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EFFECT OF FAST NEUTRONS AND GAMMA RAYS TREATMENTS ON HEADING DATE, PLANT HEIGHT AND TILLER NUMBER IN WHEAT[1]

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Abstract

Homogeneous seeds of six varieties of bread wheat, *Triticum aestivum* L. ($2n = 6x = 42$) were treated with fast neutrons and gamma rays. The irradiated seeds along with respective controls were grown in field plots during 1973-74 and heading date, plant height and tiller number studied.

Varieties used in the present study varied significantly ($P \geqslant 0.01$) for all the characters. Traetment mean squares were highly significant for plant height and tillers per plant; whereas, the varieties × treatments interaction mean squares were significant only for plant height ($P \geqslant 0.05$). Irradiated treatments exhibited significant reductions in plant height and tiller number than respective controls. However, heading was delayed among the irradiated material when compared with respective controls. Reduction in plant height was more pronounced after the treatments of gamma rays than the fast neutrons. The maximum and minimum shifts in mean values of these characters were observed in 20 kR (gamma rays) and Nf 300 RADS (fast neutrons) treatments, respectively.

Introduction

Swedish plant breeders (Gustafsson, 1947, 1954, 1963, Mackey, 1954a, 1954b) have provided convincing evidences of the usefulness of induced mutations in cereal crops. Hexaploid nature of bread wheat, *Triticum aestivum,* (L.) em. Thell, ($2n=6x=42$), presents many opportunities for the induction of mutations for useful agronomic traits (Siddiqui, 1972a, 1972b; Siddiqui & Arain, 1974).

Heading date which directly influences the maturity of the crop, is a polygenic character (Freeman, 1918) and is reported to be altered by induced mutations (Gustafsson, *et al.* 1971). Plant height and tiller number have evolutionary significance (Siddiqui, 1971) and are important for plant breeders because of their respective influences on crop yield (Romero & Frey, 1973; Joppa, 1973; Shukla, 1974; Arain & Siddiqui, 1976). Plant height has shown its association with the efficient utilization of

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nitrogen and lodging resistance (Scarascia-Mugnozza, 1965). Early maturity in wheat is associated with escape from pests, drought, heat and other stress injuries that occur late in the growing season (Edwards, *et al.* 1976).

The present work envisages to provide information on the effects of gamma rays and fast neutrons with regard to heading date, plant height and tiller number in wheat cultivars with diverse yielding potential.

Materials and Methods

Homogeneous dry seeds of six varieties of bread wheat, *Triticum aestivum* (L.) em. Thell (2n=6x=42), viz., Pak-70; Nayab; Mexipak; 6134×C-271; H-68 and C-591 were irradiated with different doses of fast neutrons and gamma rays. The brief description of these varieties is given as under:

(i) Pak-70 -------- This variety was evolved in Pakistan from a cross between C-271× (Wt.(E)-Sonora 64). It is an annular seeded, semidwarf variety of excellent yield potential. It is earlier in maturity as compared to other indigenous local varieties.

(ii) Nayab ------- This variety was evolved from a cross between (Pj.62-Gb.55 × Gb.56) × Tzpp × Nai.60) in Pakistan. It is semidwarf having amber grain colour and tapering earhead shape.

(iii) Mexipak ------- This variety was derived from a cross between Penjamo "S" Gabo 55 made at CIMMYT, Mexico and later introduced into Pakistan. It is an amber grained, semidwarf, high yielding variety with wide adaptability.

(iv) 6134 × C-271 ------- This strain was evolved in Pakistan from a progeny of a cross between 6134 × C-271. It is semidwarf line and responsive to high doses of fertilizers. Extensively used in breeding programme of Wheat Section, Agricultural Research Institute, Tandojam, Sind, Pakistan for specific characters.

(v) H-68 -------- This is an indigenous long duration variety, developed from a cross between HSW-III × I.P-120 in Pakistan. It is a tall variety with fair tillering capacity and lodges frequently under fertile soils due to its weak straw. Its grain is of good quality, medium sized and of amber colour.

(vi) C-591 ------- This is also an indigenous variety evolved from a cross between T9 × 8B, in Pakistan. It has medium sized bold grain with amber colour. This variety is of superior quality. It is tall and lodges frequently in fertile soils due to its weak straw.

The seeds of each of these varieties were subjected to Nf. 300, 600, and 900 RADS of fast neutrons and 10, 15 and 20 kR of gamma rays. The irradiated seeds and respective controls were sown in field plots during 1973-74 in a split plot (RCB) design with four replication. Wheat cultivars made up the main plots and irradiation treatments the subplots. A plot consisted of four rows, 1.2 m long with 30 cm row to row distance. Fifty two seeds were planted in each treatment plot with 13 seeds per row, while the plant to plant distance was kept 10 cm.

Ten plants were selected at random within each plot before recording observations for the following characters during growth period and at maturity stage in the field.

(i) Heading date (days)

The emerging dates of first three earheads of each plant from their boots were recorded. Heading days were calculated as the average number of days from the date of sowing to heading.

(ii) Plant height (cm)

The mean height of plants in each plot was recorded as the distance of the main culm from the ground surface to the tips of spikes excluding awns.

(iii) Tillers per plant

Ear bearing tillers (productive) were counted for the selected plants and means were calculated.

Results and Discussion

The analyses of variance for heading date (days), plant height and tiller number per plant are presented in Table 1. and the mean values of these characters are shown in Table 2.

The variety mean squares of heading date (days) were significant at 1% level of probability, which provided the evidence for the significant genetic variability for heading among the varieties (Table 1). Three varieties viz: Mexipak, H-68 and C-591 were significantly late in heading when compared with variety Pak-70 (Table 2). Treatments and varieties × treatments interaction mean squares were statistically non-significant, indicating consistency of performance for this character over different treatments.

While comparing the effect of irradiation treatments of gamma rays and fast neutron, delay in heading was more pronounced among gamma rays irradiated populations, where the maximum delay was found in 20 kR. Nevertheless, a genetical interpretation of differences of days to heading could only be possible after the detailed study of segregating populations in the present material.

The variance results of plant height (Table 1) showed that mean squares attributable to varieties were highly significant. This indicates that significant genetic variability for plant height existed among these varieties. The standard variety Pak-70 which is semidwarf, when compared to the other varieties (Table 2) was found significantly different from C-591, H-68 and a strain 6134 × C-271. The treatments and varieties × treatments interaction mean squares were significant at 1% and 5% levels of probability, respectively (Table 1). This shows that irradiation treatments were found to reduce plant height among all the varieties, with comparatively more reduction in mean height among tall varieties (C-591, H-68) than the short ones. These results are similar to the findings of many workers (Scossiroli, *et al.* 1959, 1961; Bhatia & Swaminathan, 1962; Borojevic, 1966; Siddiqui, 1972b) who also reported shifts of the mean values towards shortness of culm among the irradiated material derived from different wheat cultivars.

In the present investigations, it was observed that all the three gamma rays treatments and one fast neutron treatment (Nf. 900 RADS) were equally effective in shifting the mean values significantly towards reduced height. However, the maximum reduction

TABLE 1: Mean squares from the analyses of variance for heading date (days), plant height and tillers per plant.

Sources of variation	D.F.	Heading date (days)	Plant height	Tillers per plant
Replicates	3	4.51	30.04	14.89
Varieties (factor A)	5	996.67**	6868.34**	177.36**
Error (a)	15	3.28	30.60	11.16
Treatments (factor B)	6	74.07 NS	677.49**	43.07**
A × B interaction	30	18.70 NS	24.21*	3.36 NS
Error (b)	108	130.96	13.91	5.29
Total:	167			
Difference between	LDS(0.05)	1.031	3.152	1.903
two variety means (factor A).	LSD(0.01)	1.426	4.335	2.632
Difference between	LSD(0.05)	NS	2.111	1.301
two treatment means (factor B)	LSD(0.01)	NS	2.774	1.710
Difference between	LSD(0.05)	NS	5.169	3.187
two treatment means in the same variety	LSD(0.01)	NS	6.793	4.189

NS Non-significant * Significant at 5% level. ** Significant at 1% level.

of plant height was observed in all the varieties for gamma rays 20 kR treatment except Nayab where the maximum reduction in height was found in gamma rays 15 kR treatment (Table 2).

Varieties and treatments mean squares for tillers per plant were both significant at 1% level of probability. This shows that the varieties under study varied significantly in tillering capacity and there were significant differences between irradiated treatments. The variety (Pak-70) produced significantly more number of tillers than varieties Nayab, Mexipak and 6134 x C-271 (Table 2). However, two local varieties viz, H-68 and C-591 produced tillers per plant at par with Pak-70. In comparison between controls and irradiated populations, the irradiation treatments generally reduced tillers per plant in each variety. The mean tiller number in some irradiation treatments of all the varieties was decreased significantly when compared with respective controls except in Mexipak, where the differences in the mean values were found to be statistically non-significant. Hence, Mexipak can be considered as an unaffected genotype towards irradiation treatments with respect to tillering capacity.

TABLE 2: Mean heading date (first reading), plant height (second reading) and tillers per plant (third reading) of irradiated and control populations of wheat varieties.

Genotype	Control	Irradiation treatments						Mean for varieties
		Nf. 300 RADS	Nf 600 RADS	Nf 900 RADS	^{60}Co 10 kR	^{60}Co 15 kR	^{60}Co 20 kR	
	85 01	85 38	85.96	86.90	87 31	89 16	90 95	87 24
Pak 70	89 60	88 70	88.17	85 32**	85 90**	80 35**	78 35**	85 20
	19.52	18 67	18.55	17.92	17 70	16 75*	16 12*	17 89
	86 40	86 70	86 63	87 41	89 24	89 60	91 01	88 14
Nayab	93 87	91 57*	87 87**	86.95**	84.45**	81 65**	83 90**	87 18
	18 32	16.62	15.32	15 17	14.95*	14 47*	13 62**	15 50+
	86 33	87.87	87 67	88 11	90 82	92 53	95 75	89 87++
Mexipak	91.05	90 80	88 00**	89 87**	88.05**	84 12**	78 87**	87 25
	17.10	16 77	16 20	15 95	15 70	15 12	14 27	15 87+
	85 32	85 78	86 17	86 31	87 41	88 49	89 11	86 94
6134 x C-271	86 55	85 00	82 77**	82 67**	77 30**	74.75**	71 22**	80 04**
	13 45	12 37	11 92	11 45	10.95	10 10*	9 75*	11 43++
	98 78	99 70	100.08	100 82	100 24	100 95	101 83	100 34++
H-68	116 30	114 80	115.40	114 02*	110 75**	97 45**	95 92**	109 23++
	20 95	20.07	19 90	18.77	17 15*	16 47**	15 82**	18 45
	96 29	97 73	98 30	98.60	99.15	99 28	99 61	98.42++
C-591	123 90	123 47	123 17	120 47**	120 75**	114 45**	108.37**	119 23++
	19 35	18 00	17.45	16 35	15.55*	15 12**	14 90**	16 67
Means for treatments	89 69	90 53	90.80	91 36	92 36	93 34	94 71	91 83
	100.21	99 06	97 56*	96 55**	94 53**	88 80**	86 11**	94 69
	18 12	17.08	16.56*	15 94**	15 33**	14 67**	14 08**	15 97

+,++ Variety means significantly different from Pak-70 (Standard variety) at P ≥ 0 05, and P ≥ 0 01 respectively

*,** Treatment means significantly different from their controls at P ≥ 0 05 and P ≥ 0 01 respectively

Furthermore, among other five cultivars, the fast neutrons treatments were not effective in reducing the mean values of tillers per plant significantly, whereas the gamma rays treatments were quite sufficient to bring about significant changes than respective controls. The maximum reduction in tillers per plant was recorded in 20 kR (gamma rays) treatment for all the varieties (Table 2). The reduction in tiller number among irradiated populations has also been reported by Bhatia & Swaminathan (1962) in bread wheat; Gaul *et al.* (1966) in barley and Scossiroli (1968) in durum wheat.

As gamma rays treatments resulted in greater shift of the mean values towards negative direction than the fast neutron treatments, the fast neutrons in general can be useful from breeding point of view for the selection of more tillers per plant. Many workers have observed positive correlation between tillers per plant and yield per plant (Paroda, *et al.* 1974; Randhawa, *et al.* 1975). It is evident from the present studies that the low doses of fast neutrons, where the mean values of the irradiation populations are similar to that of respective unirradiated controls, could successfully be used for creating desired genetic variability and ultimately may be instrumental in the selection of high yielding mutants in the later generations.

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