



Studies on induced mutagenesis in wheat variety HD 2329 and Lok1

Saurabh Gautam, MN Mishra, Arun Kumar

Received: 11 February 2012

Revised Accepted: 13 March 2012

ABSTRACT

The present investigation was taken up for induced mutagenesis in wheat varieties H.D-2329 and Lok-1 during the *Rabi* season of 2011-12 at the Agriculture Research Farm, R.B.S. College, Bichpuri, Agra. The aim was to study the seed quality parameters *viz.* germination percentage, root populations and micro mutations for grain yield and related quantitative trait and to screen out macro mutants of economic importance. The seed of wheat variety UP2329 and Lok-1 were subjected to mutation. The temperature treatment of 15°C in both the variety H.D-2329 and Lok-1 and 50°C in variety Lok-1 increased the germination percent up to 100 as compared to 89 percent in control (HD-2329) and 91 percent in control (Lok-1), respectively. More or less similar effects of these treatments were observed on other parameter, root length, shoot length and seedling vigour index also in both the varieties. The study of parameters of genetic variability *viz.* $\sigma^2_e, \sigma^2_g, \sigma^2_p$, revealed that highest estimate of these parameter were observed for grains per spike and the lowest for 100 seed weight. The estimates of GCV and PCV were highest for grain per spike and lowest GCV estimates for 100 seed weight. Macro mutations of economic and academic interest were also recovered in present study the recovery of bold shiny seeded mutant by the use of 15°C temperature and high grain yielder mutants by the use of 15°C temperature in both the varieties is note-worthy.

Key Words: *Genetic advance, Heritability, HD 2329, Lok-1, Mutation, Variability, Wheat*

INTRODUCTION

Wheat is the second most important grain crop in India coming next to rice and contributes to the total food grain production of the country to the extent of 35% and is usually accorded a premier place among cereals because of the vast acreage devoted to its cultivation, its high nutritive value and its association with some of the earliest and important civilizations of the world. It has long been clear that induced mutation could be useful for the solution of specific problem where conventional methods were insufficient particularly in transferring genes for lodging resistance, disease resistance and changing the grains color, The conventional breeding method

have been found useful only combining the characters already existing in the population but no new character can be produced in the variety by these methods. On the other hand, mutation has great relevance in modern plant breeding as it helps in reconstruction of plant ideotype (Swaminathan 1968). In incorporating one or two desirable attributes in otherwise well adapted variety (Singh 1965 and Verughese and Swaminathan 1967 and 1968), in producing hereditary changes that allow another breeding technique to be applied (Julen 1954), in enlarging the genetic variation for quantitative characters and creation of macro, micro and systematic mutations. However, it should be considered a tool for increasing variability then the direct mean of producing a new variety.

In the first place, relatively few induced mutants can be used directly, and very often undesirable features

Saurabh Gautam (✉), MN Mishra
Department of Plant Breeding and Genetics
Raja Balwant Singh College, Bichpuri, Agra-283105-UP
Email: sgautam3@gmail.com

Arun Kumar
Director of Planning, Bihar Agricultural University,
Sabour (Bhagalpur) – 813 210, Bihar

accompany the desired mutation. Many of these mutations may not prove stable enough to be of value in a breeding programme. The observations have suggested that it would be desirable to investigate the nature and magnitude of genetic variability for different characters in mutants when they are stabilized in letter generations in any breeding programme. Of course, the ultimate objective is to improve grain yield and quality. The changes, therefore, must be super imposed on a plant genotype which had desirable yield quality complex. Sufficient quantitative variability is generated by mutagenic selection for better yield feasible, but some macro-mutations, such as dwarfness, may lead to increased yield because they influence such characters which improve the response to management condition. Keeping these facts in view the present study was planned to study the seed quality parameters of wheat variety mutagenised population, to screen out macro-mutations of economic and academic interest and to study the micro-mutations for grain yield and other related quantitative traits.

MATERIALS AND METHODS

The material used and the methods adopted in the present investigation with a brief of the site of the experiment are given as follows. The present experiment was conducted during *Rabi* season of 2010-2011 at the Agriculture Research Farm of R.B.S. College, Bichpuri, Agra. The R.B.S. College, Research Farm Bichpuri, Agra is situated

11 Km in west of Agra at Agra-Bharatpur Road at a latitude of 27.2° North and longitude of 77.9° East and height of 163 meter above mean sea level. The soil of agriculture research farm is generally alluvial type with calcareous layer at a depth of 1.5 to 2 meter and is well drained. The area enjoys semi-arid, sub tropical climate with hot and dry summers and severe winters.

The seed of wheat varieties U.P. 2329 and Lok 1 were taken for the purpose of mutation study. Separate lots of 500 dry seeds of wheat varieties U.P. 2329 and Lok- 1 were given 50°C ± 1 C, 15°C ± 1 C and 50°C ± 1 C + 15°C ± 1°C temperature each for 15 minutes separately and for chemical mutagenic treatments 1500 seeds were presoaked in distilled water for 6 hours and of which one set each of 500 seeds were presoaked for 2 hours in 0.3%, 0.4% and 0.5% hydroxyl amine (the chemical mutagenic) separately. The different treatment used in present study is give below in Table 1.

Sowing of seed

Laboratory: 50 seeds of each of the treatments, including control were sown in petridishes half filled with water and lined with blotting paper. Each treatment of 50 of seeds was replicated 3 times and the petridishes were kept in Environmental Growth Chamber at a temperature of 25 ± 1°C and the relative humidity of 85 ± 5 percent.

Table 1 Showing different set of treatments used on two varieties.

Main treatments	
U.P. 2329	Lok- 1
Control (Dry)	Control (Dry)
50°C temp. treatment for 15 minutes	50°C temp. treatment for 15 minutes
15°C temp. treatment for 15 minutes	15°C temp. treatment for 15 minutes
50°C hot & 15°C cold treatment for 15 minutes	50°C hot & 15°C cold treatment for 15 minutes
0.3% Hydroxyl amine	0.3% Hydroxyl amine
0.4% Hydroxyl amine	0.4% Hydroxyl amine
0.5 Hydroxyl amine	0.5 Hydroxyl amine

Field: In the field the seed of the two varieties were sown in split plot design considering the varieties as main treatments and the temperature and chemical mutagenic treatments including control as sub treatment. The sub treatments were randomized in the varieties and both type of treatments were replicated three times. Each replication comprised 5 rows each of the 4 length of each of the sub treatments in a main treatment. The spacing was maintained as 25 x 10 cm. All the necessary field operations were given as and when required.

Observations

In the laboratory: The following observations were recorded as per details as given here:

Germination percentage: The germinated seeds of the seeds sown in petridishes in laboratory were counted in each treatment and each replication and were recorded in percentage on forth day of sowing.

Root length: The root length was measured in 10 (Ten) randomly selected plants of each petridish from the point of emergence up to the root tip of the longest root. It was recorded on 8th days of germination.

Shoot length: On 8th of germination the seedling height/ shoot length was measured in cm. from its point of emergence to its tip in same 10 randomly selected plants?

Seedling vigour index: It was calculated according to the formula given by Abdul Baki and Anderson (1973) as given below:

Seedling vigour Index (SvI) = (Root length + Shoot length) × Germination percentage.

Field observation: In the field the observations were recorded on following character:

Days to ear head emergence: The number of days from the date of sowing to more than 50% flowering in the plant recorded.

Days to maturity: The numbers of days from the date of sowing to physiological maturity in each of the plots were recorded for this observation.

Plant height (cm) at maturity: Five representatives plants were selected randomly from each plot and the total length of plant was measured in centimeter from the soil base to the tip of the ear of main shoot.

Number of effective tillers per plant: The total number spike bearing tillers in plants were counted in randomly selected 10 plants of a plot at the time of maturity.

Spike length (cm): The length of the main ear excluding axis of the 10 random plants earlier selected was recorded in cm.

Number of spikelets per spike: Total numbers of spikelets of the main ear in the same 10 randomly selected plants were counted in each plant.

Number of grains per spike: From the tagged plants of each plot, the numbers of seeds per spike were counted and the average number of seeds per spike was recorded.

Grain yield per plant: All the ears of each of the plants were threshed by hand and the grains obtained were weighted in gm.

100 grain weight (gm): The yield of total seeds of a plant was divided its total number of seed and multiplied by 100 to get the test weight (100 seed weight).

Statistical Analysis

Estimation of means expressed as percentage over control: The mean data of the characters recorded sub treatment wise in the field were converted to means expressed as percentage over control assuming the control value of a character as one hundred.

Analysis of variance: The mean data recorded were also subjected to analysis of variance for design split plot and RBD comprising 14 treatments as given by Panse and Sukhatme (1961). The significant and non-significant treatment effects were judged with the help of 'F' test.

RESULTS AND DISCUSSION

Induced mutagenesis is an alternative technique of crop improvement not only in self-pollinated crops but in cross-pollinated crops also. The chromosome deletion occur in most of the induced mutation leading to negative expression. Stadler (1930) and several other had showed doubt to the practical significance of this approach. However, there are general agreements about to gather more knowledge on induced mutagenesis in making it as a tool for crop improvement. Gunkel (1965) Micro mutations which involved changes in quantitative character effect one or several genes and can only be detected by biometrical analysis. They cause polygenic variability, occur more frequently and also do not affect vitality adversely as compared to micro mutations as the physiology of the living system is much more disturbed by them in the crop plants. The present investigation focused on induced mutagenesis in wheat varieties HD 2329 and Lok-1. For the study of micro-mutations the character means of each of the treatments were converted to percent over control. Character wise analyses variance for split plot design and RBD comprising 14 treatments was made for the character under study viz., ear head emergence, days to blooming, plant height, days to maturity, number of tillers per plant, number of spikelets per spike, number of grains per spike, 100 seed weight and grain yield per plant and the treatment wise analysis was made for the characters viz. number of spikelets per spike, number of grains per spike, grain yield per plant. Estimates of parameters of statistical and genetic variability were made main and sub treatment basis from split plot design and R.B.D. ANOVA by usual methods.

For the micro-mutations the character means of each of the treatments were converted to percent over control. Character wise analyses variance for split plot design and RBD comprising 14 treatments was made for the character under study viz., ear head emergence, days to blooming, plant height, days to maturity, number of tillers per plant, number of spikelets per spike, number of grains per spike, 100 seed weight and grain yield per plant and the treatment wise analysis was made for the characters viz. number of spikelets per spike, number of grains per spike, grain yield per plant. Estimates of parameters of statistical and genetic variability were made main and sub treatment basis from split plot design and RBD. ANOVA by usual methods. The mean performance and variability data has been presented in Table 2 & 3.

15⁰C temperature treatment in both the variety HD-2329 and Lok-1 and 50⁰C in variety Lok- 1 increased the germination percent up to 100 as compared to 89 percent in control (HD-2329) and 91 percent in control (Lok-1) respectively. More or less similar effects of these treatments was observed on other parameter, root length, shoot length and seedling vigour index also in both the varieties. The study of means of characters in various treatments expressed as percent over control revealed that days to ear head emergence, days to blooming, days to maturity and plant height were reduced due to both physical and chemical mutagenic treatment in both the variety while the estimates of remaining characters were increased.

The different in estimates in control were higher in 15⁰C and 50⁰C sole temperature, 0.3% and 0.4% hydroxyl amine mutagenic treatments for most of the characters. The higher reduction in days to maturity and plant height with high increase in grain number and grain yield per plant was recorded due to 15⁰C temperature treatment in both the variety viz., tillers per plant, spike length, grains per spike, spikelets per spike and 100 seed weight.

Table 2 Estimates of mean germination percentage, root length, shoot length and Seedling vigour index characters in M₁ generation in lab condition.

Character treatment	8 th day			
	Germination %	Mean shoot length (cm)	Mean root length (cm)	Seedling vigor index
T ₁ = Control	89	12.43	17.32	2647.75
T ₂ = (50°C)	97	14.67	19.76	3339.71
T ₃ = (15°C)	100	16.22	20.45	3667.00
T ₄ = (50°C+15°C)	91	13.28	18.12	2857.40
T ₅ = 3% Hydroxyl amine	95	13.65	18.45	3049.50
T ₆ = 4% Hydroxyl amine	98	15.05	20.08	3442.74
T ₇ = 5% Hydroxyl amine	97	14.35	19.56	3289.27
T ₈ = Control	91	12.74	17.55	2998.71
T ₉ = (50°C)	100	16.76	20.66	3742.00
T ₁₀ = (15°C)	100	17.82	20.68	3850.00
T ₁₁ = (50°C+15°C)	99	15.98	20.22	3583.80
T ₁₂ = 3% Hydroxyl amine	98	15.32	20.17	3474.02
T ₁₃ = 4% Hydroxyl amine	93	13.43	18.14	2936.01
T ₁₄ = 5% Hydroxyl amine	96	14.21	19.43	3229.44

Table 3 Estimations of Parameters of Genetic Variability (Micro-mutation) for 10 Characters under Study (Main treatments).

Character/ treatment parameter	Days to ear head emergence	Days to blooming	Days to maturity	Plant height (cm)	Number of tillers/plant	Spike length (cm)	Number of grains/spik e	Number of spikelets/spike	100 seed wight (in gm)	Yield/ plant
Range	69.64-72.14	86.66-89.08	122.24-124.79	91.06-95.27	15.01-16.12	12.24-12.94	58.34-65.43	17.46-18.96	4.32-4.57	39.44-43.13
Mean	70.89	87.87	125.2	93.17	15.57	12.59	61.89	18.21	4.44	41.29
C.V.	1.005	0.65	1.25	1.97	3.24	3.57	2.02	1.55	3.98	3.10
σ^2_e	1.77	1.15	8.37	11.87	0.89	0.71	5.51	0.28	0.109	5.76
σ^2_g	20.24	19.37	14.23	50.29	3.43	1.02	170.61	7.58	0.104	41.88
σ^2_p	22.02	20.53	22.60	62.06	4.32	1.74	176.12	7.87	0.21	47.65
GCV	53.44	46.96	33.94	73.39	46.94	28.59	166.03	64.54	15.33	100.71
PCV	55.73	48.34	42.78	81.61	52.71	37.17	168.69	65.73	21.96	107.42
$h^2(b)$	0.91	0.94	0.62	0.80	0.79	0.59	0.96	0.96	0.48	0.87
G.A.	8.88	8.80	6.16	13.12	3.39	1.60	26.48	5.57	0.46	12.44

Analysis of variance RBD exhibited highly significant different among the treatments for all the characters under study while as per split plot analysis of variance the main and sub treatments did not show significant different for 100 seed weight. A study of statistical parameters of variability viz- range, mean and CV, revealed highest estimates of range (46-82) and CV (7.72%) for grains per spike and highest mean (123.52) for days to maturity, the lowest range (3.12-5.56) and mean (4.44gm) were observed for 100 seed weight while the lowest (8.01%) for grains per spike based on sub treatments analysis and on main treatment basis the highest (3.98%) CV was observed for 100 seed weight with

the lowest for days to ear head emergence. As per R.B.D. analysis the CV estimates for all the characters were very low. The study of parameters of genetic variability viz- σ^2_e , σ^2_g , σ^2_p revealed that highest estimate of these parameter were observed for grains per spike and the lowest for 100 seed weight based on both split plot analysis main and sub treatment and RBD analyses. The estimates of GCV and PCV estimates were highest for grain per spike and lowest GCV estimates for 100 seed weight as per split plot analysis, while as per RBD analysis these estimates were highest for grains per spike and the lowest for days to maturity. As per R.B.D. analysis the highest heritability estimates were

recorded for plant height and grain yield per plant character with the lowest $h_{2(b)}$ being for spikelets per spike with the lowest for 100 seed weight while as per sub treatment analysis plant height had highest heritability and the lowest for spikelets per spike, while estimates of GA were recorded highest for grains per spike as per split main and sub treatment and R.B.D. analysis.

Macro mutations of economic and academic interest were also recovered in present study the recovery of bold shiny seeded mutant by the use of 15°C temperature and high grain yielder mutants by the use of 15°C temperature in both the varieties is noteworthy. However, their testing is need in the future generation. Thus on the basis of presents investigation it can be concluded that 15°C temperature is the best treatment for improvement in grain yield per plant and selection for grains per spike will remain useful for the improvement in wheat.

REFERENCES

- Agrawal S, Mishra MN (2001) Studies on variability parameters for seed density in gamma rays in wheat. J of Interacademia 5: (2) 138-141.
- Asif M, Mujahid MY, Kisana NS, Mustafa SZ, Ahmad I (2004) Heritability, Genetic Variability and Path coefficient of some traits in spring wheat. Sarhad J Agric 20 (1): 87-91.
- Bhatia CR, Swaminathan MS (1962) Induced polygenic variability in bread wheat and its bearing on selection procedure. ZP flanzenevecht (48): 317-326.
- Bhaskaran S, Swaminathan MS (1962) Chromosome aberrations changes in DNA content and frequency and spectrum of mutations. Induce by x-rays and neutrons in polyploidy Rad. Bot I: 166-81.
- Botwright TL, Condon AG, Rebetzke GJ, Richards RA (2002) Field evaluation of early vigour for genetic improvement of grain yield in wheat. Australian J of Agril Res 53(10): 1137-1145.
- EL-Shouny KA, Ibrahim KIM, Hassan RK, El-Halem NKA (2001) Frequency and spectrum of induced morphological mutations in Triticale. Annals of Agri Sci Cairo 46(2): 681-696.
- Giri SP, Apparao BJ (2001) Effectiveness and efficiency of gamma rays in pigeon pea (*Cajanus Cajan* (L.) Millsp.). Advances in Plant Sci 24(2): 643-644.
- Kumar D, Kumar P (1983) GXE interaction in wheat under salinity SABRAO 15 (2): 93-98.
- Mahantashivayogayya K, Hanchinal RR, Salimath PM (2003) Mutagenesis. Karnataka J of Agric Sci 16(4): 556-559.
- Pansie VG, Sukhmate PV (1969) Statistical methods for Agriculture workers. ICAR New Delhi.
- Singh SS (2010) Rabi strategy-Increasing productivity of wheat region wise recommendations, National conference, ICAR.
- Singh SP, Srivastava MS, Valankar VS (1970) Variability and characters in wheat (*Triticum durum*). Indian J Agric Sci 40: 1042-1045.
- Swaminathan MS (1963) Evaluation of use of induced micro-and-macro mutations in the breeding of polyploidy crop plants. Symp. Application of Nuclear Energy in Agri Rome 455-277.
- Swaminathan MS (1964) The use of induced mutation in Plant Breeding. J Sci Indian Res 23: 455-458.
- Swaminathan MS (1965) A comparison of mutation induced in diploids and polyploids. Radiation Botany Supply 5: 619-641.
- Swaminathan MS (1968) Mutation breeding Proc., XII Intern. Congr Genet Tokyo 3: 327-247.
- Zhou Y, Zhu HZ, Cai SB, He ZH, Zhang XK, Xia XC, Zhang GS (2007) Genetic improvement of grain yield and associated traits in the Southern China winter wheat region, 1949 to 2000. Euphytica 157(3): 465-473.