ABSTRACT

The present investigation deals with the gamma-irradiation test on *Linum usitatissimum* var. Mukta. The experiments aim to study the growth responses of linseed crop to gamma-irradiation under field condition. The radiation treatment ranged between 25 krad to 150 krad. The seeds were treated in dry condition at 10 per cent moisture level. The treated seeds, along with the untreated ones were sown in micro-plots randomly with five replicates each. The following are the results in summarized form:

1. The irradiated treatments do not affect the germination process of linseed materially, except delaying the rate at high intensity dose such as 100 krad and above. Contrary to the past findings in certain other crop plants, no stimulatory effect has been observed in the present case, even the delay caused by gamma rays is not observed in the subsequent generations.

2. The survival of seedlings has, however, been found to be adversely affected by gamma-irradiation in a direct proportion to the level of intensity involved in the treatment. However, in the subsequent generations the corresponding progenies do recover to their full extent.
3. The cotyledonary expansion as well as the dry matter content of cotyledons undergo marked alteration due to gamma-irradiation in M₁ generation. The cotyledonary expansion has been found to experience stimulatory effect under gamma-irradiation of 75 krad. The water holding capacity of cotyledons of the treated progenies particularly of high intensity doses has been observed to go higher than the control. All these alterations however, recover in the subsequent generations.

4. The significant retardation noted in the root growth of seedlings due to gamma-ray treatments has been found considerable under high doses at the 16th week. In no case a stimulatory effect is noted in the present study in M₁ generation. However, the ill effects of radiation treatments have been found to recover in the subsequent generations.

5. High incidence of reduction in shoot height and the rate of growth as affected by gamma-irradiation has been found to follow a linear order with the dose. No stimulation at any stage of shoot growth is observed. The suppressive effect of gamma-ray treatment has been found to be significant even in M₂ generation to a large extent and in M₃ to some extent. In the latter, the suppressive effect continued to be significant under high intensity doses at all stages of growth. No stimulatory effect either in M₁ generation or in the subsequent one is recorded in height growth of the shoot axis.
6. The radiation treatments have also been found to negatively affect the branching in the investigated variety under all treatments and at all stages of growth as compared to control. The adverse effect of irradiation is seen in the subsequent generations too and, therefore, appears to be a permanent effect especially under higher doses.

7. The growth rate of lateral branches gets affected due to irradiation at all levels of growth under all treatments except at the lowest, to a significant level. The suppressive effect of irradiation continues only up to $M_1$ generation. In $M_3$ generation the height growth of lateral shoot becomes normal. No stimulatory effect at any level in any generation is noted.

8. The gamma-irradiation treatments significantly affects the leaf production in the treated progenies at all levels of growth. The suppressive effect of irradiation is significant in all the three generations especially in the main shoot. However, it has not been found to be significant in the lateral shoots particularly in the subsequent generations.

9. The area per leaf as well as total green area per plant gets reduced highly due to gamma-irradiation. The reduction in green area happens to be significant at all stages of growth under all treatments in all the three generations. Therefore, this trait of the plant appears to have been damaged permanently by radiation treatments.
10. The reduction due to irradiation in the under-ground biomass and the dry matter distribution of roots have been recorded at all levels of growth. This suppressive effect of irradiation continues in the subsequent generations under all treatments except in a few cases, particularly of low doses at the early stages of growth.

11. The above ground biomass also showed significant reduction in $M_1$ generation under all treatments at all stages of growth and no recovery appears to have been occurred in the subsequent generations of $M_2$ and $M_3$ in this respect.

12. The dry matter content as well as its distribution per centimeter length of the plant body is found to be affected highly in the treated plants. The dry matter distribution showed a retrogressive trend with increasing doses. But the water content has been found to increase over the control under high intensity treatment from 100 krad on ward. The increase in water holding capacity induced by irradiation treatment does not appear to continue in toto in the subsequent generations, although the dry matter content continues to be visibly less both in root and shoot.

13. The gamma-ray treatments affect the reproductive phase of the variety investigated. The number of flowers and the number of fruits get significantly reduced per plant due to the increasing intensities of radiation treatments. Further, the
number of seeds per fruit and the seed weight also get affected to a significant level due to irradiation. As a consequence, the seed yield per plot is reduced to a significant level under all treatments in a direct proportion to the dose. And the adverse effect of irradiation on the reproductive units as well as the yield continued in M₂ and M₃ generations to a lesser extent though not at the same level. The reduction in yield is found to be significant in all the three generations, although the subsequent generations show recovery to a great extent especially under high doses.

14. The reproductive capacity of the variety investigated get damaged seriously under all the doses in M₁ generation. In M₂ and M₃ generations, the reproductive capacity of the treated progenies recovers to a considerable extent but remained considerably low in comparison to control.

15. The radiation treatments causes number of variations, both morphological and anatomical in the progeny.

16. The habit of the plant has been observed to undergo a very significant change from erect to semiprostrate as a result of radiation treatment.

17. The shoot apices of treated plants undergo condensation, conversion into leaf-like bodies, twisting and bending. The shoot apices have also been seen to bifurcate often.
18. The treated plants undergo abnormal branching adventitiously.

19. The foliage leaves undergo fusion and bifurcation due to irradiation. Further, the variegation in the leaves, too, is the consequence of the same treatment.

20. The phenomenon of fasciation has also been observed under high doses such as 100 krad, 125 krad and 150 krad treatments.

21. The radiation treatments have also produced a number of qualitative and quantitative abnormalities in the floral parts, viz., complete or partial fusion of sepals and petals in progenies raised after heavy doses of gamma rays.

22. Fasciated branches have been found to flower. In such branches, the flowers arise so close to each other that they appear as condensed head-like structures having partially fused flowers.

23. The gamma-ray treatment is also found to cause heavy damage to pollen fertility, which goes down as low as to the tune of 2% under high doses.

24. All the abnormalities listed above are found to recover in the subsequent generations. No abnormality appears to be permanent.
25. A number of anatomical variations also develop in the shoot axis due to radiation treatment.

i) The ground tissue, constituting the pith and cortex undergoes proliferation along with an increase in the number of perivascular fibres in the first generation after gamma-ray treatment in a direct proportion to the irradiation level.

ii) The xylem cylinder is noticed to undergo thinning in the treated plants.

iii) The proliferation of ground tissue, the reduction in xylem development and the disorientation due to knot formation noticed in M₁ generation, do not reappear in the subsequent generations.

iv) In the affected xylem of M₁ generation, while the frequency of vessel elements undergoes reduction, the wood rays increase in number per unit area and the ray components multiply to make the ray bodies wider than in control.

v) The radial system in the wood of treated plants has been found to increase in M₁ generation, whereas in the subsequent generations it is so much reduced as to become lesser in quantity compared to the control.
vi) In the heterogenous ray system of *Linum*, the gamma radiation has induced homogeneity in having only upright or procumbent cells.

vii) The tracheary elements develop thick walls in general. They also develop gelatinous walls which almost cover the lumen of the cells.

viii) The ray cells have also been found to develop thick lignified walls after gamma-ray treatment.

ix) Both the vessels and fibres exhibit dimensional variations due to gamma-irradiation.

26. The dimensional, structural and quantitative anomalies noted in *M₁* generation have been observed to undergo partial recovery in the subsequent *M₂* and *M₃* generations.