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EFFECT OF GAMMA RAYS ON GROWTH AND SEED INDEX OF *PENNISETUM AMERICANUM**

R.M. ASLAM, K.A. SIDDIQUI** AND A. SHARIF

Department of Botany,
University of Sind, Jamshoro, Pakistan.

Abstract

Pennisetum americanum cv. Awn Selected, ex-Bornu, Japan Bajra, and B-18 were treated with 0,5, 10, 15, 20, 30 and 35 kR of gamma rays. Significant decrease in plant height was observed in cv. Awn Selected whereas in cv. ex-Bornu, plant height significantly increased in the irradiated population. In cv. Japan Bajra, an increase ($P \geq .01$) in plant height was observed in 30 kR and 25kR treatments whereas in cv. B-18 a decrease ($P \geq .01$) in plant height was noted at 15,20,25,30 and 35kR doses. Regression analysis showed that the rate of reduction of tiller number following gamma irradiation was highest in cv. Japan Bajra followed by Awn Selected and B-18. Different doses of gamma rays had no significant effect on stem circumference. Genotypic differences as well as the differences due to various radiation treatments were highly significant ($P \geq .01$) with respect to seed index. Possibilities of inducing useful mutations in pearl millet are discussed.

Introduction

Seed irradiation results in differential effects on various groups of cells affecting one stage of development without any effect on other stages. This line of reasoning was supported by an independence of effects of irradiation in various crop plants (Sparrow, 1966) at different levels of ploidy (Siddiqui, 1973). Information on the radiosensitivity of pearl millet cultivars is very scanty (Aslam & Siddiqui, 1979; Hanna, 1982). The present work was therefore undertaken to elucidate the effects of different doses of gamma rays on growth and seed index (1000-grain weight) of some contemporary varieties of pearl millet. These traits have evolutionary significance and are important for plant breeders because of their respective influences on crop yield (Burton & Powell, 1968; Siddiqui *et al.* 1979, 1980).

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** Plant Genetics Division, Atomic Energy Agricultural Research Centre, Tandojam, Pakistan.

Table 1. Effect of different doses of gamma rays on plant height and number of tillers in the four cultivars of *Pennisetum americanum*.

Radiation dose kR	Plant height				No. of tillers			
	cultivar				cultivar			
	Awn Selected	ex-Bornu	Japan Bajra	B-18	Awn Selected	ex-Bornu	Japan Bajra	B-18
0	220.80	125.50	132.50	158.75	8.25	5.00	9.25	7.75
5	180.90−−	223.00++	144.50	164.50	6.25	4.50	8.50	8.00
10	183.75−−	172.75++	145.00	167.75	5.50	4.50	7.75	7.75
15	160.00−−	158.00++	145.25	117.75−−	10.25	8.00	6.75	8.50
20	133.75−−	157.25++	168.00++	117.75−−	10.00	8.50	8.50	8.00
25	133.25−−	157.25++	168.75++	119.00−−	10.00	9.00	7.50	7.00
30	120.00−−	152.25++	118.75	117.75−−	5.00	5.25	7.59	7.75
35	128.50−−	149.75+	113.75	114.25−−	4.75	3.75	7.25	8.25

+, −, Denote significant increase and decrease respectively at 5% level.
++, −−, Denote significant increase and decrease respectively at 1% level.

Materials and Methods

Pure seeds of four cultivars of pearl millet (*Pennisetum americanum*) viz. Awn Selected, ex-Bornu, Japan Bajra and B-18 were treated with 0,5, 10, 15, 20, 25, 30 and 35kR of gamma rays using cobalt-60 source at the Atomic Energy Agricultural Research Centre, Tandojam. Seeds were sown in well prepared plots by dibling. The sowing was done at 15cm from plant to plant and 30cm from row to row in split plot design with 4 replications. Data of plant height, number of tillers, stem circumference and 1000-grain weight (seed index) were collected and analysed statistically.

Results and Discussion

i) *Effect of gamma rays on plant height*

Analysis of variance for plant height in the treated cultivars suggest highly significant ($P \geqslant .01$) differences among cultivars and treatments. The interaction between cultivars and treatments was not significant which indicates that doses of gamma rays had similar effects on all cultivars.

Plant height decreased significantly after gamma irradiation in cv. Awn Selected (Table 1). In cv. ex-Bornu significant ($P \geqslant .05$) increase in plant height was observed at 35kR. In the same cultivar highly significant ($P \geqslant .01$) increase in plant height was observed at 5, 15, 20, 25 and 30 kR doses. Evidence of significant increase in plant height at 20 and 25kR was also observed in cv. Japan Bajra whereas cv. B-18 showed significant decrease in plant height at 15, 20, 25, 30 and 35kR doses (Table 1)

Results of correlation and regression analysis (Table 2) show that there was a linear though non-significant reduction in plant height except in cv. Awn Selected. The rate of reduction for unit increase in doses was 13.3792 for cv. Awn Selected, 2.6280 for cv. ex-Bornu, and 6.0893 for cv. B-18

Evolutionary significance of plant height has recently been elucidated (Siddiqui *et al* 1979). In the modern plant breeding context, positive correlations of plant height with grain yield have been reported in many crop plants including pearl millet (Narashema Rao, 1965, Burton & Powell, 1968). Significant alteration of plant height following gamma irradiation as observed in the 4 cultivars of pearl millet has therefore theoretical as well as practical implications.

ii) *Effect of gamma rays on number of tillers*

Regression analysis (Table 2) revealed that the rate of reduction of tillers following gamma irradiations was highest in Japan Bajra (−0.2143) followed by Awn Selected

Table 2. Regression and correlation analysis of the effects of gamma irradiation in *Pennisetum americanum*.

Trait/ cultivar	r	b	c	M.S. Reg.	M.S. Dev.	F-ratio	S(b)	S(v)	t
Plant height.									
Awn Selected	−0.9346*	−13.3792	217.7125	7518.0882	181.6232	41.39	2.0795	0.1453	−6.43
ex-Bornu	−0.2268	− 2.6280	172.6071	290.0629	891.4361	0.33	4.6070	0.3976	−0.57
Japan Bajra	−0.2401	1.9762	150.9554	164.0238	447.0325	0.37	3.2625	0.3963	−0.61
B-18	−0.6903	− 6.0893	154.5893	1557.3348	285.0848	5.46	2.6053	0.2954	−2.34
No. of tillers									
Awn Selected	−0.2135	−0.2083	8.4375	1.8229	6.3628	0.29	0.3892	0.3988	−0.54
ex-Bornu	−0.1261	0.1071	5.5804	0.4821	4.9769	0.10	0.3442	0.4050	0.31
Japan Bajra	−0.6457	−0.2143	8.8393	1.9286	0.4494	4.29	0.1034	0.3117	−2.07
B-18	−0.0329	− .0060	7.9018	1.4881	0.2289	0.007	0.0738	0.4080	−0.08

* Significant at 1% level.

(–0.2083) and B-18 (–.0060). However, the relationship was not significant. This situation is quite different from the results of the gamma irradiation on number of tillers on different varieties of wheat where tiller numbers showed a pronounced influence on grain yield (Siddiqui *et al.* 1980).

iii) *Effect of gamma rays on stem circumference*

Correlation and regression analysis (Table 3) indicated that the effect of different doses of gamma rays had no significant effect in reducing or increasing the stem circumference of different cultivars of pearl millet. However, a trend of reduction in stem circumference was observed in cv. Awn Selected (b = –0.25) followed by cv. Japan Bajra (b = –0.2190) and ex-Bornu (b = –0.1333). Presumably cv. B-18 remained unaffected by different treatments of gamma rays. The present results provide information on the effects of gamma rays on stem circumference of pearl millet which does not seem to have been reported earlier.

Table 3. Correlation and regression analysis of the effects of gamma rays on stem circumference of 4 cultivars of pearl millet.

Cultivar	r	b	c
Awn Selected	–0.4201	–0.2500	7
ex-Bornu	–0.2649	–0.1333	6.9
Japan Bajra	–0.4373	–0.2190	6.33
B-18	–0.0240	0.0095	5.25

iv) *Effect of gamma rays on seed index*

The analysis of variance indicate that genotypic differences as well as differences due to various irradiation doses were highly significant ($P \geqslant .01$) with respect to seed index (1000-grain weight) . Difference in genotypic response are further elucidated in Table 4. The results show highly significant differences between cv. Awn Selected and Japan Bajra.

Very limited information on the genetics of 1000-grain weight is available in pearl millet (Burton & Powell, 1968; Tyagi *et al.* 1982). Studies in other cereals reveal that the character has high heritability. Cytogenetic investigations in wheat (Kuspira & Unrau, 1957; Halloran, 1976; Siddiqui *et al.* 1978) have shown that chromosome 6A exerts pronounced influence in enhancing the 1000-grain weight. The present investi-

Table 4. Effect of gamma rays on 1000-grain weight in four cultivars of pearl millet.

Cultivar	Average over dose	Significance		S.E.	LSD_1	LSD_2
Awn Selected	8.43	c	c	0.1539	0.84	1.52
ex-Bornu	9.11	bc	AB			
Japan Bajra	10.02	a	A			
B-18	9.61	ab	AB			

Means not followed by the same letter are statistically significant. Capital and small letters indicate significance at 1% and 5% levels of probability respectively.

gations offer new possibilities of increasing seed index in cultivars of pearl millet by exploitation of mutation through gamma irradiation. The character is particularly suitable for mutation breeding because it is composed of components, measured precisely with small samples and exhibits little genotype environment interaction (Frey, 1965; Siddiqui *et al.* 1978).

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