CHAPTER VI
SUMMARY AND CONCLUSIONS

The present investigation on “Heterosis and combining ability for grain yield, its attributes and micro nutrients (Fe and Zn content) in pearl millet [Pennisetum glaucum (L.) R. Br.]” was undertaken to obtain the information on heterosis, combining ability and nature of gene action for seed yield and its components by using line x tester analysis. Four female (testers), seven male (lines) and the resulting 28 crosses were evaluated in a Randomized Block Design with three replications at the Pearl Millet Research Station, Junagadh Agricultural University, Jamnagar during kharif-2017.

The observations were recorded on five randomly selected plants from parents and crosses for twelve characters viz., days to flowering, days to maturity, plant height (cm), number of effective tillers per plant, ear head length (cm), ear head diameter (cm), test weight (g), dry fodder yield per plant (g), grain yield per plant (g), harvest index (%), Fe content and Zn content.

The mean values were subjected to analysis of variance for the experimental design as per Panse and Sukhatme (1985). The heterosis was worked-out as per the standard procedure, while the combining ability analysis was done as per the method proposed by Kempthorne (1957).

The salient findings of the present investigation are summarized as under:

Analysis of variance for the experimental design revealed significant differences among the genotypes for all the characters suggesting the presence of wide genetic variability in the material used. The differences among the parents were also found significant for most of the characters except test weight. The differences among the hybrids were also found significant for all the characters suggesting that hybrids differed themselves for all the characters except for number of effective tillers per plant, ear head length, ear head diameter. The mean squares due to parents vs hybrids were also found significant for all the characters except for number of effective tillers per plant indicating presence of mean heterosis for these characters.
Summary and Conclusions

1. High heterosis was observed for days to flowering, days to maturity, plant height, number of effective tillers per dry fodder yield per plant, grain yield per plant and Fe content. Whereas, the magnitude of heterosis was moderate for ear head length, ear head diameter, test weight, and Zn content.

2. The hybrids exhibited marked heterosis over better parent and standard variety for various characters. Significant and positive estimates of heterobeltiosis and standard heterosis were observed in 05 and 22 cross combinations, respectively for grain yield per plant. The range of heterobeltiosis was from -31.36 to 23.32%. The highest heterobeltiosis was registered by the cross JMSA₅ 20171 x 153-SB-17 followed by ICMA₁ 10222 x 127-SB-17, ICMA₁ 12444 x 118-SB-17, JMSA₅ 20171 x 130-SB-17, ICMA₁ JMSA₅ 20171 x 54-SB-17 and ICMA₁ 10222 x 128-SB-17. While, the standard heterosis ranged from -22.14 to 65.22% for the grain yield per plant. The cross combination JMSA₅ 20171 x 153-SB-17 followed by ICMA₁ 10222 x 127-SB-17, JMSA₅ 20171 x 54-SB-17, ICMA₁ 10222 x 128-SB-17, ICMA₁ 12444 x 118-SB-17 and JMSA₅ 20171 x 128-SB-17 exhibited the highest heterosis over standard check also recorded significant standard heterosis for days to flowering, days to maturity, plant height, ear head length, ear head diameter, test weight and dry fodder yield per plant. The results thus, showed that the heterosis for grain yield per plant was associated with heterosis for its component characters.

3. The magnitude of heterosis varied from cross to cross for all the characters studied. The conspicuous heterotic response in certain crosses and low in others, revealed the nature of gene actions, which varied according to the genetic makeup of the parents. Significant level of positive and negative heterobeltiosis and standard heterosis in several crosses for most of the traits also indicated genetic diversity of parents used in present investigation.

4. Analysis of variance for combining ability revealed that the mean squares due to female (testers) were significant for ear head length, test weight, dry fodder yield per plant and harvest index. Whereas, the mean square due to male (lines) were significant for only Zn content. The mean square due to line x testers were found significant for days to flowering, days to maturity, plant height, dry fodder yield per plant, grain yield per plant and Fe content. The
results indicated the importance of both additive and non-additive genetic variances in the expression of these characters.

5. The estimated components of genetic variance indicated that the magnitude of variance due to female (tester) ($\sigma^2_t$) was higher than those due to testers ($\sigma^2_t$) and lines x testers ($\sigma^2_{lt}$) for ear head length, ear head diameter, test weight and harvest index. While, male (lines) ($\sigma^2_l$) was higher for Zn content. The magnitude of $\sigma^2_{lt}$ was higher in case days to flowering, days to maturity, plant height, dry fodder yield per plant, number of effective tillers per plant, grain yield per plant and Fe content.

6. Analysis of variance for combining ability revealed that both additive and non-additive genetic variances played an important role in governing all the characters. The additive genetic component was predominant in the genetic control of ear head length, ear head diameter, test weight, harvest index and Zn content, while non-additive genetic component was more important for days to flowering, days to maturity, plant height, number of effective tillers per plant, dry fodder yield per plant, grain yield per plant and Fe content.

7. The greater than unity ratio of $\sigma^2_{gca}:\sigma^2_{sca}$ were only for ear head length, ear head diameter, test weight, harvest index and Zn content indicated that this character was governed by additive type of gene action. Whereas, less than unity ratio of $\sigma^2_{gca}:\sigma^2_{sca}$ were for days to 50% flowering, days to maturity, plant height, number of effective tillers per plant, dry fodder yield per plant, grain yield per plant and Fe content suggested that these characters were predominately under the control of non-additive gene action. Additive gene action is fixable and selection would be advantageous in segregating generations, while non-additive gene action can be exploited by adopting biparental mating in early segregating generations followed by pedigree selection.

8. The estimates of gca effects indicated that none of the parents was found good general combiner simultaneously for all the characters. This indicated that separate parents would have to be used for improvement of different traits. However, the parental female ICMA1 10222 gave desirable gca effect simultaneously for five characters viz., days to flowering, days to maturity,
Summary and Conclusions

plant height, grain yield per plant and harvest index followed by 160-SB-17 for four characters viz., days to flowering, days to maturity, ear head length and dry fodder yield per plant. These parents were identified as the best lines in the present study. The high yielding segregants are expected to appear in the progenies of the crosses for their utilization in the improvement in component traits, which are related to grain yield in pearl millet.

9. The results indicated that the parents (lines and/or testers) showing desirable gca effect for more number of components possessed high concentration of favourable genes for more number of traits and should be utilized in multiple crossing programmes in order to combine important attributes and to develop high yielding types in pearl millet.

10. The estimates of sca effect of the crosses indicated that two hybrids manifested significant and positive sca effect for grain yield per plant. The best two specific combinations were JMSA₅ 20171 x 153-SB-17 and ICMA₁ 12444 x 118-SB-17 was also found good specific combiner for dry fodder yield per plant and number of effective tillers per plant. As well as, the cross JMSA₅ 20155 x 54-SB-17 also showed desirable sca effect for plant height, test weight, Fe content and Zn content. The cross ICMA₁ 12444 x 127-SB-17 also showed desirable sca effect for days to flowering and days to maturity. The cross ICMA₁ 10222 x 130-SB-17 recorded significant sca effects in desirable direction for Fe content, Zn content, test weight and ear head diameter. The high sca effect observed for grain yield per plant was associated with desirable sca effect manifested by its component characters like plant height, number of effective tillers per plant, ear head diameter, test weight and dry fodder yield per plant.

11. The crosses showing high heterosis coupled with high sca effect involved at least one parent with good gca effect. Such crosses are expected to give desirable transgressive segregants in the segregating generations if additive genetic system present in good general combiner and the complementary epistatic effect in F₁ act in same direction to maximize the desirable plant attribute.
Summary and Conclusions

From the present findings it can be concluded that sufficient variation was present in the material for grain yield and its components. Both additive and non-additive genetic variances were found important in the expression of all the traits. The additive gene action was more important for the five characters such as ear head length, ear head diameter, test weight, harvest index and Zn content. Thus, it would be possible to improve these traits through pedigree breeding method. The preponderance of non-additive genetic variance was observed in the inheritance for seven characters such as days to flowering, days to maturity, plant height, dry fodder yield per plant, grain yield per plant and Fe content. This suggested that heterosis breeding or bi-parental mating would be more suitable for the improvement of these traits in pearl millet.

Considerable amount of heterobeltiosis and standard heterosis was observed for most of the characters studied. The crosses JMSA5 20171 x 153-SB-17, ICMA1 10222 x 127-SB-17 and JMSA5 20171 x 54-SB-17 displayed high magnitude of standard heterosis for grain yield per plant and some of its components. The cross ICMA1 10222 x 130-SB-17 showed highest heterobeltiosis over better parent in desirable direction for Fe content, Zn content These crosses could be exploited further for obtaining desirable types in pearl millet.

The female ICMA1 10222 and JMSA5 20171 and the male 128-SB-17 displayed high gca effect and for grain yield per plant and some desirable traits like plant height, ear head length, ear head diameter and harvest index. Therefore, these parents were identified as good general combiners and could be preferred in breeding programme as these parents upon crossing, are expected to give desirable segregants in the succeeding generations.

The crosses JMSA5 20171 x 153-SB-17 displayed high sca effect for grain yield per plant and the cross ICMA1 10222 x 130-SB-17 recorded significant sca effects in desirable direction for Fe content, Zn content. The high sca status of the hybrids indicated that substantial role was also played by dominance and epistatic interaction. Such crosses could be exploited through heterosis breeding

The most of the crosses exhibiting high sca effect involved either good x poor, poor x poor or good x good general combiners, in that order, for majority of the characters studied. The results suggested the presence of additive x dominance,
Summary and Conclusions

dominance x dominance and additive x additive type of gene interactions. The presence of additive or additive x additive interaction effects would enhance the chances of making improvement through simple selection. The prevalence of both additive and non-additive genetic effects suggested the simultaneous exploitation of these gene actions by adopting selective inter-mating and recurrent selection, which would accumulate more of additive genetic variability. The non-additive gene effect can be exploited by the breeding procedures involving bi-parental mating followed by few cycles of recurrent selection. When epistasis is present, the recurrent selection followed by pedigree or bi-parental mating or diallel selective mating systems may prove to be effective in the improvement of parental lines used in the present study for improvement of grain yield and its attributes and those improved parental lines can be used for the development of best heterotic hybrids.