6. SUMMARY

The present investigation was undertaken to standardize the mutation breeding methodology with a view to explore the possibility of rapid varietal development over hybridization. Therefore, an attempt was made to develop an effective screening technique to identify promising progenies in the mutagenized population of Cowpea [Vigna unguiculata (L.) Walp]. Efforts were mainly directed to evolve a system of selection for polygenic variability in earlier generation M_2 which would enhance the efficiency of breeding for polygenic characters through induced mutagenesis.

The immediate effect of mutagenic treatments on germination, plant survival and pollen sterility was studied in M_1 generation. In general, all the mutagenic treatments caused considerable damage to the genetic material. Dose-dependent increase in biological damage was recorded with all the three mutagens used. Among the three mutagens treated, gamma rays caused maximum biological damage, followed by EMS and combined in M_1 generation. In order to identify plants with maximum mutagenic damage, the M_1 plants were classified in three classes i.e. germination, plant survival and pollen sterility parameters so that the highly damaged plants can be identified early, as they are expected to yield mutations with higher frequency in the succeeding generations.
The macro mutational studies in $M_2$ generation revealed many interesting features. There was a clear parallelism between the frequency of chlorophyll and morphological mutations depending on the mutagens and doses. However, chlorophyll mutations appeared with higher frequency than morphological mutations. The frequency of both chlorophyll and morphological mutations was almost linearly dose dependent in case of gamma-rays, whereas, in case of chemicals, the medium dose gave highest frequency of both chlorophyll and morphological mutations. Among the mutagens used EMS (%) showed maximum effectiveness in including macro mutations, followed by combined and gamma rays.

As regards the spectrum of chlorophyll mutations, all the four mutations types (albina, chlorina, xantha and viridis) recorded were induced by the three mutagens with different rates. Among the various chlorophyll mutations, viridis type was induced most frequently, whereas albina was the rarest mutation induced. Most frequent among the morphological mutations were narrow leaved, early, tall, dwarf, bushy plant type and pod type, and seed type whereas sterile and rouge mutant were the most rarely induced mutations. A mild relative mutagenic specificity was observed in relation to morphological mutations. All the viable mutation types were induced by the gamma rays, chemical and combined (gamma rays + EMS), whereas gamma irradiation induced only more types of morphological mutations.

The mutagenic effectiveness (per unit mutagenic dose) and efficiency (in relation to sterility induced in $M_1$ generation) were also studied. Among the mutagens tested, gamma rays were more efficient and effective than chemical. Out of the chemical and combined mutagens over combined
(Gamma rays + EMS) for both these parameters effectiveness as well as efficiency.

In general, all the mutagenic treatments generated substantial amount of variability for all the fifteen polygenic characters studied viz days to 50% flowering, days to maturity, plant height (cm), number of primary branches per plant, number of secondary branches per plant, number of clusters per plant, number pods per cluster, pod length (cm), number of seeds per pod, 100-seed weight (g) and seed yield per plant (g), seed yield per plot (kg), biological yield per plant (g), harvest index (%) and protein content (%) in both M2 and M3 generations. The polygenic variability recorded in M3 coefficient of variation was more than in M2 coefficient of variation for different characters except few cases. However, the magnitude of variability expressed in M2 itself is high enough to exercise effectiveness selection. Among the characters studied, yield and pods per plant showed maximum induced variability followed by number of branches per plant, number of seeds per pod and plant height (cm), whereas, days to maturity and days to 50 per cent flowering showed minimum variability. The increase in variance due to generation advancement was negligible for seed yield per plant (g), number of pods per cluster and number of seeds per pod, whereas it was significantly higher for the remaining four polygenic characters. This leads to the conclusion that selection for seed yield, number of pods per cluster and number of seeds per pod could be confined to M2 alone, as much advantage is not expected by advancing the mutagenized population to M3. Among the mutagens tested gamma rays induced the highest magnitude of polygenic variability followed by chemical and combined (Gamma rays + EMS). Another
important feature of this analysis was detection of a great deal of heterogeneity among different $M_2$ families in each mutagenized population in respect of mean values for all the characters. It is proposed that selection in $M_2$ should be based on desired shift in character mean and higher coefficient of variation than the highest observed in the control to identify the promising $M_2$ families. Intra family selection was also practiced among promising families. As a result a large number of promising families were isolated from the $M_2$ population itself most of which were confirmed in $M_3$ generation. The frequency of such families with different mutagens was in the order of gamma rays > chemical > combined.

Among the three populations (distinguished in $M_2$) studied in $M_3$ generation, the macro mutational population showed greater variability than the unselected and selected non-segregating $M_3$ populations. As expected, selection in $M_2$ in general, pushed the material in the desired direction, but simultaneously reduced its total variability. Interestingly, character means in the macro mutational $M_3$ populations were not affected adversely. Therefore, in contrast to most of the previous studies, the present study strongly suggests that the chances of success will be higher in the macro mutational populations.

Another important fact revealed by the present investigation is the relative advantage of early generation selection. It was found that a high proportion of $M_2$ selections were confirmed as promising in $M_3$ generation. Although, promising progenies were further added to the total as a result of additional variability detected in $M_3$ generation, the material has to be increased nearly two times to spot these new promising progenies.
13% additional) in the advanced generation. This suggests that early generation selection can greatly help in identifying the promising families that are likely to show greater variability and better response to selection, and simultaneously reduce the volume of material by rejecting the non-mutated “Roughage”. This can immensely economies time and effort by advancing only the M₂ selections to M₃ for confirmation, further selection, preliminary testing and multiplication.

Thus, the overall analysis of the present investigation indicates that there is tremendous scope of improvement for polygenic characters through induced mutagenesis. The following conclusions can be drawn from the results obtained in this study.

1. The unwanted, non-mutated or poorly mutated material can be rejected in M₁ itself by identifying and selection of the plants with maximum genetic damage on the basis of seedling stage and sterility parameter in adult plants. It means that only the plants belonging to high seedling damage and high sterility should be advanced to the next generation for further evaluation.

2. Selection for polygenic characters can be started even in M₂ generation with high degree of confidence and precision on the basis of family mean and variance.

3. Selection for some characters may be confined to only M₂ generation as they do not show appreciable increase in variance as a result of advancement to the next generation. Such characters in the present study are, number of pods per cluster, seed yield per plant (g) and number of seeds per pod.
4. Selection efficiency for polygenic mutations can be further improved by selecting normal looking plants from the progenies segregating for macro mutations, as they always carry greater amount of polygenic variability also.

5. By selecting the right type of mutagens (gamma rays) at appropriate doses, the micro mutation frequency can be further enhanced appreciably.

The results of the present study convincingly demonstrate that beginning with the selection of proper mutagenic treatment combinations for the genotype to be improved upon, initiating the selection process. In M₁ generation itself by identifying plants with maximum mutagenic damage and further isolation of the progenies with high degree of induced variability in M₂, it is possible to obtain confirmed promising strains for polygenic mutations in M₃ generation, and the material can be tested in preliminary yield trials (PYT) in M₄ generation. If found convincingly superior to the existing standard checks, some of these selections can be evolved into varieties for multilocation testing. Such an approach gives all the advantages of rapid plant improvement through mutation breeding with greater confidence and higher speed.