

# INDUCED VARIABILITY IN SOYBEAN

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THE efficiency of induced mutations in increasing genetic variability has been demonstrated in several crops and a number of varieties have been evolved (Mac Key, 1956; Sigurbjornsson and Micke, 1974). However, this tool has remained practically unexploited for the improvement of soybean (*Glycine max* (L) Merrill). This study was, therefore, undertaken to assess the extent of induced genetic variability for different quantitative characters in soybean.

## MATERIALS AND METHODS

Two hundred seeds of 'Bragg', 'Ankur', 'Semmes', 'PK-71-39', 'UPSM-229', 'UPSM-539' and 'Type-49' soybeans were irradiated with 10 kr, 15 kr and 20 kr of gamma-rays at the National Botanic Gardens, Lucknow. The irradiated seeds along with unirradiated controls were planted in single row plots in the rainy season. At maturity seeds of individual plants were harvested and kept separately for each variety and each treatment. The individual  $M_1$  progenies were planted in the next rainy season and screened for macro-mutations. All the  $M_2$  progenies which did not segregate for macromutations were harvested in bulk treatment wise constituting  $M_3$  seeds. A trial consisting of 28 treatments using the bulk  $M_3$  seeds of aforementioned seven varieties irradiated with 0 kr, 10 kr, 15 kr, and 20 kr of gamma-rays was planted in randomized block design with 4 replications in the subsequent rainy season. Each plot consisted of 5 rows 6 meter long. The row to row distance was 60 cm and plant to plant distance 4-5 cm. Fifteen random plants in the middle 3 rows of each plot were tagged immediately after germination for taking observations on days taken to flower and maturity, plant height, pods per plant, seeds per pod, branches per plant, and yield per plant. In addition, 5 meter strips from the middle 3 rows of each plot were harvested for estimating the yield per plot to which the yield of separately harvested 15 plants was also added.

## RESULTS

Significant varietal differences were noted for all the characters, but the mean differences (plot basis) between treatments within varieties were rarely significant indicating that there were no unidirectional mutations. However, the extent of variability in irradiated populations was invariably more than in the controlled populations, for all the characters except days taken to flowering and branches per plant.

*Days taken to maturity:* Except for 'Bragg' and 'Type-49', the effect of doses was insignificant in all the varieties. The variance of unirradiated population was uniformly less than the irradiated populations in all the varieties; however, the difference were significant only in a few cases such as 'Semmes' 20 kr, 'UPSM-229' 20 kr, 'UPSM-534' 20 kr, and 'Type-49' 10 kr, 15 kr and 20 kr. Heritability (B.S.) estimates ranged from 0-58%. The dose differences were not consistent but the 20 kr treatment showed relatively more variability.

*Plant height:* The effect of different doses of gamma rays on mean plant height was insignificant for all the varieties except 'T-49' in which the 15 kr treatment significantly increased plant height. The estimated variances for

plant height within most of the irradiated populations were higher than the control populations. The variance for plant height in 'Bragg' 0 kr was 27.2 as compared to the 136.4 for Bragg 15 kr. Similar observations were also made in case of 'Ankur', 'Semmes', 'PK-71-39', 'UPSM-534' and 'Type-49'. The broad sense heritability ranged from 0 to 80 per cent indicating considerable amount of induced variability in these populations. Although the effect of doses were not consistent 20 kr appeared to be more effective than 10 kr and 15 kr.

*Pods per plant:* The significant effect of gamma irradiation in altering the mean number of pods per plant was noticed only in a few cases. The number of pods per plant in case of 'Ankur' 15 kr and 20 kr were 122 and 130 respectively as compared to 100 pods per plant in unirradiated 'Ankur'. Similar observations were made in 'PK-71-39' 20 kr and 'Type-49' 20 kr. Except 'UPSM-534', highly significant differences between the variances of irradiated population were noted in all varieties as compared to unirradiated populations. An increase in the variance as high as 5 times was noticed in case of 'UPSM-229' 20 kr. The heritability in broad sense for pods per plant ranged from 0 in case of 'UPSM-534' to 81.5% per cent in case of 'UPSM-229' 20 kr suggesting definite possibility for effective selection.

*Seeds per pod:* The different doses of gamma rays had significant effect on seeds per pod in certain treatments but the magnitude of differences were very small. The variances within irradiated populations increased markedly as compared to unirradiated controls of all the varieties. The highest difference was observed in case of 'Ankur' 20 kr which had 12 time more variance than the unirradiated 'Ankur'. The heritability in broad sense ranged from 0 to 92%.

*Yield:* The treatments did bring some differences in the mean yielding ability but these were statistically insignificant. The data in all these varieties indicated consistently a higher mean yield for 20 kr treatment. Such differences are also apparent when yield was taken on the plot basis. 'Type-49' 10 kr gave significantly higher yield (1970 kg/ha) as compared to 1380 kg/ha for the control. All the irradiated populations showed significantly higher variance than the unirradiated controls with occasional exceptions. The magnitude of the differences in the variance of yield per plant between the control and irradiated population was as high as 6 fold in case of 'Semmes' 20 kr. The heritability estimates ranged from 14 to 84% giving a definite indication of induced genetic variability for yield per plant. As observed in other characters, the effect of 20 kr was consistently more as compared to 10 kr and 15 kr.

#### DISCUSSION

The results have demonstrated varietal differences regarding responses to irradiation treatment for most of the characters. For example, only varieties 'Ankur', 'Semmes', 'UPSM-229', 'UPSM-534' and 'Type-49' showed significant induced variance for days taken to maturity but for plant height significant differences were noticed in irradiated populations of 'Bragg', 'Ankur', 'Semmes' 'PK-71-39'. Likewise some varieties showed significant induced variance for

some characters and not for other characters and thus, the variety  $\times$  dose interactions were character specific. For certain characters like yield, all the varieties showed significant induced variance but the magnitude differed from variety to variety. The data clearly demonstrate that some varieties are more responsive to induced variation than others for a particular character. This was further reflected by the heritability values in various populations of different varieties. These values differed from variety to variety as well as from character to character. Very high heritability was observed for plant height in 'Bragg' 15 kr (80%), for pods per plant in 'UPSM-229' 20 kr (81%), for seeds per pod in 'Bragg' 20 kr (81%), 'Ankur' 20 kr (92%), and Type-49 20 kr (79.8%) and for yield in Semmes 20 kr (84%), 'UPSM-229' 20 kr (80%). Since the highest values of heritability were always observed in populations irradiated with 20 kr, this dose appears to be most effective for inducing quantitative variation.

Interestingly, even though the variances were increased by irradiation, the mean performance of irradiated population remained unchanged indicating bidirectional mutations. It is generally believed that in a population selected for high mean the induced mutation would reduce the mean since the desirable genes would be mutated to undesirable ones. This may be true only when the proportion of favourable genes is more than unfavourable genes so that, probability of unfavourable mutations is more. The mean performance of a population having equal proportion of favourable and unfavourable genes would remain unchanged, since mutations in plus and minus directions will be equally likely. Therefore, the data obtained from this study indicate that most of the varieties used have almost equal proportion of desirable and undesirable genes. The increased variances in irradiated population, indicated that superior yielding lines can be isolated from these populations.

#### SUMMARY

The magnitude of induced genetic variability for different quantitative characters was estimated in the  $M_3$  generations of seven soybean [*Glycine max* (L.) Merrill] varieties irradiated with 10 kr, 15 kr and 20 kr gamma rays. In mean performance irradiated populations were not significantly different from the unirradiated populations for most of the characters. However, the total variances within irradiated populations were significantly higher than the variances in control populations for most of the characters indicating induced genetic variability. The magnitude of differences in variance for yield/plant was highest between 'Ankur' 15 kr and 'Ankur' 0 kr.

#### REFERENCES

- Mac Key, (1966). Mutation Breeding in Europe. *Brookhaven Symp Biol.* 9: 150.  
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