CHAPTER VI
SUMMARY

The present investigation "Genetic divergence and combining ability studies in genus *Pisum* L." was undertaken to gather information on the genetic architecture of yield and its components and to establish relationship among them (*P. sativum* and *P. arvense*), using line x tester analysis technique, proposed by Kempthorne (1957).

Twenty genetically diverse female lines were selected for making crosses with three testers viz., T 163, P 200 and T 61. Thus, 60 F₁s, 60 F₂s and 23 parents were grown in a randomized block design with three replications. Observations on thirteen characters, namely, plant height, pod height, days to flower, number of nodes, number of primary branches, number of pods per axil, number of pods per plant, number of days to maturity, number of seeds per pod, length of the pod, breadth of the pod, test weight and yield per plant, were recorded using five randomly selected plants in parents and F₁s and fifteen plants in F₂. The data collected were compiled and subjected to statistical analysis for estimation of combining ability effects and their variances, heterosis and inbreeding depression, heritability and genetic advance, correlation, and genetic divergence. The findings of investigations are summarised hereunder.

1. Analysis of variance revealed significant differences among parents and crosses, indicating significant variability
and sufficient amount of heterosis.

2. The combining ability analysis through $F_1$ indicated preponderance of additive gene action for seven characters (number of primary branches, number of pods per axil, number of pods per plant, days to maturity, number of seeds per pod, length of the pod and test weight); non-additive for three characters (plant height, pod height and yield per plant), and both additive and non-additive gene action for rest of the characters (number of days to flower, number of nodes and breadth of the pod). In $F_2$, all the characters except plant height and number of pods per plant showed preponderance of additive gene action.

3. Overdominance in $F_1$ was observed for plant height, pod height, days to flower and yield per plant, and dominance for number of nodes, days to maturity and breadth of the pod. Rest of the characters viz., number of primary branches, number of pods per axil, number of pods per plant, number of grains per pod, test weight and length of the pod, showed partial dominance.

"In $F_2$, overdominance was present for plant height and number of pods per plant and dominance for days to flower and yield per plant. For test weight no dominance was observed. For rest of the characters partial dominance was present."

4. On the basis of general combining ability effects the best parents in respect of yield were 6112, 6113 and P 260. The
parent 6112 showed best g.c.a. effects for seven characters, while parent 6113 for six characters and P 260 for only four characters. Parents showing best g.c.a. effects, other than yield, were 6253 (days to flower, days to maturity, length of the pod, breadth of the pod and test weight), 6563 (days to flower, days to maturity, number of grains per pod, length of the pod and breadth of the pod), P 135 (length of the pod, breadth of the pod and test weight), WSM (plant height, number of pods per plant and test weight), P 302 (plant height, number of primary branches and number of grains per pod), and P 209 (plant height, days to flower and days to maturity). Parents showing consistent performance in respect of g.c.a. in both F₁ and F₂ generations were P 260 (yield per plant, number of primary branches and number of pods per plant), 6112 (test weight, length of the pod and days to flower), 6113 (test weight, length of the pod and breadth of the pod), 6253 (test weight, length of the pod and days to maturity), 6563 (length of pod, number of grains per pod and days to flower and maturity), WSM (number of pods per plant and plant height), and P 302 (plant height, number of primary branches and grains per pod).

5. Considering the best s.c.a. effects, best heterosis over better parents and also best per se performance the crosses 6112 x T 163, P 260 x T 163 and 6253 x P 200 were best in respect of yield. Other promising crosses for yield were P 41 x T 61, P 260 x T 61, 6113 x T 163 and 6253 x T 163. All these crosses involved best general combiners. The cross 6112 x T 163 was not only superior
for yield showing about 50 per cent heterosis over best
depression which ran from 27 to 52 per cent. For pods per plant, a
cross WSM x P 200 showed 33 per cent heterosis over best check.
Three crosses, namely, 6563 x T 163, WSM x P 200 and P 244 x P 200,
showed significant heterosis over better parent ranging from 34 to
52 per cent and inbreeding depression from 45 to 63 per cent.
For number of primary branches, crosses P 244 x P 200, WSM x P 200,
P 260 x P 200 and Kala x P 200 showed significant heterosis over
best check, the range being from 34 to 62 per cent. However,
only one cross (P 244 x P 200) showed superiority over better
parent by 46 per cent and showed 44 per cent inbreeding depression.
For test weight, cross 232/2 x T 61 showed 8 per cent superiority over
best check, while eight crosses showed superiority over
better parent, the increase being from 10 to 31 per cent.

For breadth of the pod, crosses 6253 x T 61 and 6253 x P 200; for length of pod cross 6112 x T 61; for number of grains per pod crosses 6112 x T 163 and P 302 x T 163; for number of nodes crosses 6563 x P 200, P 302 x T 163 and P 264 x P 200; for pod height crosses 6563 x P 200, 6253 x P 200 and P 302 x T 61; for plant height crosses 6112 x P 200 and 6112 x T 61, and for days to maturity crosses 6113 x T 163, 6115 x T 61 and 6112 x T 61, have been found to be significantly superior to better parents, however, none of the cross was found significantly earlier to early parent.

7. Tester-wise average heterosis over mid-parent indicated the best performance of hybrids involving tester T 61 for yield, test weight, plant height, length and breadth of the pod and days to flower. The hybrids with tester P 200 were superior for number of pods per plant, number of primary branches, pod height and number of nodes. The crosses with tester T 163, however, were not found superior for any character.

8. The maximum average inbreeding depression for different characters was found to be 28 per cent for yield, 30 per cent for number of pods per plant, 12 per cent for plant height and 10 per cent for pod height. No inbreeding depression was observed for number of grains per pod and length of the pod. Further, for days to flower, number of nodes, number of primary branches and test weight average inbreeding depression ranged from 2 to 4 per cent. For breadth of pod, F2 was found superior
to \( F_1 \) by 2 per cent. A cross \( P_{260} \times P_{200} \) showed 30 per cent superiority in \( F_2 \) over \( F_1 \) in respect of primary branches, cross \( P_{135} \times P_{200} \) showed 26 per cent superiority in \( F_2 \) for number of seeds per pod and the cross \( P_{302} \times T_{61} \) showed least inbreeding depression for pod height.

9. Among parents four characters viz., number of pods per plant, number of grains per pod, breadth of the pod and yield per plant showing heritability values to be 25, 54, 54 and 52 per cent, respectively were found less heritable in contrast to rest of characters which showed high heritability, ranging from 86 to 98 per cent. Among \( F_1 \), the heritability estimate for yield was lowest (0.2%) and expected genetic advance was 0.05 per cent. The heritability estimates for rest of the characters in descending order viz., test weight (85%), number of grains per pod (83%), number of primary branches (75%), length of the pod (70%), number of pods per axil (64%), number of days to flower (54%), days to maturity (48%), number of pods per plant (42%), breadth of the pod (41%) and number of nodes (40%). The genetic advance for primary branches was 94.4 per cent. Further, 54 per cent improvement was expected for selecting for bolder grains (39%) for number of pods per plant, (30%) for pod length, (29%) for number of pods per axil, (21%) for number of grains per pod and for rest of the characters, the genetic gain over respective mean values was below 20 per cent. The heritability values in \( F_2 \) showed an increasing trend over \( F_1 \) for all the characters except days to flower and number of pods per plant. Same was
true for genetic advance. By only one year of selfing 23 per cent improvement was expected in making selections in $F_2$. Thus, the best criterion for selection among parents on the basis of heritability and genetic advance would be to base selection on characters viz., test weight, length of pods, number of primary branches, number of pods per axil, pod height, plant height and number of nodes. In $F_1$, the safest criterion to be relied would be number of primary branches, test weight, number of pods per plant and length of pods showing genetic advance ranging from 30 to 94 per cent. In $F_2$, selection criterion can be based upon number of primary branches, number of seeds per plant, number of pods per axil, test weight, length of the pod and pod height showing genetic advance ranging from 33 to 77 per cent.

10. The characters— plant height, pod height, number of nodes, number of primary branches, number of pods per plant and days to flower and maturity were found strongly and positively correlated with yield as well as among themselves, but number of grains per pod, length of the pod and test weight were negatively associated with yield and also to the above mentioned seven characters.

An increase in plant height was accompanied with increase in number of nodes which in turn increased the number of primary branches and consequently the duration of flowering and maturity was prolonged which permitted more time for flowers and pods to be formed, thus leading to formation of more number of pods per plant and commensurate increase in yield but an overall increase in all these characters lead to a decrease in size of pods and
reduction in the number and size of grains. Thus, the former seven characters belong to first set while the later three characters to the second set. A sort of balance was observed in these two sets. Increase in first set of characters not only counteracted the decrease in second set but over weighed it, so that complementation of seven characters is much more than the counteraction of three characters. Therefore, inspite of negative association of three characters with yield it is not seriously affected in view of seven characters exerting beneficial role.

The breeding procedure to be adopted for autogamous nature of this pulse crop was discussed and importance of pure line selection over hybrids was emphasized. Pedigree method was recommended for exploitation of additive genetic variance. As \textit{inter se} mating at \(F_2\) level using biparental mating approach helps in accumulating additive genetic variance, the importance of the same was also recommended. In order to exploit additive as well as non-additive genetic variance, importance of reciprocal recurrent selection, which involved selection for a couple of cycles followed by multi-locational tests was, however, stressed.

\textbf{Genetic divergence}

This study was taken up among 23 parents, all indigenous, except two viz., 6202 and Victoria. Sufficient amount of diversity was found to be present as four lines—P 200, P 135, 6112 and 6202 fell distinctly in separate clusters IV, V, VI and VII, respectively, rest lines fell in clusters I, II and III. Clusters II and IV involved lines which showed maximum productivity. Number of pods per
plant, number of primary branches and plant height were the main characters which contributed maximum towards yield. No association was found to exist between genetic diversity and geographical origin. Genetic divergence was also compared to manifestation of heterosis over better parent for yield per plant, but no association between these two characters could be established.