight (kg)	Fruit length (cm)	Fruit girth (cm)	Fruit flesh thickness (cm)	Number of Seeds per fruit	Hundred seed weight (g)	Yield per Vine (kg)
1.	Vine length (m)	-0.089	-0.172	-0.366	0.517*	0.244	1.072**	-0.086	-0.028	0.434	-0.348	-0.342	-0.158	0.017	-0.069
2.	Branches per vine		-0.427	0.244	-0.250	-0.613*	-0.026	0.574*	0.793**	0.307	0.587*	0.531*	0.465	0.702**	0.771**
3.	Node at which first male flower appeared			-0.319	0.452	0.207	-0.728**	-0.066	-0.555*	-0.129	-0.107	-0.134	-0.374	-0.495	-0.515*
4.	Node at which first female flower appeared				-0.234	0.021	0.247	-0.092	0.221	0.058	0.346	-0.088	0.378	0.122	0.382
5.	Days to first male flower opening					0.409	-0.153	-0.145	-0.257	0.102	-0.165	-0.220	-0.334	0.011	-0.263
6.	Days to first female flower opening						0.420	-0.458	-0.626**	-0.156	-0.173	-0.234	-0.434	-0.570	-0.381
7.	Sex ratio							-0.073	-0.212	0.544*	-0.288	-0.813**	-0.039	-0.288	-0.030
8.	Fruits per vine								0.610*	0.065	0.350	0.241	0.324	0.513*	0.199
9.	Fruit weight (kg)									0.432	0.412	0.220	0.753**	0.887**	0.593*
10.	Fruit length (cm)										-0.298	-0.295	0.415	0.414	0.390
11.	Fruit girth (cm)											0.560*	0.399	0.460	0.418
12.	Fruit Flesh thickness (cm)												0.038	0.167	0.427
13.	Number of seeds per fruit													0.836**	0.528*
14.	Hundred seed weight (g)														0.650**

* Significant at P = 0.05%
** Significant at P = 0.01%

Table 7 : Phenotypic correlation coefficients among 15 characters in a 5 x 5 partial diallel of pumpkin

S. No.	Characters	Branches per vine	Node at which first Male flower appeared	Node at which first Female flower appeared	Days to male flower appearance	Days to female flower appearance	Sex Ratio	Fruits per vine	Fruit weight (kg)	Fruit length (cm)	Fruit girth (cm)	Fruit flesh thickness (cm)	Number of Seeds per fruit	Hundred seed weight (g)	Yield per Vine (kg)
1.	Vine length (m)	-0.111	-0.167	0.300	0.491	0.197	0.230	-0.085	-0.031	0.410	-0.324	-0.324	-0.136	0.021	-0.066
2.	Branches per vine		-0.377	0.226	-0.241	-0.509	0.024	0.441	0.726**	0.312	0.514*	0.471	0.394	0.518*	0.707**
3.	Node at which first male flower appeared			-0.292	0.379	0.186	-0.069	0.100	-0.528*	-0.109	-0.122	-0.143	-0.330	-0.396	-0.472
4.	Node at which first female flower appeared				-0.155	0.000	0.094	-0.021	0.221	0.069	0.292	-0.068	0.263	0.099	0.261
5.	Days to first male flower opening					0.275	-0.056	-0.083	-0.242	0.093	-0.146	-0.161	-0.294	-0.026	-0.261
6.	Days to first female flower opening						-0.032	-0.315	-0.537*	-0.137	-0.138	-0.210	-0.357	-0.469	-0.320
7.	Sex ratio							-0.001	-0.039	0.212	-0.003	-0.171	0.000	0.106	-0.030
8.	Fruits per vine								0.520*	0.050	0.350	0.271	0.211	0.386	0.133
9.	Fruit weight (kg)									0.400	0.395	0.195	0.704**	0.786**	0.571*
10.	Fruit length (cm)										-0.281	-0.280	0.373	0.358	0.368
11.	Fruit girth (cm)											0.527*	0.369	0.416	0.389
12.	Fruit Flesh thickness (cm)												0.030	0.121	0.397
13.	Number of seeds per fruit													0.707**	0.508
14.	Hundred seed weight (g)														0.558

* Significant at P = 0.05%
** Significant at P = 0.01%

Table 17 : Percentage of total transgressive segregants (TTS) and significantly transgressive segregants (STS) in the F_3 generations.

S. No.	Crosses	Fruits per vine		Fruit weight		Yield per vine	
		TTS	STS	TTS	STS	TTS	STS
1	CM-45 x CM-14	40.12	42.34	43.45	40.71	39.23	43.84
2.	CM-45 x CM-12	39.16	44.13	48.11	37.22	50.33	49.92
3.	CM-45 x TPT-local	43.13	41.14	40.24	36.24	41.29	36.39
4.	CM-45 x CM-64	40.22	41.14	45.21	33.14	47.84	43.82
5.	CM-14 x CM-12	49.32	50.37	49.67	48.13	46.33	39.92
6.	CM-14 x TPT-local	42.66	42.34	42.16	41.14	42.83	45.44
7.	CM-14 x CM-64	38.16	43.29	39.38	43.38	43.10	39.23
8.	CM-12 x TPT-local	40.09	45.67	44.32	39.38	38.13	44.12
9.	CM-12 x CM-64	42.38	44.13	43.33	41.69	46.34	41.33
10.	TPT-local x CM-64	39.82	45.14	46.94	39.23	43.98	46.38

Table 1 : **Analysis of variance for certain characters in 5 x 5 partial diallel of pumpkin**

S. No.	Characters	Mean sum of squares		
		Replications (df =2)	Treatments (df = 14)	Error (df = 28)
1	Vine length (m)	0.5599	3.9042**	0.0543
2.	Branches per vine	0.2813	4.6152**	0.2165
3.	Node at which first male flower appeared	0.1501	0.6968**	0.0221
4.	Node at which first female flower appeared	0.4940	1.2705**	0.1483
5.	Days to first male flower opening	1.4760	5.3155**	0.1994
6.	Days to first female flower opening	0.3906	2.9974**	0.3210
7.	Sex ratio	0.0179	0.0148	0.0175
8.	Fruits per vine	0.1233	0.2213**	0.0229
9.	Fruit weight (kg)	0.0127	0.3988**	0.00376
10.	Fruit length (cm)	7.6787	13.8552**	0.4196
11.	Fruit girth (cm)	2.9746	12.3955**	0.2381
12.	Fruit Flesh thickness (cm)	0.02691	0.1954**	0.0057
13.	Yield per vine (kg)	0.6809	11.2605**	0.1295
14.	Number of seeds per fruit	323.00	34,694.025**	822.09
15.	Hundred seed weight (g)	10.7646	8.2277**	0.8211

** Significant at P = 0.01

Table 12: Segregation pattern in F_3 generation for number of branches per vine

S. No.	Crosses	Per cent of population in different class intervals						Mean		
		0-3	3.1-6	6.1-9	9.1-12	12.1-15	15.1-18	P_1	P_2	F_3
1.	CM-45 x CM-14	2.1	3.1	55.50	32.0	7.27	1.6	7.43	8.23	8.77
2.	CM-45 x CM-12	0	2.5	29.3	52.1	15.1	0	7.43	11.47	10.73
3.	CM-45 x TPT-Local	0	2.03	33.6	51.30	13.07	0	7.43	7.6	10.06
4.	CM-45 x CM-64	0	2.2	45.6	47.33	5.05	0	7.43	8.9	9.8
5.	CM-14 x CM-12	0	3.3	28.53	50.34	15.43	2.4	8.23	11.47	10.5
6.	CM-14 x TPT-Local	2.5	2.3	48.57	41.35	5.1	0	8.23	7.6	9.27
7.	CM-14 x CM-64	2.04	3.12	45.39	30.34	15.6	2.61	8.23	8.9	10.27
8.	CM-12 x TPT-Local	1.72	5.92	52.23	26.57	13.6	0	11.47	7.6	8.7
9.	CM-12 x CM-64	0	2.05	25.52	44.23	26.1	2.1	11.47	8.9	11.24
10.	TPT-Local x CM-64	0	2.04	58.29	35.01	4.3	0	7.6	8.9	9.63

Table 11: Segregation pattern in F_3 generation for sex ratio

S. No.	Crosses	Per cent of population in different class intervals						Mean		
		0-0.03	0.031-0.06	0.061-0.09	0.091-0.12	0.121-0.15	0.151-0.18	P_1	P_2	F_3
1.	CM-45 x CM-14	0	1.6	3.46	45.92	41.92	7.2	0.1417	0.117	0.1192
2.	CM-45 x CM-12	1.6	2.4	4.32	42.64	41.69	7.35	0.1417	0.1171	0.1160
3.	CM-45 x TPT-Local	0	0	4.84	47.22	40.99	6.95	0.1417	0.1041	0.1174
4.	CM-45 x CM-64	0	1.82	5.10	45.34	39.45	8.29	0.1417	0.351	0.1120
5.	CM-14 x CM-12	0	2.13	4.99	48.12	38.66	6.10	0.1172	0.1171	0.1170
6.	CM-14 x TPT-Local	2.2	3.45	5.49	46.13	37.83	7.1	0.1174	0.1041	0.1160
7.	CM-14 x CM-64	0	4.44	6.22	45.15	34.32	9.87	0.1173	0.3342	0.1170
8.	CM-12 x TPT-Local	0	5.11	5.39	33.49	47.93	8.08	0.1171	0.1041	0.1380
9.	CM-12 x CM-64	0	3.99	6.12	34.13	46.14	9.62	0.1174	0.3352	0.1280
10.	TPT-Local x CM-64	0	4.93	7.12	41.93	39.16	6.86	0.1041	0.336	0.0958

Table 14: Segregation pattern in F_3 generation for fruit weight

S. No.	Crosses	Per cent of population in different class intervals						Mean		
		0-1	1.1-2	2.1-3	3.1-4	4.1-5	5.1-6	P_1	P_2	F_3
1.	CM-45 x CM-14	0	15.0	28.3	54.45	2.25	0	2.54	3.164	3.302
2.	CM-45 x CM-12	0	18.21	24.03	52.67	5.09	0	2.54	3.58	3.4
3.	CM-45 x TPT-Local	0	14.34	39.34	44.66	1.66	0	2.54	3.18	3.73
4.	CM-45 x CM-64	2.0	14.32	32.44	46.78	2.36	2.1	2.54	3.23	3.79
5.	CM-14 x CM-12	0	6.12	21.62	29.33	36.43	6.5	3.164	3.58	4.03
6.	CM-14 x TPT-Local	0	7.24	25.35	48.49	17.02	1.9	3.164	3.18	3.38
7.	CM-14 x CM-64	2.04	6.2	23.14	50.30	17.02	1.6	3.164	3.23	3.76
8.	CM-12 x TPT-Local	0	7.1	24.12	52.11	16.52	0	3.58	3.18	3.28
9.	CM-12 x CM-64	1.6	6.72	17.3	52.6	20.1	1.6	3.58	3.23	3.89
10.	TPT-Local x CM-64	0	9.75	20.9	49.35	18.51	1.49	3.18	3.23	3.35

Table 15: Segregation pattern in F_3 generation for fruit length

S. No.	Crosses	Per cent of population in different class intervals						Mean		
		0-7.5	7.6-15	15.1-22.5	22.6-30.0	30.1-37.5	37.6-45	P_1	P_2	F_3
1.	CM-45 x CM-14	0	1.6	30.1	51.26	15.3	1.06	23.43	24.56	25.36
2.	CM-45 x CM-12	0	2.7	50.44	32.49	14.37	0	23.43	23.23	22.5
3.	CM-45 x TPT-Local	0	2.5	49.86	32.72	13.43	1.49	23.43	20.15	22.63
4.	CM-45 x CM-64	0	1.62	32.03	50.32	14.32	1.71	23.43	26.73	25.78
5.	CM-14 x CM-12	0	2.32	48.32	32.51	15.12	1.73	24.56	23.23	24.83
6.	CM-14 x TPT-Local	2.3	2.81	49.69	31.33	12.29	1.58	24.56	20.15	22.3
7.	CM-14 x CM-64	0	1.61	29.38	52.70	14.33	2.22	24.56	26.73	26.00
8.	CM-12 x TPT-Local	0	1.66	31.24	50.69	15.01	1.60	23.23	20.15	25.03
9.	CM-12 x CM-64	0	1.62	25.43	53.22	18.12	1.61	23.23	26.73	28.44
10.	TPT-Local x CM-64	0	1.62	28.69	49.17	18.88	1.64	20.15	26.73	26.59

Table 13: Segregation pattern in F_3 generation for number of fruits per vine

S. No.	Crosses	Per cent of population in different class intervals						Mean		
		0-1	1.1-2	2.1-3	3.1-4	4.1-5	5.1-6	P_1	P_2	F_3
1.	CM-45 x CM-14	0	38.39	30.47	21.34	7.9	1.9	1.4	1.97	1.66
2.	CM-45 x CM-12	3.12	39.45	29.34	22.45	6.1	0	1.4	2.33	1.67
3.	CM-45 x TPT-Local	0	40.21	27.51	23.4	8.7	0	1.4	1.73	1.7
4.	CM-45 x CM-64	0	39.75	30.34	20.01	9.9	0	1.4	1.7	1.67
5.	CM-14 x CM-12	0	28.33	41.59	21.22	6.84	2.02	1.97	2.33	2.4
6.	CM-14 x TPT-Local	0	42.54	32.54	20.5	4.42	0	1.97	1.73	1.53
7.	CM-14 x CM-64	0	41.59	29.52	19.54	7.7	1.65	1.97	1.7	1.73
8.	CM-12 x TPT-Local	2.34	41.66	28.01	21.59	6.4	0	2.33	1.73	1.57
9.	CM-12 x CM-64	0	39.45	31.01	22.5	7.04	0	2.33	1.7	1.77
10.	TPT-Local x CM-64	0	38.77	33.22	21.51	6.5	0	1.73	1.7	1.8

Table 16: Segregation pattern in F_3 generation for yield per vine

S. No.	Crosses	Per cent of population in different class intervals						Mean		
		0-3	3.1-6	6.1-9	9.1-12	12.1-15	15.1-18	P_1	P_2	F_3
1.	CM-45 x CM-14	0	5.5	34.83	52.67	4.3	2.7	5.6	6.67	9.97
2.	CM-45 x CM-12	0	2.1	12.17	37.39	43.24	5.1	5.6	10.66	12.62
3.	CM-45 x TPT-Local	2.1	8.1	66.58	15.21	6.3	1.8	5.6	6.59	8.34
4.	CM-45 x CM-64	0	5.01	60.16	25.3	7.51	2.02	5.6	9.4	10.96
5.	CM-14 x CM-12	2.14	6.02	55.32	30.41	6.11	0	6.67	10.66	8.53
6.	CM-14 x TPT-Local	1.99	8.07	51.67	25.45	10.81	2.01	6.67	9.4	8.73
7.	CM-14 x CM-64	10.99	7.06	48.83	30.47	8.45	1.6	6.67	6.59	7.26
8.	CM-12 x TPT-Local	2.01	10.8	54.66	23.33	7.1	2.1	10.66	6.59	9.006
9.	CM-12 x CM-64	2.23	4.79	6.03	54.59	30.30	2.08	10.66	9.4	11.26
10.	TPT-Local x CM-64	2.03	6.03	40.03	48.60	3.04	0	6.59	9.4	8.91

* Significant at P = 0.05
** Significant at P = 0.01

Table 10: Genotypic (g) path coefficients among fruit yield per vine and 14 yield components in a 5 x 5 partial diallel of Pumpkin

Entries	Vine length (m)	Branches per vine	Node at which first Male flower appeared	Node at which first Female flower appeared	Days to male flower appearance	Days to female flower appearance	Fruits per vine	Fruit weight (kg)	Fruit length (cm)	Fruit girth (cm)	Fruit flesh thickness (cm)	No.of seeds	100-seed weight (g)	Yield per vine (kg
Vine length (m)	0.219	-0.167	0.021	-0.109	0.059	0.067	0.030	0.018	-0.193	0.157	0.029	-0.192	-0.007	-0.069
Branches per vine	-0.019	1.879	0.051	-0.073	-0.028	-0.168	-0.198	-0.506	-0.137	-0.265	-0.045	0.563	-0.283	0.771**
Node at which first male flower appeared	-0.038	-0.802	-0.119	0.095	0.051	0.057	0.023	0.354	0.057	0.048	0.011	-0.452	0.200	-0.515*
Node at which first female flower appeared	0.080	0.459	0.038	-0.299	0.027	0.006	0.032	-0.141	-0.026	-0.156	0.007	0.458	0.049	0.382
Days to first male flower opening	0.113	-0.470	-0.054	0.070	0.113	0.112	0.050	0.164	-0.045	0.075	0.018	-0.404	-0.004	-0.263
Days to first female flower opening	0.054	-1.153	-0.025	-0.006	0.046	0.274	0.158	0.399	0.070	0.078	0.020	-0.525	-0.230	-0.381
Fruits per vine	-0.019	1.079	0.008	0.028	-0.016	-0.126	-0.344	-0.389	-0.029	-0.158	-0.020	0.392	-0.207	0.199
Fruit weight (kg)	-0.006	1.490	0.066	-0.066	-0.029	-0.172	-0.210	-0.638	-0.192	-0.186	-0.018	0.911	-0.358	0.593*
Fruit length (cm)	0.095	0.577	0.015	-0.017	0.012	-0.043	-0.022	-0.275	-0.445	0.135	0.025	0.502	-0.167	0.390
Fruit girth (cm)	-0.076	1.102	0.013	-0.103	-0.019	-0.047	-0.120	-0.263	0.133	-0.451	-0.047	0.483	-0.186	0.418
Fruit Flesh thickness (cm)	-0.075	0.999	0.016	0.026	-0.025	-0.064	-0.083	-0.140	0.131	-0.253	-0.084	0.046	-0.068	0.427
Number of seeds per fruit	-0.035	0.874	0.045	-0.113	-0.038	-0.119	-0.111	-0.480	-0.185	-0.180	-0.003	1.211	-0.338	0.528
Hundred seed weight (g)	0.004	1.319	0.0590	-0.036	0.001	-0.156	-0.176	-0.566	-0.184	-0.207	-0.014	1.012	-0.404	0.650**

* Significant at P = 0.05%　　Residual effect = 0.2211

** Significant at P = 0.01%

Table 9: Phenotypic (p) path coefficients among fruit yield per vine and 14 yield components in a 5 x 5 partial diallel of Pumpkin

Entries	Vine length (m)	Branches per vine	Node at which first Male flower appeared	Node at which first Female flower appeared	Days to male flower appearance	Days to female flower appearance	Fruits per vine	Fruit weight (kg)	Fruit length (cm)	Fruit girth (cm)	Fruit flesh thickness (cm)	Number of seed per fruit	Hundred seed eight (g)	Yield per vine (kg)
Vine length (m)	**-0..162**	-0.056	0.039	0.044	-0.009	0.016	0.013	0.011	0.120	0.016	-0.087	-0.017	0.008	-0.066
Branches per vine	0.018	**0.505**	0.087	0.033	0.005	-0.041	-0.065	-0.270	0.091	-0.025	0.126	0.049	0.194	0.707**
Node at which first male flower appeared	0.027	-0.191	**0.231**	-0.043	-0.007	0.0150	0.015	0.196	-0.032	0.006	-0.038	-0.041	-0.148	-0.472
Node at which first female flower appeared	-0.049	0.114	0.068	**0.147**	0.003	0.000	0.003	-0.082	0.020	-0.014	-0.018	0.033	0.037	0.261
Days to first male flower opening	-0.080	-0.122	-0.088	-0.023	**-0.019**	0.022	0.012	0.090	0.027	0.007	-0.043	-0.037	-0.010	-0.261
Days to first female flower opening	-0.032	-0.257	-0.043	0.000	-0.005	**0.081**	0.046	0.200	-0.040	0.007	-0.056	-0.044	-0.176	-0.320
Fruits per vine	0.014	0.223	0.023	0.003	0.005	-0.041	**-0.147**	-0.193	0.015	-0.017	0.073	0.026	0.145	0.133
Fruit weight (kg)	0.005	0.367	0.122	0.032	0.005	-0.043	-0.077	**-0.372**	0.17	-0.019	0.052	0.088	0.295	0.571*
Fruit length (cm)	-0.066	0.157	0.025	0.010	-0.002	-0.01	-0.007	-0.149	**0.292**	0.014	-0.075	0.046	0.134	0.368
Fruit girth (cm)	0.052	0.260	0.020	0.043	0.003	-0.011	-0.052	-0.147	0.082	**-0.049**	0.141	0.046	0.156	0.389
Fruit Flesh thickness (cm)	0.052	0.238	0.033	-0.010	0.003	-0.017	-0.040	-0.073	-0.082	-0.026	**0.268**	0.004	0.045	0.397
Number of seeds per fruit	0.022	0.199	0.076	0.039	0.006	-0.029	-0.031	-0.262	0.109	-0.018	0.008	**0.124**	0.265	0.508*
Hundred seed weight (g)	-0.003	0.261	0.091	0.015	0.000	-0.038	-0.057	-0.292	0.105	-0.020	0.032	0.088	**0.375**	0.558*

* Significant at P = 0.05%   Residual effect = 0.2703

** Significant at P = 0.01%

CHAPTER - V

DISCUSSION

A brief discussion pertaining to the present investigation in pumpkin is presented here under the following heads.

5.1 MEAN PERFORMANCE OF PARENTS AND F_3s

5.2 VARIABILITY, HERITABILITY AND GENETIC ADVANCE AS PER CENT OF MEAN

5.3 COMBINING ABILITY AND GENE ACTION

5.4 CHARACTER ASSOCIATION

5.5 PATH COEFFICIENT ANALYSIS

5.6 SEGREGATION PATTERN

5.7 TRANSGRESSIVE SEGREGANTS

F_3 evaluation

Success of any crop improvement programme depends on the nature and magnitude of the genetic variability and gene action, association of economic plant traits among themselves and also individually with fruit yield. The efficiency of selection in breeding programmes depends on the extent of variability present in the population. Being monoecious and cross pollinated crop pumpkin provides ample scope for utilization of heterosis.

The main goal of the plant breeder is to create genetic variability through hybridization and selection of superior plants by proper evaluation of the extent of genetic variation available for yield and yield components, their heritability and genetic advance which could be effected will be of great value to the breeders. For assessment of variability, heritability, isolation of superior parents and crosses and selection of suitable breeding procedures for characters under study we can proceed for the biometrical techniques along with combining ability studies.

To obtain the information on these aspects the present investigation was carried out to evaluate 5 parents and their 10 F_3 crosses of pumpkin derived out of a 5 x 5 partial diallel cross for mean performance, variability, heritability, genetic advance as per cent of mean, combining ability of parents and crosses as well as the segregation pattern of the crosses. The results obtained are briefly discussed below.

5.1 MEAN PERFORMANCE OF PARENTS AND F_3S

To produce better genotypes, parents with high order of performance would be useful. A small amount of variation present in parents and F_3 population can be seen from the mean values for different characters (Table 2). A perusal of mean performance of parents indicated that CM-14 recorded the maximum vine length followed by CM-45 and CM-64 while CM-12 recorded the lowest vine length followed by TPT-local. Among F_3 populations, TPT-local x CM-64 which involved the parents with low x medium mean performance showed the maximum vine length. However, the cross CM-14 x TPT-local (high x average) showed minimum vine length followed by CM-12 x TPT-local (average x low).

In case of number of branches per vine CM-12 recorded the highest mean performance followed by CM-64 whereas the lowest mean performance was recorded by CM-45. The highest number of branches in F_3 population was recorded by CM-12 x CM-64 (high x average) followed by CM-45 x CM-12 (average x high) while the lowest number of branches was recorded by CM-12 x TPT-local (high x low) followed by CM-45 x CM-14 (low x average). This suggested that one of the parents in a cross should have high mean performance along with other parents as medium performing one to result in a high potential hybrid.

Out of five genotypes studied, CM-45 recorded the highest node of first male flower appearance whereas TPT-local registered the lowest node of male flower appearance. Among F_3 crosses, CM-45 x CM-64 (high x average) registered the lowest node of male flower appearance followed by TPT-local x CM-64 (low x average).

For node of first female flower appearance the genotype, TPT-local registered the highest mean performance while the genotype CM-12 registered the lowest mean performance. Among the crosses CM-12 x CM-64 (average x average) registered the lowest node of female flower followed by CM-12 x TPT-local (average x high).

The parent TPT-local registered the lowest number of days to first male flower opening whereas CM-14 recorded the highest number of days to first male flower opening. However, among F_3 hybrids, TPT-local x CM-64 (low x average) recorded the lowest number of days to first female flowering followed by CM-12 x CM-64 (average x average).

The parent CM-12 recorded the lowest number of days to first female flower opening while CM-45 showed the highest number of days to first female flower opening. Among the F_3 hybrids, CM-12 x CM-64 (low x average) registered the lowest number of days to first female flowering followed by CM-12 x TPT-local (low x average).

Regarding the sex ratio, the genotype CM-45 recorded the highest mean performance while TPT-local recorded the lowest mean performance. In F_3 crosses, TPT-local x CM-64 (low x average) recorded the highest mean performance followed by CM-12 x TPT-local (average x low).

The number of fruits per vine registered the highest mean performance by the genotype CM-12 followed by CM-14 and the lowest mean performance by the genotype CM-45. Among the F_3 crosses CM-14 x CM-12 (average x high) recorded the highest mean performance followed by TPT-local x CM-64 (average x average), CM-12 x TPT-local (high x average) and CM-14 x CM-64 (average x average). This indicated the importance of genotypes CM-12 and CM-14 in increasing the number of fruits per vine.

As far as fruit weight is concerned the genotype CM-12 registered the highest mean performance followed by CM-64 while the genotype CM-45 registered the lowest mean performance. Among the F_3 crosses CM-14 x CM-12 (average x high) registered the highest mean performance followed by CM-12 x CM-64 (high x average) which indicates the importance of the genotype CM-12 in increasing the fruit weight. The genotype CM-12 can be used in future breeding programmes to increase the fruit weight.

The genotype CM-64 registered the highest mean performance followed by CM-14 for fruit length while, the lowest mean performance was recorded by TPT-local. Among the F_3 hybrids, CM-12 x CM-64 (average x high) recorded the highest mean performance followed by TPT-local x CM-64 (average x high) for fruit length. This shows the ability of CM-64 in increasing the fruit length.

The genotype CM-12 registered the highest fruit girth followed by CM-14. While the lowest mean performance was recorded by the parent, CM-45. In F_3 hybrids, CM-45 x CM-12 (average x high) recorded the highest mean performance followed by CM-14 x CM-12 (average x high). This indicated that CM-12 has got high influence in increasing the fruit girth.

The parent CM-12 registered the highest mean performance for fruit flesh thickness followed by CM-64. The lowest mean performance was recorded by the parent CM-45. Among the F_3 hybrids, CM-45 x TPT-local (low x average) registered the highest mean performance followed by CM-45 x CM-12 (low x high).

Yield per vine determines the economic value of parents and crosses. Out of five genotypes studied, CM-12 recorded the highest mean performance followed by CM-64 for yield per vine. The lowest mean performance was recorded by the genotype CM-45. Among the F_3 crosses CM-45 x CM-12 (low x high) recorded the highest mean performance followed by CM-12 x CM-64 (high x average). This indicates the ability of CM-12 in improving the yield per vine.

For number of seeds per fruit the genotype CM-12 recorded the highest mean performance followed by TPT-local. The lowest mean performance was displayed by CM-45. Among the crosses CM-45 x CM-14 (low x average) recorded the highest mean performance followed by CM-12 x CM-64 (high x average).

Out of five genotypes studied, CM-12 registered the highest mean performance for hundred seed weight followed by CM-14, while CM-45 recorded the lowest mean performance. In F_3 crosses CM-45 x CM-64 (low x average) recorded the highest mean performance followed by CM-14 x CM-12 (average x high).

Based on mean performance it could be concluded that the parent CM-12 was the best parent for number of branches per vine, fruit weight, fruit flesh thickness, yield per vine, number of fruits per vine, fruit girth, hundred seed weight followed by CM-64.

In F_3 population, CM-45 x CM-12 was better yielder than both of the parents involved in this cross. This cross also showed better value for fruit girth. The population of CM-45 x TPT-local showed better value for vine length while CM-12 x CM-64 for number of branches per vine, CM-45 x CM-64 for node at which first male flower appeared and hundred seed weight, CM-14 x CM-64 for node at which first female flower appeared, TPT-local x CM-64 for days to first male flower opening and sex ratio, CM-14 x CM-12 for number of fruits per vine and fruit weight, CM-45 x TPT-local for fruit flesh thickness. These crosses can be advanced to evolve improved varieties and to exploit in future breeding programmes.

5.2 GENETIC PARAMETERS

5.2.1 Variability

The success of any breeding programme in any crop depends on the existence of heritable genetic variability. Hence knowledge on variability is a pre-requisite for initiating appropriate breeding procedure in a crop improvement programme. To apportion the observed variability due to genetic and environmental factors, parameters such as genotypic and phenotypic coefficient of variation have to be assessed. In the present study the estimates of phenotypic coefficients were higher than the estimates of genotypic coefficients for all the characters indicated the environmental influence in their inheritance.

The character yield per vine and sex ratio registered highest GCV and PCV values. Similar results were reported by Borthakur and Shadaque, (1990), Sendurkumaran *et al.* (1997), Mohanty and Mishra, (1999) and Mohanty, (2000) for yield per vine in pumpkin, Sahni *et al.* (1987) and Krishnaprasad and Singh, (1989) for yield per vine in ridgegourd, Mariyappan and Pappaiah, (1990) for yield per vine in cucumber, Varalakshmi *et al.* (1995) for sex ratio in ridgegourd.

Moderate GCV and PCV values were recorded for number of seeds per fruit, number of fruits per vine, vine length, number of branches per vine, and fruit weight. Doijode and Sulladmath, (1986) also reported similar results for number of seeds per fruit in pumpkin, Suribabu *et al.* (1986) for number of seeds in bittergourd. However Mohanty and Mishra, (1999) and Mohanty (2000) recorded high GCV and PCV values for number of fruits per vine in pumpkin. Sahni *et al.* (1987) reported moderate GCV and PCV values for vine length in ridgegourd, Chhonkar *et al.* (1979) for vine length in muskmelon. However high values of GCV and PCV for number of branches per vine were reported by Mangal *et al.* (1981) in bittergourd, Sahni *et al.* (1987), Abusaleha and Dutta, (1990) and Varalakshmi *et al.* (1995) in ridgegourd. In case of fruit weight moderate GCV and PCV values were also reported by Thakur *et al.* (1994) in bittergourd, Solanki and Seth, (1980) and Mariappan and Pappaiah, (1990) in cucumber, Kallo *et al.* (1983) in muskmelon.

Low GCV and PCV values were recorded for fruit length, fruit girth, node at which first male flower appeared, hundred seed weight, fruit flesh thickness, node at which first female flower appeared. These results are in conformity with Sahni *et al.* (1987), Krishnaprasad and Singh (1989), Abusaleha and Dutta, (1990) for fruit length in ridgegourd, Gopalakrishnan *et al.* (1980) for fruit girth in pumpkin, Mohanty, (2000) for node at which first male flower appeared in pumpkin, Varalakshmi *et al.* (1995) for hundred seed weight in ridgegourd, Krishnaprasad and Singh, (1989), Varalakshmi *et al.* (1995) for node at which first female flower appeared in ridgegourd.

Low GCV and PCV values were also recorded for days to first male flower opening and days to first female flower opening. Similar results were reported by Prasad *et al.* (1993) for days to first male flower opening in bottlegourd, Gopalakrishnan *et al.* (1980), Borthakur and Shadaque, (1990) for days to first female flower opening in pumpkin.

5.2.2 Heritability and Genetic advance

Both heritability and genetic advance are important parameters for selection than heritability estimates alone. If high heritability is accompanied with high genetic advance, it indicates additive gene action and will be most effective for direct selection. If high heritability accompanied with low genetic advance, for that character(s) selection will not be rewarding.

In the present investigation fruit weight, yield per vine, vine length, number of seeds per fruit, number of branches per vine and number of fruits per vine recorded high heritability with high genetic advance indicating the role of additive gene action and will be most effective for direct selection in improvement of these traits. These findings are in conformity with the findings of Gopalakrishnan *et al.* (1980) for fruit weight in pumpkin, Mangal *et al.* (1979) for yield per vine in pumpkin, Sendurkumaran *et al.* (1997) for number of seeds per fruit in pumpkin, Gopalakrishnan *et al.* (1980) for number of branches per vine in pumpkin, and Gopalakrishnan *et al.* (1980) for number of fruits per vine in pumpkin.

High heritability coupled with moderate genetic advance was recorded for fruit girth, fruit flesh thickness, fruit length, node at which first male flower appeared and hundred seed weight. These findings are in conformity with Mohanty (2001) for fruit flesh thickness in pumpkin, Gopalakrishnan *et al.* (1980), for fruit length in pumpkin. However Singh *et al.* (1977) and Mishra *et al.* (1998) obtained high heritability with high genetic advance for fruit girth in bittergourd, where as Mohanty and Mishra, (1999) obtained low heritability and low genetic advance for node at which first male flower appeared in pumpkin, while Doijode and Sulladmath, (1986) observed high heritability and low genetic advance for hundred seed weight in pumpkin.

High heritability coupled with low genetic advance was recorded for node at which first female flower appeared, days to first male flower opening and days to first female flower opening. These findings are in conformity with findings of Mohanty (2000), Mohanty and Mishra (1999) for node at which first female flower appeared in pumpkin, Gopalakrishnan *et al.* (1980), Sendurkumaran *et al.* (1997) for days to first male flower opening in pumpkin and Gopalakrishnan *et al.* (1980), Sendurkumaran *et al.* (1997) for days to first female flower opening in pumpkin.

Low heritability coupled with moderate genetic advance was recorded with sex ratio. However Suribabu *et al.* (1986) reported high heritability and moderate genetic advance for sex ratio in bittergourd.

5.3. COMBINING ABILITY AND GENE ACTION

Combining ability analysis was worked out as proposed by Griffing (1956). The parent CM-64 with high mean performance recorded as good combiner for vine length. Among F_3 crosses TPT-local x CM-64 showed maximum significant and positive sca effects. The estimates of variance indicated that sca was predominant when compared to the gca for vine length indicating that the inheritance of this trait is mostly governed by non-additive gene action. The ratio of variances of gca to sca was low indicating the preponderance of non-additive gene action for this trait. Doijode *et al.* (1982) and Mohanty, (2000) reported additive, non-additive gene action respectively and Sirohi (1993 and 1994) reported over dominance for vine length in pumpkin.

The variance due to sca for vine length was predominant when compared to that of gca indicating that inheritance of vine length was mostly governed by non-additive gene action. This is in conformity with the results of

Doijode *et al.* (1982), Mohanty, (2000) and Sirohi (1993 and 1994) in pumpkin.

Among the parents CM-14 with longer vine was found to be a good combiner for this attribute. Thus, this parent was of considerable use for obtaining the genotypes with longer vine through recombination breeding. The cross TPT-local x CM-64 showed a highly significant positive sca effect indicating the operation of non-additive gene action.

The genotypes CM-12 and TPT-local recorded high negative gca effects and could be useful in obtaining the plant types with shorter vine length. The cross CM-14 x TPT-local exhibited the highest significant negative sca effect. This combination could be used for breeding genotypes with shorter vine length to produce more number of branches due to the suppression of apical dominance. Since non-additive gene action was predominant for this trait, reciprocal recurrent selection would be a right choice for breeding of dwarf varieties.

The sca variance component was higher than gca variance component for branches per vine indicating the presence of non-additive gene action. This is in conformity with results obtained by Solanki and Seth, (1983) in cucumber.

The genotypes CM-64 and CM-12 were found to be good combiners. However, the parent was being an average general combiner exhibited the highest number of branches per vine. The crosses CM-45 x TPT-local (average x average) followed by CM-14 x CM-64 (average x average) recorded high sca effects for number of branches per vine indicating that these combinations could be utilized by exploiting non-additive gene action for improving the number of branches per vine.

In the present study the contribution of non-additive gene action in controlling the node of first male and female flowers appearance, is evident from the preponderance of sca variance component than gca variance component. This is in conformity with the reports of Gopalakrishnan *et al.* (1980) for node of first male flower appearance, Ramanajitha (2001) for node of first female flower appearance in pumpkin. However predominance of additivity was also reported by Mohanty, (2000) in pumpkin for node of first male flower appearance.

The genotypes, CM-64 and TPT-local showed negative gca effects indicating that they were the best general combiners for node of first male flower appearance. The crosses CM-45 x CM-64 (average x high) and CM-12 x TPT-local (average x average) recorded negative sca effects indicated the importance of both additive and non-additive gene action governing this trait. Negative and significant sca effects for node of first male flower appearance in these crosses indicated that the possibility of improvement of this trait through recombination breeding. The parents, CM-14 and CM-64 showed significant negative gca effects indicating that they were good general combiners for node of first female flower appearance. The cross CM-14 x CM-64 showed highly significant negative sca effect, with good mean performance for node of first female flower appearance indicating that this cross could be utilized for breeding early flowering varieties in pumpkin through selected diallel with concurrent random mating in early segregating generations followed by mass selection.

Estimates of variance components due to sca was higher than that of gca indicating that days to first male and female flowering was largely under the influence of non-additive gene action. Thus confirms the reports of Khattra *et al.* (2000) in bittergourd. Since earliness is a desirable trait, the parents having significant and negative gca effects should be selected for improving this trait.

The genotype TPT-local, showed highly significant negative gca effect as well as earliness in their *per se* performance and this is the best general combiner for days to first male flowering. The crosses CM-45 x CM-14 and CM-14 x TPT-local recorded significant and negative sca effects for days to first male flowering indicating the importance of both additive and non-additive gene actions governing this trait. The parent, CM-12 recorded less number of days to first female flowering and negatively significant gca value. The cross CM-12 x CM-64 displayed a highly significant negative sca effect indicating the importance of both additive and non-additive gene action. Significant and negative sca effects for days to first male and female flowering in these crosses indicated scope for improvement of these traits through pedigree breeding which utilizes both additive and non-additive gene effects.

Estimates of variance components due to sca was higher than that of gca indicating that sex ratio was largely under the influence of non-additive gene action, thus confirms the findings of Singh *et al.* (1995) in bottlegourd. The parents CM-45 and CM-12 were found to be average combiners, while the parents TPT-local and CM-64 were found to be good combiners. The crosses CM-45 x CM-14, CM-14 x CM-12 and CM-45 x CM-12 prominently showed positive sca effect indicating that these crosses could be amenable for improving sex ratio. Dominant genes for additive (or) epistatic effects were found to be responsible for expression of this trait. These crosses showed positive sca effect indicating the scope for exploiting both additive and non-additive gene action through biparental mating followed by progeny selection for improving the sex ratio.

Predominance of non-additive gene action for number of fruits per vine is evident from the higher estimates of sca variance component than gca variance component. The findings are in conformity with results of Maurya and Singh, (1994) in bottlegourd, Philipvarghese and Rajan, (1994) in snakegourd. However predominance of additive gene action was also reported for this trait by Singh *et al.* (1995) in bottlegourd. The genotypes CM-14 and CM-12 were good with high mean performance and when involved in the cross (CM-14 x CM-12) exhibited high mean performance, with non-additive gene action. Here the fruits per vine could be improved through a selective diallel mating (or) biparental mating in early segregating generations and advancing through pedigree method in later generations.

In the present study the contribution of non-additive gene action in controlling fruit weight was evident from the preponderance of sca variance component than gca variance component. This is in consonance with the reports of Munshi and Sirohi, (1994) in bittergourd, Maurya and Singh, (1994) in bottlegourd. However predominance of additive gene action was also reported for this trait by Khattra *et al.* (2000) in bittergourd, Singh *et al.* (1995) in bottlegourd.

The genotypes, CM-12 and CM-64 were found to be good general combiners and recorded high positive gca effects and also high *per se* performance for individual fruit weight. The cross between these two good general combiners recorded poor sca effect. In contrast CM-45 x CM-64 exhibited the highest sca effect besides recording high *per se* mean performance indicated the predominance of the non-additive gene action. This trait could be improved by choosing breeding methods such as selective diallel mating (or) biparental mating.

Predominance of non-additive gene action for fruit length was evident from the higher estimate of sca variance component than gca variance component. However both additive and non-additive gene action was reported by Sivakami *et al.* (1987) in bottlegourd and additive gene action by Khattra *et al.* (2000) in bittergourd. The genotypes, CM-64 and CM-12 were found to be good general combiners exhibiting high *per se* performance for this trait. The cross combinations, CM-12 x CM-64, CM-12 x TPT-local, TPT-local x CM-64, CM-45 x CM-14, CM-45 x TPT-local and CM-14 x CM-12 recorded high positive sca effects for fruit length indicated the scope for improvement of this trait governing both additive or additive x additive and non-additive gene effects through recombination breeding followed by selection.

The sca variance component was higher than the gca variance component for fruit girth indicating the predominance of non-additive gene action. These are in agreement with the results of Sivakami *et al.* (1987) who reported both additive and non-additive gene action in bottlegourd. However additive gene action was reported by Khattra *et al.* (2000) in bittergourd.

Among parents, CM-12 and CM-14 recorded good gca effects. The crosses CM-45 x CM-12 (average x high), CM-14 x TPT-local (average x average), CM-45 x TPT-local (average x average), and CM-14 x CM-12 (average x high) exhibited positive sca effect indicating the predominance of additive and non-additive gene action for the expression of this character in these crosses. The hybrids with significant positive sca effects are of considerable importance in improving the fruit girth through selection by progeny testing and recurrent selection.

A comparison of estimates of gca and sca components of variance for fruit flesh thickness revealed the importance of non-additive gene action. This is in conformity with the results of Doijode *et al.* (1982) in pumpkin, where as additive and non-additive gene action was reported by Mohanty, (2000) in pumpkin.

Among parents, CM-12, CM-45 and TPT-local recorded to be good general combiners. The cross CM-45 x CM-12 (high x average), recorded highest sca effect indicating the role of non-additive gene action. In this cross fruit flesh thickness could be improved through a selective diallel mating or biparental mating.

The variance due to sca was predominant for yield per vine compared to that due to gca indicating that the inheritance of fruit flesh thickness was mostly governed by non-additive gene action. This is in conformity with the results of Khattra *et al.* (2000) in bittergourd, and both additive and non-additive by Mohanty, (2000), Ramanajitha (2001) in pumpkin.

The parents, CM-12 and CM-14 exhibited significant gca effects. So these could be used as donors for improving fruit yield per vine in future breeding programmes. The hybrid CM-45 x CM-12 (average x high) had exhibited high positive sca effect with high mean performance. The significant sca combinations which involved high x high general combiners may be advanced through pedigree method of breeding for improving yield *per se*, while the crosses which involved poor domination may be ameliorated through a selective diallel mating or biparental mating or any other form of recurrent selection followed by pureline selection, so as to exploit both additive as well as non-additive gene actions.

The sca variance component was higher than the gca variance component for number of seeds per fruit indicating predominance of non-additive gene action. This is in consonance with the reports of Celine and Sirohi, (1998) in bittergourd. The parents CM-12, CM-14 and CM-64 were found to be good general combiners with good *per se* performance. The cross CM-45 x CM-14, (low x average), CM-12 x CM-64 (high x average), CM-45 x CM-64 (low x average) and CM-14 x CM-12 (average x high) displayed highly significant positive sca effects with high mean performance indicating the importance of non-additive gene action in expression of number of seeds per fruit.

In the present investigation the contribution of non-additive gene action in controlling hundred seed weight was evident from the preponderance of sca variance component than gca variance component. These findings are in conformity with the results of Celine and Sirohi, (1998) in bittergourd.

The parents, CM-12, CM-14 and CM-64 were found to be good general combiners and recorded high positive gca effects and also high *per se* mean performance for hundred seed weight. The crosses CM-45 x CM-64 (low x average), CM-45 x CM-14 (low x average), CM-45 x CM-12 (low x high), and TPT-local x CM-64 (average x average) had showed high sca effects with high *per se* performance indicating the predominance of dominant gene action. In these crosses hundred seed weight could be improved by choosing the breeding methods such as selective diallel mating or biparental mating.

From the foregoing discussion, it is evident that non-additive effects were predominant for all characters. The influence of dominance and epistasis was observed in the present study since widely divergent parents were used. Further the characters concerned also possessed complexity of inheritance with low magnitude of additive effects.

Based on this study, it could be suggested that repeated selection and intermating of the segregating materials for two (or) three cycles, makes it possible to achieve simultaneous improvement in fruit yield and related yield attributes.

5.4 CHARACTER ASSOCIATION

A clear understanding of the interrelationships of characters with yield and themselves will be of great value in any crop improvement programme for effective selection. The efficiency of selection for yield mainly depends on the direction and extent of association between yield and its components and among themselves. Correlation studies are helpful to determine the relationships among various traits, which are useful in making selection as yield components and also provide information on the nature and extent of association between any two pairs of quantitative traits. The association of fruit yield with its components and among themselves in parents and F_3s are discussed below.

In the present investigation yield per vine had recorded high positive and significant correlation with number of branches per vine followed by hundred seed weight. Hence, the increase in yield per vine can be achieved through increase in number of branches per vine and hundred seed weight.

These results are in concurrence with Narasimha Rao *et al.* (2000) for number of branches per vine in ridgegourd. Rastogi and Aryadeep, (1990) for number of branches per vine in cucumber, Tyagi (1972) for hundred seed weight in bottlegourd, Sidhu and Brar, (1981) for hundred seed weight in watermelon. Significant and positive correlation was also recorded for traits *viz.,* fruit weight and number of seeds per fruit with yield per vine. These results are in concurrence with Rana *et al.* (1985) for fruit weight in pumpkin, Prasad *et al.* (1993) for fruit weight in bottlegourd, Sendurkumaran *et al.* (1998) for number of seeds per fruit in pumpkin, Tyagi (1972) for number of seeds per fruit in bottlegourd. Hence simultaneous selection of genotypes for number of branches per vine, hundred seed weight, fruit weight and number of seeds per fruit has to be adopted to improve the fruit yield in pumpkin.

The character vine length exhibited negative correlation with yield per vine. This indicated that increase in vine length would decrease yield per vine due to competition between these two divergent forces and resulted in negative correlation. These results are in concurrence with the findings of Kumar and Singh, (1998) Badade *et al.* (2001) for vine length in bottlegourd. Hence selection and development of hybrids with more vine length may not be useful. So the best alternative would be to select hybrids with fairly less vine length which might result in high yield per vine.

Coming to interrelationship among the yield components, fruit weight had exhibited positive and significant correlation with fruit flesh thickness indicating any selection aimed for increase in fruit flesh thickness would increase the fruit weight inturn increases the fruit yield per vine as the fruit weight had significant and positive correlation with yield per vine. Similar observations were reported by Singh and Singh, (1988) for fruit weight with fruit flesh thickness in watermelon.

The above results revealed that yield could be increased by increasing the number of branches per vine, hundred seed weight, fruit weight, number of seeds per fruit as these were significantly and directly associated with yield.

5.5 Path coefficient analysis

Yield in plants is the end product of interaction of many correlated characters. Selection for these characters is more effective when based on component characters which are highly heritable and positively correlated. When more number of variables are considered in correlation the association becomes more complex and less obvious . Under such situation the use of path coefficient analysis is helpful. Although correlation coefficients indicate the nature of association among the traits, path analysis shows the contribution of a character (direct) and also its influence through (indirect) other components to yield. Hence correlation in conjugation with path coefficient analysis will give a clear idea of the nature of association of their relative contribution to yield. In the present investigation path coefficient analysis was worked out and the results are discussed below (Table 9).

Among all the characters studied, the characters number of branches per vine followed by hundred seed weight displayed positive direct effect on yield at both phenotypic and genotypic levels. This suggests that increase in number of branches per vine and hundred seed weight might increase the fruit yield per vine. Similar trend was reported by Prasuna and Rao, (1989) for number of branches per vine in cucumber. However Sidhu and Brar, (1981) reported negative direct effect for hundred seed weight will effect in improving the yield per vine in watermelon.

Fruit length, fruit flesh thickness, node at which first male flower appeared, node at which first female flower appeared, number of seeds per fruit and days to first female flower opening showed low positive and direct effects. Similar results were reported by Gopalakrishnan *et al.* (1980) in pumpkin.

Though negative direct effects were observed for fruit weight, number of fruits per vine, and fruit girth they resulted in positive correlation with yield per vine due to higher positive indirect effects. These results are in conformity with Sendurkumaran *et al.* (1998) for fruit weight in pumpkin, Gopalakrishnan *et al.* (1980) for number of fruits per vine in pumpkin and Narasimha Rao *et al.* (2000) for fruit girth in ridgegourd.

Vine length, days to first male flower opening showed negative direct effects on yield per vine.

Most of the traits indirectly influenced the yield through fruits per vine and fruit weight towards the favourable direction which had a positive effect on yield per vine, suggesting that preference should be given to these parameters in selection programme to isolate superior lines with potentiality for higher fruit number, fruit weight and higher fruit yield.

For the computation of selection criteria, the characters that were utilized in the present investigation may be adequate due to low residual effects.

5.6 SEGREGATION PATTERN

The segregation pattern of crosses throw light on genetic width of that crosses and helps breeder to identify superior individual plants.

The cross CM-45 x CM-12 showed better segregation pattern and highest mean performance for yield per vine (Table 16). The percentage of plants exceeding the mean for yield per vine was 5.1.

The cross CM-12 x TPT-local showed the highest mean performance for sex ratio. The percentage of plants exceeding the mean was 9.62 per cent. Selection can be made in this cross to obtain plants having more number of fruits per vine.

In case of branches per vine and fruit length the cross CM-12 x CM-64 displayed the higher mean performance. The percentage of plants exceeding their means were 28.2 and 19.92 respectively. Selection can be made in these crosses to obtain plants having more number of branches per vine and more fruit length.

Whereas in case of fruits per vine and fruit weight the cross CM-14 x CM-12 showed the highest mean performance. The percentage of plants exceeding their means were 29.08 and 42.93. Selection can be made in these crosses to obtain plants having more number of fruits per vine, more fruit weight and there by more yield per vine.

Based on segregation pattern, it can be deduced that the crosses CM-12 x TPT-local showing high proportion of segregants exceeding the overall mean of crosses in respect of sex ratio, CM-12 x CM-64 in case of number of branches per vine and fruit length, CM-14 x CM-12 in respect of number of fruits per vine and fruit weight, and CM-45 x CM-12 in respect of yield per vine are highly desirable and can be utilized to obtain high yielding genotypes in future generations.

5.7 TRANSGRESSIVE SEGREGANTS

Transgressive segregants in F_3 may arise due to dominance and dominance interactions which are fixable or due to recombinations of genes with positive effects and responsible for production of transgressive segregants in the future generations. These findings also revealed that the parents differed for many genes and the introgression of genes from different lines created a large amount of genetic variability for yield and yield components.

The highest number of total transgressive segregants (TTS) and significantly transgressive segregants (STS) were observed in F_3 generation of the cross CM-14 x CM-12 for number of fruits per vine and fruit weight and CM-45 x CM-12 for yield per vine. These crosses can be advanced to select high yielding genotypes in subsequent generations.

CHAPTER - VI

SUMMARY

Combining ability analysis was carried out with five genotypes of pumpkin (viz., CM-45, CM-14, CM-12, TPT-local and CM-64 as parents) and their ten F_3 crosses obtained from 5 x 5 partial diallel to obtain information on the following aspects at Horticultural garden, Sri Venkateswara Agricultural College, Tirupati during *rabi* 2002-2003 in a randomized block design with three replications.

1. Variability, heritability and genetic advance as per cent of mean
2. General and Specific combining ability effects
3. Gene action
4. Association of characters
5. Direct and indirect effects of yield components on fruit yield and
6. Segregation pattern and transgressive segregants were obtained through partial diallel analysis for the 15 characters studied.

The parents CM-12 and CM-64 displayed high *per se* performance for yield and yield component characters . Among the F_3 crosses, CM-45 x

CM-12, CM-12 x CM-64 and CM-12 x TPT-local recorded high mean performance for yield and its component traits.

Higher genotypic and phenotypic coefficients of variation and high heritability with high genetic advance were displayed for yield per vine, while high heritability with low genetic advance was shown by node at which first female flower appeared. Hence, selection for such character may not be rewarding. The analysis of variance for combining ability revealed that both general combining ability (gca) and specific combining ability (sca) effects were significant for most of the characters under study. Estimates of components of variance revealed that the variance due to sca was greater than the variance due to gca indicating the role of non-additive gene action in inheritance of all characters.

The study of gca effects indicated that CM-12 was the best general combiner for number of branches per vine, number of fruits per vine, fruit weight, fruit girth, fruit flesh thickness, yield per vine and number of seeds per fruit. The parent CM-64 was found to be good general combiner for vine length, sex ratio and fruit length, while TPT-local for node at which first female flower appeared and sex ratio. The parent CM-14 was observed to be good combiner for node at which first male flower appeared, days to first male flower opening and hundred seed weight, where as CM-45 for days to first female flower opening.

Character association revealed that genotypic correlation were higher than the corresponding phenotypic correlations. The characters *viz.,* number of branches per vine, hundred seed weight, fruit weight and number of seeds per fruit displayed significant and positive association with yield per vine. These traits also exhibited strong and positive association among themselves. Hence simultaneous selection for these attributes may bring an improvement in fruit yield per vine.

Path coefficient analysis indicated that number of branches per vine, hundred seed weight and fruit length showed maximum positive direct effects on fruit yield per vine. The indirect effects of most of the other characters via, number of branches per vine were positive and maximum indicating that fruit weight and number of branches per vine should be given emphasis in selection programme.

Based on segregation pattern studies it can be deduced that the cross CM-45 x CM-12 showed high proportion of segregants exceeding the overall mean of crosses in respect of fruit yield per vine, CM-12 x TPT-local for sex ratio, CM-12 x CM-64 for number of branches per vine and fruit length, CM-14 x CM-12 for number of fruits per vine and fruit weight.

The highest number of TTS and STS were observed in the cross CM-14 x CM-12 for number of fruits per vine and fruit weight and CM-45 x CM-12 for fruit yield per vine.

As the vigour of producing higher yield per vine is continued to appear even in the F_3 generation, it can be suggested that the present breeding programme may be studied further.

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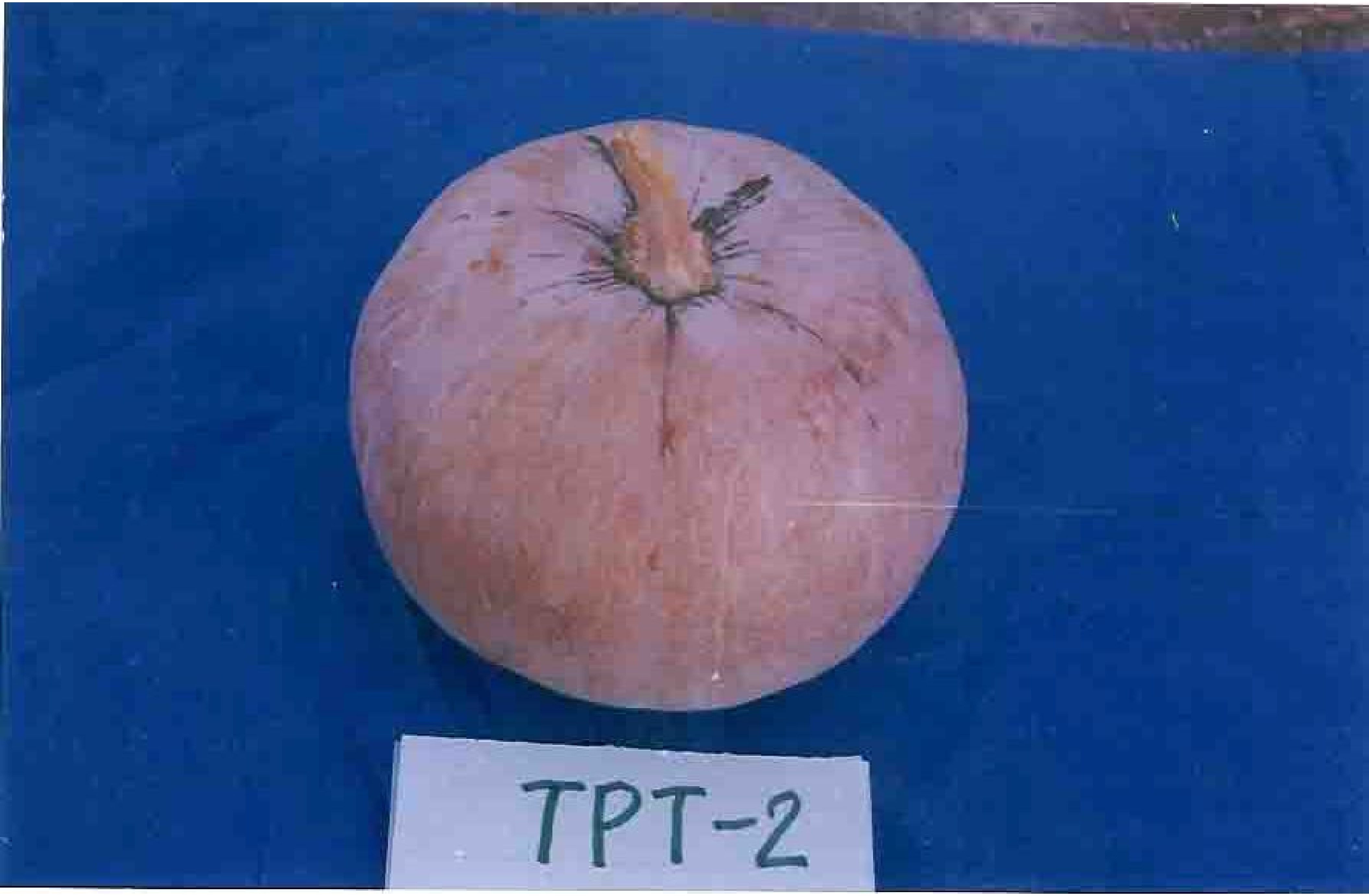
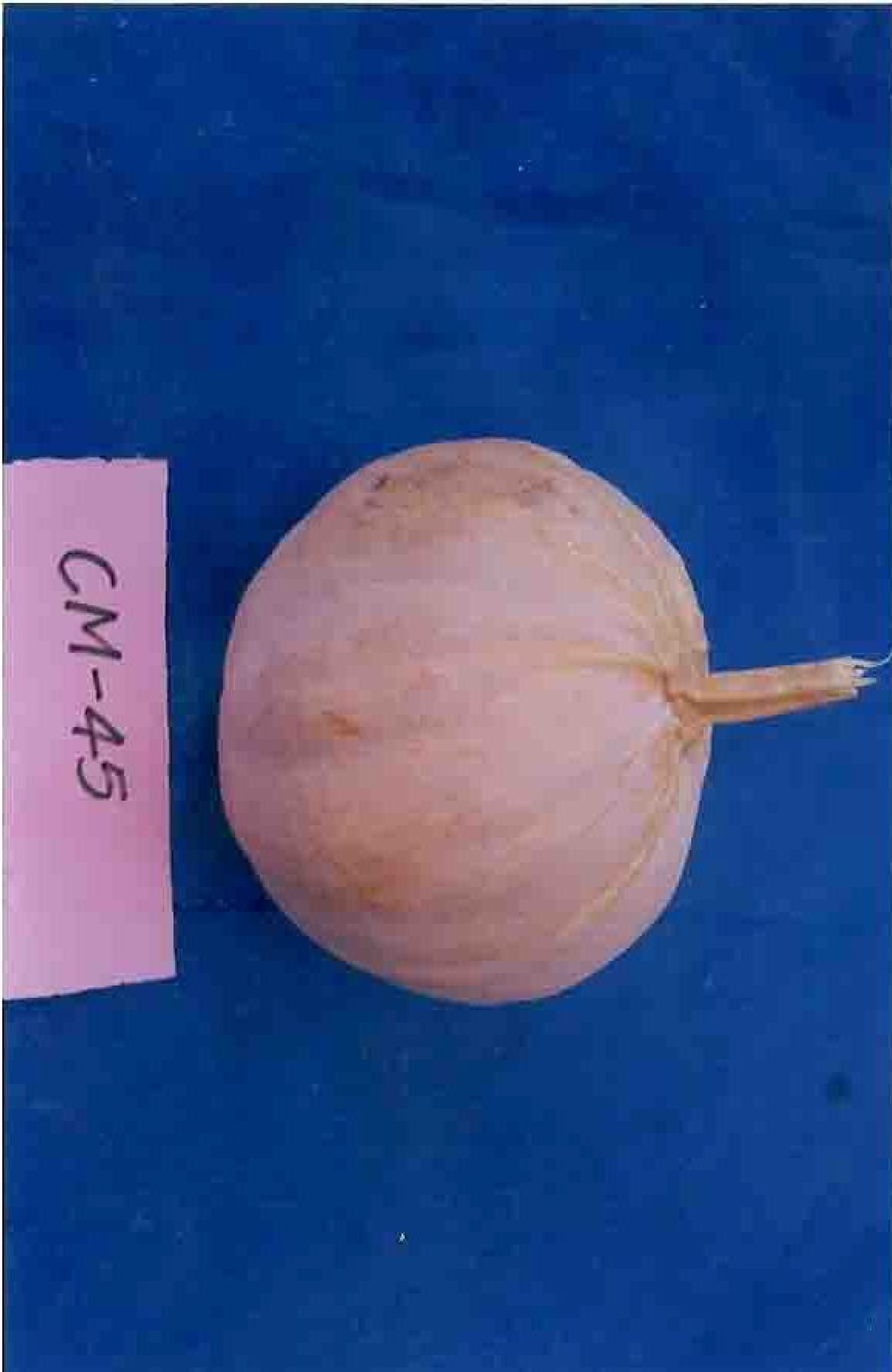
* Originals not seen.


TPT-2


CM - 12


CM-14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CM-64

Field No:6 Area : 0.09ha
Genetic Analysis of Yield & Yield Attributes in F_3's of 5x5 Partial Diallel set in Pumpkin (*Cucurbita moschata Duch-ex-Poir*)
Entries : Parents : 5
Hybrids: 10
Spacing : 2m X 1m
N P K (kg/ha)
Fertiliser dose:50: 35: 35
FYM : 20 t/ha
Date of sowing : 19-11-2002.
Chairman : Dr.K.Hari Babu
Student : K.Umameshawari