Chapter 6

SUMMARY

In the present study an effort was made to explore the possibility of inducing genetic variability for eight quantitative traits viz; days to flowering, plant height (cm), days to maturity, number of fertile branches per plant, pods per plant, seeds per pod, 100-seed weight (g) and total plant yield (g) by using three chemical mutagens namely, ethylmethane sulphonate (EMS)-an alkylating agent, sodium azide (SA)-a respiratory inhibitor and hydrazine hydrate (HZ)-a base analogue on var. Avrodhi and var. BG-256 of chickpea (Cicer arietinum L). The other aspects of the study were (i) estimation of biological damage caused in M₁ generation (ii) study of comparative effectiveness and efficiency of mutagens used (iii) frequency and spectrum of morphological mutants (iv) estimation of total mutation rate among the mutagens and within their treatments (v) estimation of phenotypic and genotypic coefficients of variation, heritability and genetic advance (vi) screening of high yielding mutants and estimation of their seed protein content in M₃ generation.

The induced biological damage in M₁ generation due to different mutagenic treatments of EMS (0.1 to 0.4%), SA (0.01 to 0.4%) and HZ (0.01 to 0.04%) was measured by studying seed germination, seedling height, plant survival at maturity, microsporogenesis and pollen fertility. Results of the present study revealed that different concentrations of these mutagens caused a dose dependent reduction in these characters except meiotic aberrations in both the varieties. Chromosomal anomalies like univalents, multivalents, laggards, bridges micronuclei, nucleolar
fragmentation, stickiness of chromosomes and cytomixis were observed in the treated populations. EMS induced the maximum whereas, SA treatments gave minimum frequency of meiotic abnormalities. In general, EMS produced more deleterious (damaging) effects than SA and HZ.

A broad spectrum of chlorophyll mutations was obtained in M$_2$ generation of chickpea. Lower and moderate concentrations of EMS produced more chlorophyll mutation frequency whereas, no general trend was observed in SA and HZ treatments. Total (pooled) chlorophyll mutation frequency on mutagen basis indicated almost equal frequency in EMS and HZ while SA showed poorest frequency. ‘Xantha’ followed by ‘Chlorina’ outnumbered other types of chlorophyll mutants in both the varieties.

Effectiveness and efficiency of the mutagens varied not only within their treatments but also among them. In general, lower concentrations of EMS and SA and moderate concentrations of HZ were found to be most effective. Based on the values of effectiveness in both the varieties, the order of mutagenic effectiveness was: HZ>SA>EMS. Three criteria viz; seedling injury (Mf/I), pollen sterility (Mf/S) and meiotic abnormalities (Mf/Me) were taken into account for estimation of mutagenic efficiency. The order of efficiency in both varieties with regard to Mf/I and Mf/S was: HZ>EMS>SA and EMS>HZ>SA respectively, while with regard to chromosomal aberrations, the order of efficiency in var. Avrodhi was: EMS>SA>HZ and in var. BG-256 was: HZ>EMS>SA.

A broad spectrum of morphological mutations were detected in M$_2$ generation. The extended variability among the isolated mutants was
assessed in terms of mutation frequency. Both spectrum and relative
frequency of morphological mutations varied depending on variety and
mutagen. EMS induced the widest spectrum and frequency followed by HZ
and SA. Variety Avrodhi produced the broadest spectrum and frequency
than var. BG-256. Spectrum and frequency of mutation on mutagen basis
show relative specificity in case of induction of various type of mutations.
EMS showed broadest spectrum of mutations for plant type and leaf
morphology whereas, SA and HZ showed specificity for pod, seed and
yield mutations.

Chlorophyll and morphological mutation frequency was pooled to
derive a comprehensive efficiency order of the mutagen in the form of
mutation rate. Differences were observed in the mutation rates obtained
with the two varieties as well as among the mutagens applied and
also within their treatments. Among the mutagens, EMS indicated
highest mutation rate and was the most efficient followed by HZ and SA.
HZ 0.03 % and EMS 0.2% mutagenic treatments produced the highest
mutation rates.

Attempts were made to ascertain the effect of mutagenic treatments
on mean and coefficient of variation (CV%) in M₁ generation. Average
mean for almost all the quantitative traits remained more or less unchanged
in the treated population. However, the CV% differed from trait to trait and
the highest CV% over control was recorded for fertile branches/plant. The
mean shifted in both, positive as well as negative direction, its stretch
being more towards the negative side for days to flowering, plant height
and days to maturity in M₂ generation. The mean values for yield and its
components increased in most of the mutagenic treatments in M₂ whereas,
M₃ generation exhibited a complete positive shift in mean. The genotypic coefficient of variation, heritability and genetic advance were substantially enlarged in various quantitative traits in M₂ and M₃ generations.

Selection response in M₃ generation was evaluated for certain mutants which were superior to others in their performance for seed yield per plant. Mean number of fertile branches, pods per plant and yield per plant showed manifold increase over control mean. The other quantitative traits, namely, days to flowering, plant height, days to maturity etc. showed no significant differences in mean values. Higher estimates of GCV (%), PCV (%), heritability and genetic advance for yield and its component traits were also recorded. The increased genetic variability in yield and its components provides a good scope for further selection for these promising mutants.

Correlation studies between various character pairs of the isolated mutants exhibited a strong positive association between number of pods and total plant yield, thereby, indicating that the mutagenic treatments could alter the mode of association between characters apart from generating allelic variability.

Almost all the mutagenic treatments selected in M₂ generation induced a slight increase in seed protein content of the M₃ isolated mutants. In general, negative correlation between yield and seed protein content was observed in the high yielding mutants. It was further observed that wherever, there was pronounced increase in protein content in different mutants lines, there was corresponding decrease in the values of coefficient of variation (CV %) indicating that no further improvement in seed protein is possible.
Overall, results have shown that moderate concentrations of chemical mutagens used in the present study proved to be more efficient in generating polygenic variability than the higher concentrations; the latter induced high genetic damage via genotoxicity and lethality in the two varieties of chickpea.