SUMMARY AND CONCLUSION
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The legume breeder’s prime objective is to develop genotypes capable of producing optimal crop yield of a satisfactory quality in suitable area of production. In view of this background, the utility of novel approaches has been thought quite crucial for enhancing the yield potential and for developing the antinutritional component free genotypes of lentil in our country. Keeping in mind the excellent potential of induced mutations in plant improvement programmes, it was thought very much appropriate and relevant to initiate the mutation breeding work in lentil for achieving its genetic improvement.

The survey of literature indicated that very little attention has been paid by the scientists of our country in regard to creation of new variability and antinutritional free genotypes through the established method of induced mutation in lentil.

In present study two cultivars of lentil L-4611 and L-4639 were used to induce genetic variability. For this two chemical mutagens ethyl methanesulphonate (EMS) and Sodium Azide (SA) were tried.

Studies pertaining to mutation breeding of lentil were spread over three generations.

Studies in $M_1$ generation:

The different parameters studied in $M_1$ generation were seed germination, seedling height and seedling injury, pollen sterility, plant survival and leaf morphological changes.

1. Seed Germination:

The two mutagens had an inhibitory effect on germination in both the cultivars of lentil. The degree of inhibition in germination was found to be in proportion with the increasing concentration of the mutagen.
However, the germination percentage was slightly higher in cultivar L-4611 after EMS and SA treatments as compared with cultivar L-4639 of lentil.

2. Seedling height and seedling injury:

There was a linear reduction in seedling height with increasing concentration of the mutagens. In contrast, the percentage seedling injury increased with an increase in concentration of the mutagens. The maximum seedling injury was observed at the highest concentration of the two mutagens in both the cultivars.

Both the cultivars were more sensitive to EMS than the SA treatments.

3. Pollen sterility:

The two cultivars showed a more or less similar response to increased pollen sterility with increasing concentrations of the two mutagens. The maximum sterility could be seen at 0.15% EMS in L-4611 and L-4639 cultivars. In case of Sodium Azide maximum sterility could be seen at 0.03% concentration in L-4611 and L-4639 cultivars. Both the cultivars indicated better sensitivity towards EMS treatments.

4. Plant survival:

A decrease in plant survival was observed with a corresponding linear increase in the rate of lethality and seedling injury for all the mutagenic treatments in both the cultivars.

5. Leaf abnormalities:

The leaves of the treated plants exhibited variations in the shape and size as compared to the control plants. Some of the leaves demonstrated a bifoliate tendency. The leaf variations were observed mostly in the basal region of the M1 plants.
Studies in M₂ generation:

In M₂ generation, which was raised as progeny lines, chlorophyll mutants like *albina*, *xantha*, *chlorina* and *viridis* were detected. The frequency showed wide fluctuations with the dose of mutagens in both the varieties. Higher concentration of both the mutagens produced the highest frequency of chlorophyll mutants in both the varieties.

The M₂ population revealed quite a good number of viable morphological mutants having desirable characteristics. The spectrum of such mutants was found to be broad in case of both the varieties of lentil. The different morphological mutants obtained were of the following types: 1) Tall, 2) Dwarf, 3) early maturing, 4) high yielding, 5) Bold seed, 6) Spotted seed, 7) Small seed and 8) Twining in both the cultivars of lentil. In addition to this in cultivar L-4639 the black seed mutant was also observable. The frequency of viable mutants demonstrated a variable trend at different concentrations of both the mutagens.

Most of the viable mutants could be observed as breeding true in the subsequent M₃ generation. Some of these mutants can be very well utilized on commercial basis in view of the varied positive attributes possessed by them. In this regard the early maturing, high yielding and bold seed mutant of lentil would be of great value.

The data on quantitative characters such as height of plant, days to flowering, days to maturing, number of pods per plant, number of seeds per pod and 100 seed weight were collected in M₂ and M₃ generations of lentil.

The statistical analysis of the pertinent data was carried out to understand the effect of mutagens in shifting the mean and variance in either direction. The mean, S.E. and t values were computed. Most of the mutagenic treatments in both the varieties of lentil succeeded in generating a significant positive shift in mean values.
Trypsin inhibitor of lentil germplasm and mutants:

About 49 lentil germplasm and 200 M2 plants were analyzed for trypsin inhibitor (TI) by electrophoresis and quantitation. A marginal difference in TI content and isooinhibitor profile was detected in lentil germplasm. The lowest TI content (140.25TIU) was found in IC-201695 germplasm, while the highest TI content could be recorded in the germplasm IC-208326 (830.666TIU). Out of seven isooinhibitors, four isooinhibitors of trypsin were major, while three isooinhibitors were minor with weak expression as revealed by X-ray film technique.

In comparison with the control TI profile some M2 mutants showed significant changes in trypsin isooinhibitors. There were some feebly expressed isooinhibitors in these mutants. These mutants also showed 30-50% reduction in TI content by quantitation. The quantitation of protein of germplasm and mutants showed significant variation and changes.

Trypsin inhibitor during seed germination:

The variety L-4611 was studied for this objective. From the TI profile it could be seen that up to 10th day stage of germination the TI content remained almost constant and thereafter a decrease in TI content could be seen.

Effect of heat on trypsin inhibitor activity:

L-4611 germplasm of lentil was studied for the heat processing inactivation of trypsin inhibitor activity. TI activity was completely lost after 45 minutes of boiling of seed extract in boiling water bath.

Lectin content in lentil germplasm and mutants:

49-lentil germplasm and 200 M2 mutants were analyzed for lectin content. A noticeable difference in lectin content was detectable in lentil germplasm. The lowest lectin content
(3.478) was found in L-345, while the highest content could be noticed in germplasm L-4642 (23.188).

In comparison with control, the lectin content in some of the M₂ mutants revealed significant changes in lectin content. These mutants showed 10-40% reduction as regards that parameter.

**Phenol content in lentil germplasm and mutants:**

Regarding phenol content, 49 lentil germplasm and 200 M₂ mutants were analyzed and noticeable differences could be observed in germplasm. While in mutants the phenol content was observed to be reduced up to 10-40% as compared with control.

From the foregoing it is concluded that the various mutagenic treatments tried in the present study have very much succeeded in inducing genetic variability with significant alterations in growth and metabolism of the plant body. The results obtained decisively demonstrated the usefulness and the effective potential of the induced mutational approaches in genetic improvement of lentil for recovering superior mutant plant types having high seed yield besides low trypsin inhibitor/lectin/phenol content.

As lentil is a nutritious pulse in human diet, its mutants like the low trypsin inhibitor, lectin and phenol content carrying would assume substantial economic importance. Such material would require lesser heat processing to nullify the antitryptic, lectin and phenol activity possessed by them. All such features can be used in conventional breeding programme to help develop high yielding, low trypsin inhibitor, low lectin besides reduced polyphenol lentil lines.