

Induced Mutagenesis for Study of Genetic Variability in Wheat (*Triticum aestivum* L.)

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Abstract – Genetic improvement of any crop depends upon variability present in that crop. By hybridization and conventional breeding method variability of wheat crop is being exhausted hence mutation breeding, alternative and potential source to create variability may be utilized for further improvement. An experiment was conducted to evaluate wheat variety RAJ-4037 in 9 different doses of gamma ray (5KR, 10KR, 15KR, 20KR, 25KR, 30KR, 35KR and 40KR) including control during M₁ and M₂ generation in Rabi 2010-2011. The data were recorded on 14 characters to study the analysis of variance, family mean, progeny mean, co-efficient of variation, heritability and genetic advance. It was observed that higher doses of gamma rays reduces the germination %, root length, shoot length and seedling height in M₁ generation. Higher magnitude of GCV and PCV was recorded for number of tillers per plant and CTD while plant height and test weight show high heritability. Moderate to low genetic advance was observed for CTD and plant height in M₂ generation. The mutant line such as F₁ P₁₂, F₄ P₁₃, F₅ P₁₂ and F₅ P₁₃ were identified as the best progeny for grain yield per plant and test weight among all the progeny of different families.

Keywords – Induced Mutation, Genetic variability, GCV, PCV, Canopy Temperature Depression and Wheat.

I. INTRODUCTION

Wheat (*Triticum aestivum* L.) the “versatile cereal food” is also described as the “stuff of life” or “king of cereals”. It is the second most important cereal in India after rice. India is the second largest producer (80.6t) of wheat in the world next to China. The area under cultivation of wheat in India is 28.5 million hectares with production of 80.7 million tonnes and productivity of 2.8 tonnes/hectare (14). History of wheat improvement by acclimatization, selection and hybridization dates back to the remote past, but with the passage of time these methods were supplemented by other breeding methods also. Nowadays, mutation induction has become an established tool in plant breeding to supplement existing germplasm, and to improve cultivars for genetic variation in certain specific traits (7, 12 and 13). The presence and magnitude of genetic variability in a gene pool is the pre-requisite of a breeding programme. Large spectrum of genetic variability among the genotypes along with suitable selection criteria offers better scope for selection of appropriate genotypes (2).

The expected response to selection is called as genetic advance (GA). High genetic advance coupled with high heritability estimates offers the most effective condition for selection (14). The utility of heritability therefore

increases when it is used to calculate genetic advance, which indicates the degree of gain in a character obtained under a particular selection pressure (6). Present research was conducted with the following objectives: 1) To study the effect of gamma ray on germination (%), root length (cm), shoot length (cm) and seedling height (cm) in M₁ generation. 2) To estimate the heritability and genetic advance for different quantitative traits. 3) To identify the mutant line which appear to be promising under Allahabad agro climatic condition.

II. MATERIALS AND METHODS

Experimental Material

One variety of wheat (RAJ-4037) was chosen for the experimentation in M₁ and M₂ generations. The seeds were obtained from Department of Genetics and Plant Breeding, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad.

Mutagen employed

Gamma rays one of the physical mutagen was used to induce the genotypic variation on seeds. The seeds were irradiated at the National Botanical Research Institute (NBRI), Lucknow and source of gamma rays was Cobalt (60 Co).

Mutagenic treatment

A total of 100 pure, matured, uniform size bold seeds were taken for irradiation and treated with 5KR, 10KR, 15KR, 20KR, 25KR, 30KR, 35KR and 40KR.

Experimental design

The irradiated and control seeds were grown in Augmented Compact Family block design with two replications during Rabi 2010 (M₁ generation) and 2011 (M₂ generation).

M1 Generation

Out of 100 treated seeds, 15 seeds were sown in petridishes for all the eight different doses of gamma rays and control for laboratory experiment. In the laboratory germination percent, root length (cm), shoot length (cm) and seedling height (cm) were recorded. The laboratory experiment was followed by field experiments. In the field nine different plots were prepared and sowing was done with 25 X 5 cm spacing. After the crop was harvested 16 plants from each treatment were selected randomly for post harvest observations. Plants within the population of different treatments were further designated as F₁P₁, F₁P₂--F₁P₁₆. Similarly, in all other treatments 16 random plants were selected and designated as above.

M2 Generation

The seeds of all randomly selected 16 plants from each treatment were sown in single row plot of 2 m length with a spacing of 25 X 5 cm. Observations were recorded on five randomly selected plants from every 16 lines of each treatments from both replications for various characters viz., days to 50% flowering, days to maturity, grain filling period, canopy temperature depression, plant height, number of tillers per plant, spike length, flag leaf width, test weight and grain yield per plant.

Statistical analysis

Analysis of variance was done for partitioning the total variation in to variation due to replications, treatment and error. Genotypic coefficient of variation is the variance due to the genotype present in the population. Phenotypic Coefficient of variation denotes the total variance present in a population for a particular character (Burton 1952) (4). Heritability (broad sense) is the heritable portion of phenotypic variance. The estimate of heritability helps the plant breeder in selection of elite genotypes from diverse genetic populations (Burton and Devane, 1953) (5). Genetic advance *i.e.*, the expected genetic gain was worked out by using the formula suggested by Lush (1949) and Johnson *et al.* (1955) (8). Statistical analysis was done by using Indostat software.

III. RESULTS AND DISCUSSION

The data of laboratory experiment for germination percentage, root length and shoot length revealed that with the increase in doses of mutagen there was a reduction in mean values of these traits (Table-1). Similar findings in wheat have also reported by Borzouei *et al.* (2010) (3). Analysis of variance revealed that between families variance was significant for plant height, width of flag leaf, number of tillers per plant, spike length, canopy temperature depression, test weight and grain yield per plant whereas within progenies the mean sum of squares were non- significant for most of the characters and significant for plant height, number of tillers per plant, canopy temperature depression, test weight and grain yield per plant (Table-2).

The estimates of phenotypic coefficient of variation (PCV) were higher than those of genotypic coefficient of variation (GCV) for all the traits. However, the highest PCV and GCV were recorded for spike length (10.51, 6.39), canopy temperature depression (21.01, 14.39), flag leaf width (15.37, 8.89) and number of tillers per plant (13.29, 9.68), (Table 3). Similar results have been reported by Agarwal and Mishra (1) in wheat crop and similar result in dicoccum wheat also have been reported by Mahantashivayogayya (9). Heritability is a measure of the relationship between parent and progeny and has been widely used to assess the degree to which a character may be transmitted from parent to progeny. High heritability was observed for traits viz., plant height (90), grain yield per plant (56), and number of tillers per plant (53), (Table 3). These observations support the earlier findings of Agarwal and Mishra (1) and Mahantashivayogayya (9) in wheat, similar result in soybean have been reported by Johnson *et al.* (8).

IV. CONCLUSION

From present investigation, it can be concluded that higher doses of gamma rays reduces the germination percentage, root length, shoot length and seedling height in M₁ generation (laboratory experiment) where as at low doses it was at par with control. In M₂ generation (field experiment), significant value for economically important characters such as grain yield per plant, test weight, number of tillers per plant and spike length was observed. Number of tillers per plant, flag leaf width and canopy temperature depression showed high GCV and PCV while plant height, number of tillers per plant and test weight showed high heritability. High genetic advance was observed for canopy temperature depression, plant height and number of tillers per plant. The mutant line such as F₂ P₁, F₄ P₆, F₄ P₁₃, F₅ P₁₂ and F₅ P₁₃ were identified as the best progeny for grain yield per plant and test weight among all the progeny of different families so these progeny can be utilized in next generation for improvement and to identify the induced mutant for desirable quantitative traits.

Table 1: Germination (%), Root length, Shoot length and Seedling length in wheat variety RAJ-4037

Characters	Control	5 KR	10 KR	15 KR	20 KR	25 KR	30 KR	35 KR	40 KR
Germination (%)	99.55	97.33	95.55	94.22	94.22	88.00	77.77	65.33	58.66
Root length (cm)	6.56	5.96	5.91	5.71	5.81	5.54	5.21	4.75	4.60
Shoot length (cm)	5.40	5.31	5.23	5.00	5.24	4.81	4.53	4.35	3.86
Seedling length (cm)	13.46	13.13	12.90	12.60	13.00	11.80	10.76	9.73	9.40

Table 2: Analysis of variance for different characters in M₂ Generation of wheat.

S.No.	Characters	Mean sum of square				
		Replication df (1)	Families df (8)	Progeny df (135)	Error A df (8)	Error B df (135)
1	Days to 50%flowering	121.42	9.53	2.29	10.25	2.16
2	Days to maturity	0.28	1.95	2.02	2.43	1.88
3	Grain filling period	124.03	18.12	3.41	9.52	3.37
4	Plant height	16.84	1343.29**	6.69**	23.94	4.21

5	Tillers / plant	0.24	21.04**	0.86*	2.18	0.61
6	Spike length	7.83	13.81*	0.37	3.83	0.52
7	Flag leaf width	0.04	0.31*	0.02	0.06	0.02
8	Canopy temp. depression	0.99	11.06**	0.84**	0.89	0.51
9	Test weight	121.22	53.17*	4.31**	14.71	2.79
10	Grain yield / plant	26.05	14.92*	1.86**	2.86	0.72

* and ** significant at 5% and 1% level, respectively; GCV- genotypic coefficient of variation, PCV- Phenotypic coefficient of variation, h^2 (bs)- Heritability (broad sense), GA- Genetic advance

Table 3: Estimation of genetic parameters for different quantitative characters in M_2 generation

S. No.	Characters	GCV	PCV	h^2 (bs) (%)	GA mean 5%
1	Days to 50% flowering	0.72	2.15	11	0.49
2	Days to maturity	0.25	1.37	3	0.09
3	Grain filling period	2.25	6.66	11	1.56
4	Plant height(cm)	8.46	8.91	90	16.56
5	No. of tillers/plant	9.68	13.29	53	14.51
6	Spike length (cm)	6.39	10.51	37	7.99
7	Flag leaf width (cm)	8.89	15.37	33	10.59
8	Canopy temperature depression	14.39	21.01	47	20.31
9	Test weight (g)	4.70	7.14	43	6.38
10	Grain yield/plant (g)	6.50	8.64	56	10.04

ACKNOWLEDGMENT

Thanks to Dr. S. Marker (Associate Professor and Head of department of Genetics and Plant Breeding, SHIATS, Allahabad) for providing here valuable suggestions during preparation of this manuscript.

REFERENCES

- [1] Agrawal S and Mishra M. N 2001. Studies on variability parameters for seed density in gamma- rays in wheat. *J. of Interacademia*; 5: 2, 138-141.
- [2] Basita D., Mishra T.K. and Das S.R., 2008. Genetic variability and selection indices for grain yield in upland rice. *Oryza J.* 45 (1) 72-75.
- [3] Borzouei A., Kafi M., Khazaei H., Naseriyani B. and Majdabadi A. 2010. Effects of gamma radiation on germination and physiological aspects of wheat (*triticum. aestivum* L.) seedlings. *Pak. J. Bot.*, 42(4): 2281-2290.
- [4] Burton G. W. 1952. Quantitative inheritance of grasses. Proc. 6th Int. *Grassland congress*, 1:277-283.
- [5] Burton G.W. and Devane, E.M. 1953. Estimation of heritability in tall fescus. *Agron. J.*, 45: 478-481.
- [6] Hasib K.M., Ganguly P.K. and Kole P.C., 2000. Variability, heritability genetic advance in F₂ populations of aromatic rice involving induced mutant and basmati varieties. *Nuclear Agric Biol J.*, 29: 201-206.
- [7] Johnson H.W., Robinson H.F. and Comstock, R.E. 1955. Estimates of genetic and environmental variability in soybean. *Agron. J.*, 47:314-18.
- [8] Mahantashivayogayya K. Hanchinal R. R. Salimath, P. M 2003. Mutagenesis. *Karnataka J. of Agric. Sci.*, 16: 4, 556-559.
- [9] Muller H.J., 1927. Artificial transmutation of the gene. *Science*, 66 : 84-87.
- [10] Shalini S., Sheriff R.A., Kulkarni R.S and Venkantarmana P., 2000. Correlation and path analysis of Indian mustard germplasm. Res. on crops in India , 1(2) :226-229.
- [11] Singh S. S., 2010. Rabi strategy – Increasing productivity of wheat region wise recommendations, National conference, ICAR.

- [12] Stadler L.J., 1928. Mutations in barley induced by X-rays and radiations. *Science*, 68: 186-187.

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