Chapter-VI

SUMMARY AND CONCLUSION
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“Studies on the stability parameters and biometrical traits of yield and yield contributing characters in linseed (Linum usitatissimum L.)” was carried out to gather the information on yield, quality and developmental traits pertaining to productivity involving 10 parents of wider genetic base and their all possible crosses under diallel mating design in linseed. The final experiment was conducted in Randomized Complete Block design with three replications at three diverse locations namely, Rath (Hamirpur), Jabalpur and Kanpur in the Rabi season of 1998-99. The experiment consisted of 10 parents and their 45 F₁s and F₂s of straight single crosses with no reciprocals at each location.

The observations on 13 characters at all the three locations in parents, F₁s and F₂s were recorded with regard to days to 50% flowering, days to maturity, plant height, technical plant height, number of tillers per plant, number of capsules per plant, number of seeds per capsule, 1000 seed weight, harvest index, fibre yield per plant, oil content in percent and seed yield per plant. Data were put to different statistical analyses viz, component analysis for gene action, combining ability, heterosis, inbreeding depression, stability parameters, heritability and genetic advance. The results of the study have been attributed to succeeding paragraphs

Analysis of variance revealed significant differences among the treatments for all the characters at all the locations and in both the generations. The orthogonal break up of treatment
mean sum of squares like parents vs F₁s and parents vs F₂s were also significant for all the traits in both the generations at all the locations and pooled over locations.

High degree of variability was observed in all the traits for all the locations and pooled over locations. However, its magnitude varied from character to character and generation to generation.

The variance component analysis showed highly significant differences for additive component at all the locations in both the generations for days to 50% flowering, plant height, number of capsules per plant, fibre yield per plant, oil content and seed yield per plant whereas, it also indicated significant differences in number of seeds per plant, technical plant height and 1000 seed weight at all the locations and in days to maturity at Rath and Kanpur in F₂ generation.

Dominance components (\(\hat{H}_1\) and \(\hat{H}_2\)) showed highly significant values for all the characters in both the generations except technical plant height for \(\hat{H}_1\) in F₂ at Kanpur; number of tillers per plant for both \(\hat{H}_1\) and \(\hat{H}_2\) at Jabalpur and in F₂ at Kanpur, days to maturity, number of branches per plant and harvest index for both \(\hat{H}_1\) and \(\hat{H}_2\) in F₂ at Kanpur.

Combining ability variance analysis was conducted for 13 characters in F₁ and F₂ generations separately for all the locations. In F₁ s, the mean sum of squares due to GCA and SCA was recorded highly significant for all the characters at each location.

In F₁, the values of GCA variance were less than those of SCA variance for all the characters at all the locations except for
days to maturity at all the locations, plant height at Jabalpur and Kanpur, days to 50% flowering and fibre yield per plant at Rath and Kanpur where GCA variance was higher. In F2, mean sum of squares of GCA and SCA were significant for all the characters at all the locations. The estimates of GCA variance were less than SCA variance for most of the yield contributing characters at all the locations except plant height and oil content at all the three locations, days to 50% flowering and seed yield per plant at Rath and Jabalpur, technical plant height and fibre yield per plant at Rath and Kanpur.

The high estimates of $\sigma^2 \hat{g}$ were present in comparison to $\sigma^2 \hat{s}$ for the characters namely days to 50% flowering, plant height, number of tillers per plant, fibre yield per plant in both the generations and for days to maturity in F1, while other characters showed high estimates of $\sigma^2 \hat{s}$. The $\sigma^2 \hat{s}l$ interaction was comparatively higher than $\sigma^2 \hat{g}l$ interaction for all the characters except number of capsules per plant and harvest index in both the generations indicating better stability in all the traits except number of capsules per plant and harvest index.

The sum of interaction components ($\sigma^2 \hat{g}l + \sigma^2 \hat{s}l$) exceeded the sum of genetic variances ($\sigma^2 \hat{g} + \sigma^2 \hat{s}$) for days to 50% flowering, days to maturity, number of capsules per plant, number of seeds per capsule, 1000 seed weight in both the generations, while characters, plant height, number of tillers per plant, number of branches per plant, harvest index and oil content reflected higher values in F2 generation.

The estimates of $\sigma^2 \hat{g}l$ were significant for days to 50% flowering, days to maturity, plant height, technical plant height,
number of branches per plant, number of capsules per plant, harvest index and seed yield per plant in both the generations whereas, 1000 seed weight in F2 generation and fibre yield per plant in F1 generation showed same significant differences. The $\sigma^2_{gl}$ interactions were less in comparison to $\sigma^2_{sl}$ interaction for all the characters in both the generations except number of capsules per plant and harvest index in both the filial generations. The interaction of $\sigma^2_{sl}$ revealed significant differences for all the characters in both the generations except number of seeds per capsule, harvest index in F2 and oil content in F1 generation.

The mean performance and significant GCA effects revealed that the parents LMH-62, Sweta and Garima were good general combiners in both the generations and in pooled analysis for days to 50% flowering; LMH-62 and RLC-6 for days to maturity; LMH-62, RLC-6, Garima and Shubhra for plant height; DPL-21, LCK-88062 and KL-43 for technical plant height and for number of tillers per plant, LMH-62, Sweta and Shubhra for number of branches per plant, LMH-62 for number of capsules per plant; Neelam and LCK-88062 for number of seeds per capsule; Neelam and J-23 for 1000 seed weight, LMH-62, Garima, Shubhra and Neelam for harvest index; DPL-21, LCK-88062, KL-43 and Neelam for fibre yield per plant, LMH-62, RLC-6, Sweta, Shubhra and KL-43 for oil content and LMH-62, Garima and LCK-88062 for seed yield per plant. It is significant to point out that the parent LMH-62 amongst all was found to be best general combiner for more than 55 percent of the characters while LCK-88062 for more than 35 percent and Garima, Shubhra, KL-43 and Neelam for more
than 30 percent and Sweta and RLC-6 for more than 20 percent were as best combiners.

The significant and desirable SCA effects for seed yield were found in eight combinations in F₁ and in five combinations in F₂ generation. These combinations involved all sorts of possible combinations between higher and lower order of GCA effects. Crosses Neelam/LMH-62, LMH-62/DPL-21, LMH-62/RLC-6, Sweta/LMH-62, Shubhra/LMH-62, LMH-62/J-23, RLC-6/Garima, Sweta/LCK-88062 in F₁ generation; LMH-62/RLC-6, Garima/KL-43, LMH-62/DPL-21, Neelam/LCK-88062 and Neelam/Garima in F₂ generation exhibited significant and desirable SCA effects involving one parent with desirable GCA effect and other parent with undesirable GCA effects for seed yield per plant. The cross combinations exhibiting significant and desirable SCA effects and in which both the parents were having desirable and significant GCA effects were J-23/Garima and LMH-62/J-23. In case of fibre yield per plant cross combinations Shubhra/DPL-21, DPL-21/J-23, LMH-62/DPL-21, Sweta/DPL-21, DPL-21/Garima and Shubhra/LCK-88062 in F₁ generation, DPL-21/Garima, LMH-62/DPL-21 and Shubhra/LCK-88062 in F₂ generation exhibited significant and desirable SCA effects involving one parent with desirable GCA effects for fibre yield per plant. Crosses Neelam/LCK-88062 and Neelam/KL-43 in F₁ and crosses DPL-21/LCK-88062, DPL-21/KL-43, KL-43, LCK-88062 and Neelam/KL-43 exhibited significant and desirable SCA effect with both the parents were having significant and desirable GCA effects for fibre yield per plant. Cross LMH-62/DPL-21 exhibited significant and desirable SCA effect involving one parent with desirable GCA effect was common for
both seed and fibre yield therefore, it is highly considerable for the development of double purpose variety

Heterosis estimated in percent over the superior parent for seed yield was significant and positive in 23 crosses on pooled basis. Majority of the hybrids also exhibited desirable and significant SCA effects. Whereas 33 crosses revealed significant and desirable heterosis over mid parent on pooled basis. The maximum 68.75 percent heterosis over superior parent was observed in case of Sweta/DPL-21 followed by Shubhra/Sweta (65.41 percent), Sweta/KL-43 (51.23 percent), Shubhra/RLC-6 (45.49 percent), DPL-21/KL-43 (41.65 percent), DPL-21/RLC-6 (38.65 percent), Sweta/LCK-88062 (37.77 percent), Shubhra/J-23 (33.98 percent), Neelam/RLC-6 (30.98 percent) and Sweta/RLC-6 (27.95 percent) for seed yield per plant and other attributes. Five top ranking cross combinations exhibiting average heterosis were Shubhra/Sweta (100.75 percent), Sweta/KL-43 (77.33 percent), Sweta/LCK-88062 (65.17 percent), Shubhra/RLC-6 (61.87 percent) and DPL-21/KL-43 (56.92 percent) for seed yield per plant and other related characters. Significant inbreeding depression for seed yield was noted in 29 crosses. The highest magnitude of inbreeding depression was noted for the cross Neelam/LMH-62 (37.84 percent) and minimum negative inbreeding depression (-35.92 percent) was expressed by the cross Shubhra/DPL-21 for seed yield per plant. Increase in seed yield was due to non-additive genetic component as manifested by the preponderance of dominant genes for high yield in the present set of material.

The stability analysis revealed that genotype × environment interactions were highly significant for all the
characters. The non-linear components (pooled deviation) were also found to be highly significant for all the characters. The environment (linear) component was highly significant for all the characters. The large variation in regression coefficients revealed that the varieties/species and their F₂s had different degree of environmental response. None of the parents and F₂s manifested average stability when all the three parameters were considered together for all the characters. However, parents LMH-62, KL-43 and RLC-6 for seed yield per plant, LCK-88062 and Neelam for fibre yield per plant and Sweta and RLC-6 for oil content were found to be stable on the basis of their performance under wide range of environmental fluctuation. Stability parameters for 45 F₂ s were worked out at all the locations for all the characters and out of these six combinations namely, LMH-62/Garima, RLC-6/Garima, Sweta/Garima, RLC-6/LCK-88062, Garima/LCK-88062 and DPL-21/LCK-88062 for seed yield per plant and cross combinations LMH-62/DPL-21, DPL-21/KL-43, LMH-62/LCK-88062 and Garima/KL-43 were observed highly stable for fibre yield per plant.

High heritability estimates were observed for days to 50% flowering, plant height, harvest index, fibre yield per plant, oil content and seed yield per plant in both the generations, while it was moderate for technical plant height and number of capsules per plant in F₁ and for days to maturity, number of tillers per plant, number of branches per plant and number of capsules per plant in F₂ population on pooled basis. The low heritability estimates were noted for number of branches per plant and number of capsules per plant, 1000 seed weight in F₁ on pooled basis.
Expected genetic gain was high for days to 50% flowering plant, height, fibre yield per plant and seed yield per plant coupled with high heritability estimates in both the generations and for number of tillers per plant in F₁ and for technical plant height in F₂. Medium genetic gain was worked out for harvest index in both the generations, for days to maturity and for technical plant height in F₁, for number of tillers per plant, number of branches per plant, number of capsules per plant, number of seeds per capsule and 1000 seed weight in F₂. Rest of the characters exhibited low estimates of genetic gain.

On the whole, it is suggested that population improvement concept with the use of biparental mating, reciprocal recurrent selection followed by concurrent breeding approach would be more helpful for those characters which are governed by non-additive gene action. Pedigree method and back cross procedure are equally important for the improvement of yield characters governed by additive type of gene. After all possible combinations, the handling of material may be carried out with the help of pedigree and mass selection. No doubt, this study will definitely help the plant breeders dealing with the crop to check out the sound breeding programme for enhancing yield with other characters in order to release varieties of high yield level with stable performance in all kinds of environments.

It is also suggested that the breeding strategy for such valuable crop like linseed should be initiated separately for the development of seed type, double purpose type (seed and fibre) and flax type to utilize each and every part of the crop.