INDUCED GENETIC VARIABILITY FOR PLANT HEIGHT AND TILLER NUMBER IN *PENNISETUM AMERICANUM*

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Abstract

M_2 Populations of four varieties (Awn-Selected, ex-Bornu, Japan Bajra and B-18) of pearl millet, *Pennisetum americanum,* derived from different treatments (0,05,10,15,20,25,30, and 35 kR) of gamma rays were assessed for induced genetic variability pertaining to plant height and tiller number. Significant increases in plant height were observed in the M_2 populations of variety Awn-Selected at 10 kR (P=.05), 20 kR (P=.05) and 25 kR(P=.05). In the M_2 population of variety Japan Bajra significant increase in plant height were noted at 15 kR (P=.05). M_2 populations of variety B-18 also showed significant increases in plant height at 10 kR (P=0.05), 15 kR(P=0.05) 20 kR (P=0.01) and 35 kR (P=0.05).

Genotypic differences among varieties were highly significant (P=0.01) for tiller number. Significant decrease in tiller numbers were observed in M_2 populations of Awn-Selected (30 kR and 35kR), ex-Bornu (35 kR), Japan Bajra (15 kR, 25 kR) and B-18(20 kR and 25 kR). Substantial induced variability was noted in M_2 populations of all the four varieties. The paper discusses evolutionary significance of plant height and tiller number in pearl millet with reference to mutation breeding. Recurrent Selection is recommended for the genetic improvement of pearl millet.

Introduction

Pearl millet *Pennisetum americanum* Leeke,commonly Known as bajra has bisexual flowers and protogynous habit of flowering. Pearl millet is grown on about

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31 million hectars in the world mainly in dry tropics as an annual crop for its grain as well as fodder. In Pakistan, pearl millet occupies about 559000 hectars and is frequently grown in marginal areas under adverse conditions of infertile soil,intense heat and limited rainfall.

Plant height and tiller number have evolutionary significance (Siddiqui, 1971) and their alteration can be instrumental in producing genotypes and populations with high genetic homeostatis (Lerner 1954). Research related to mutation breeding in pearl millet is limited (Burton and powell 1969; Singh *et al.* 1978; Gupta *et al.*, 1982; Aslam and Siddiqui 1979, 1984). A recent review of mutation breeding (Hanna, 1982) indicates that additional sources of veriability for plant height and tiller number are needed for further genetic improvement of pearl millet.Present studies were therefore, undertaken to induce additional variability in four current varieties of pearl millet, in an attempt to create new ideotypes.

Borojevic (1966) estimated genetic variability through heritability in the broad sence. However, in the maintenance of the original induced genetic variability as well as its increase through the generations of selfing suggested that the phenomenon in question was an additive component of genetic variability.More recently , Borojevic and Sesek(1981) found that irradiation induced 10-20 % decrease in the mean value of quantitative characters in the M_2 generation of *Triticum aestivum,* which is an allohexaploid (2x = 6x =42). It seems worth while to study this phenomenon in a diploid (2n = 14) like *Pennisetum americanum.* Thus the present studies also offer the possibility of testing Gregory,s hypothesis (1965) that artificially induced mutation increase in frequency with decreasing magnitude of change and that the probability of improvement increases with decreasing magnitude of change.

Materials And Methods

Four varieties (Awn-Selected, ex-Bornu, Japan Bajra and B-18) of bajra (*Pennisetum americanum*) were treated with gamma rays ranging from (0.5, 10,15, 20, 25, 30 and 35 kR) by a Cobalt– 60 source at the Atomic Energy Agricultural Research Center, Tandojam. M_1 generation was grown in a split plot design. The details of M_1 generation have been published earlier (Aslam and Siddiqui, 1979). M_2 population of each variety derived from different mutagenic treatments was grown in a split plot design with 4 replications. The data were analysed statistically.

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Results And Discussion

Plant height.

Analysis of variance (Table 1) indicated that genotypic differences among varieties were non-significant for plant height. However, the differences among various treatments of gamma-rays were statistically significant (P=.05). Likewise, varieties treatment mean squares were also significant (Table 1).

Treatments of gamma-rays were instrumental in enhancing the plant height in all the treated varieties except in variety ex-Bornu, Significant increases in plant height (Table 2) were observed in the variety Awnon Selected at 10 kR (P=.05), 20 kR (P=.05) and at 25 kR (P=.01). In the variety Japan Bajra, significant increases in plant height were noted at 15 kR (P=.05). Similarly, in variety B-18, significant increase in plant height was noted at 10 kR (P=.05), 15 kR (P=.05) 20 kR (P=.01) and 35 kR (P=.05).

Table 1. Analysis of Variance For Plant Height in Four Varieties of *Pennisetum americanum.*

M_2 GENERATION

Source of variation	D.F.	M.S.	F.Ratio
Replicates	3	1833.9453	—
Varieties (V)	3	746.6120	0.66 N.S
Error (a)	9	1136.8967	—
Treatment (D)	7	271.2757	2.16*
VXD	21	373.0286	2.97*
Error (b)	84	125.7958	—
Total	127	—	—

N.S. - Non-significant: *Significant at .05% level.

	Varieties (V)	Doses (D)	VxD
$S\bar{x}$	5.96	2.80	5.61
C.V.	2.97%	1.40%	2.79%
LSD .05	—	7.89	15.78

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Table 2. Estimates of Genetic Variability for Plant Height in Four Varieties of *P.americanum*.

M_2 GENERATION

Variety	Dose kR	Mean	Standard Deviation	Coefficient of variability%	Variance
Awnon Selected	0	191.00	± 18.00	9.42	324.0
	5	192.50	± 15.00	7.79	225.0
	10	196.75*	± 26.62	13.53	708.9
	15	200.25	± 21.546	10.75	464.25
	20	211.00*	± 18.31	8.6	335.33
	25	219.00*	± 18.35	9.34	337.00
	30	193.00	± 9.57	4.89	91.6
	35	195.50	± 9.57	4.89	91.6
ex-Bornu	0	200.00	± 00.00	0.00	000.0
	5	211.25	± 19.31	9.14	372.9
	10	207.75	± 18.26	8.79	333.58
	15	202.00	± 11.66	5.77	136.00
	20	211.50	± 23.216	10.97	539.00
	25	208.00	± 10.012	4.81	100.28
	30	207.00	± 15.25	7.36	232.66
	35	195.50	± 34.42	17.60	185.00
Japan Bajra	0	207.75	± 15.5	7.46	240.25
	5	188.50	± 27.0	12.64	729.00
	10	213.25	± 22.23	10.42	294.55
	15	231.25*	± 20.99	9.57	440.96
	20	206.75	± 19.68	8.85	387.56
	25	189.00	± 20.37	9.29	415.11
	30	190.00	± 22.10	10.31	488.76
	35	210.00	± 21.52	10.06	463.23
B-18	0	198.00	± 08.89	4.51	79.05
	5	193.50	± 10.13	19.37	102.80
	10	182.50*	± 15.57	7.91	242.50
	15	188.75*	± 18.20	9.48	331.40
	20	204.25**	± 18.50	9.53	342.52
	25	199.25	± 18.59	9.54	345.60
	30	200.50	± 18.81	9.62	354.12
	35	203.60*	± 18.79	9.57	353.36

* & ** Denote significance at .05 & .01% level of probability.

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M_2 population of variety B-18 exhibited considerable increase in plant height (b = 6.4643). On the other hand reduction in the plant height of the M_2 populations was observed in the variety Japan Bajra (b = -3.4643) as well as in variety ex-Bornu. Reduction in plant height is relevant to lodging resistance. Chemical mutagen seem to be more effective than ionizing radiation in reducing the plant height in pearl millet. Venkateswarlu and Mani (1973) induced two dwarf mutants by MES treatment. More recently Gupta *et al.* (1982) have reported dwarf mutants in pearl millet induced through EMS. The height of these dwarfs varied from 21 cm to 46 cm in comparison to that of the control which grew up to 190 cm. The dwarf mutants were characterised by high tiller number, delayed flowering and high number of nodes. The segregation frequency in M_2 indicated monogenic and recessive nature of inheritance of this dwarfism.

Population of the variety Awnon Selected derived from 10 kR and 15 kR, exhibited considerable increase in variance (Table 2) indicating that selection for plant height can be productive. Similarly, the genetic constitution of variety ex-Bornu seem to offer good possibilities of selection for plant height generally in all the treated populations but particularly in the M_2 population derived from 35 kR. Treated populations of Japan Bajra and B-18 were also characterized by higher

Table 3. Analysis of Variance For Tiller Numbers in Four Varieties of *P.americanum.*

	M_2 GENERATION		
Source of Variation	D.F.	M.S.	F.
Replicates	3	53.9167	—
Varieties (V)	3	40.3125	8.19**
Error (a)	9	4.9236	—
Treatments (D)	7	15.5714	4.32**
V x D	21	23.7411	6.58**
Total	127		

* & ** = Significant at .05 and .01% probability level.

	Varieties (V)	*Doses (D)*	*V&D*
5x			
C.V.	0.39	0.47	0.95
LSD .05	4.27%	5.17%	10.33%
LSD .01	1.25	1.34	2.67
	1.80	1.77	3.55

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co-efficients of variability than respective controls. Increase in plant height appears to be a positive contribution of irradiation treatments as it has productive implication in the genetic improvement of pearl millet. Nwasike *et al.* (1983) have recently demonstrated that in pearl millet plant height is positively correlated with dry head weight and grain yields which indicates that tallar plants yield better. The genotypic correlation of number of stands was also positive with plant height.

Tiller number.

Analysis of variance for tiller number in M_2 generation of the four varieties of pearl millet is given in Table 3. Genotypic differences among the varieties were highly significant (P=.01) The analysis also revealed highly significant (P=.01) differences among various radiation treatments.

In all the four varieties, majority of treated populations exhibited significant decrease in tiller number (Table 4) whereas in some there was no significant shift in the mean values of tillers. It has been suggested earlier (Gregory, 1955) that the problem of the shift in an irradiated population is in the magnitude of individual changes. Gregory (1966) has further argued that the number of minus and plus mutations in the polygene system are nearly equal and that it is the maginitude of the phenotypic effects of a mutation which gives minus effects and not its unidirectional character. However, plant characters such as tiller number which have evolutionary significance (Siddiqui, 1971), must also be assessed in the light of the history of previous selection. The present results (Table 4) show that the co-efficient of variability increased considerably in the treated populations of Awnon Selected (at 30 kR and 35 kR) and ex-Bornu (35 kR).

In all the four varieties substantial variability for tiller number was also observed in untreated controls (Table 4). This is in agreement with Gregory (1966) who demonstrated that quantitative characters which show greater variability in genetic background before the treatment offer better opportunities for obtaining positive mutations after the treatment. It appears that for the genetic Improvement of tiller number in pearl millet, several cycles of recurrent selection will be needed after irradiation. However, this character cannot be selected in isolation. Tiller number is known to possess positive correlation with seedling vigour which is positively correlated with plant hight, ear length and grain yield in pearl millet (Chhina *et al.*, 1983). It is also known that environments that induce highest number of tillers also produce highest yields (Joppa, 1973; Arian and Siddiqui 1976 Siddiqui *et al.*, 1979).

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Table 4. Estimates of Genetics Variability For Tiller Number in Four Varieties of *P. americanum*.

M_2 GENERATION

Variety	Dose in kR	Mean	Standard Deviation	Coefficient of Variability	Variance
Awnon Selected	0	10.25	± 2.3629	23.05	5.5833
	5	9.00	± 1.7677	19.64	3.125
	10	7.75	± 1.4361	18.53	2.0625
	15	11.00	± 2.0332	18.48	4.1342
	20	10.25	± 2.2646	22.09	5.1286
	25	9.25	± 2.4102	26.07	5.8095
	30	5.25**	± 2.6803	51.05	7.1844
	35	5.75**	± 2.8228	49.09	7.9682
ex-Bornu.	0	6.50	± 2.7507	42.32	7.5666
	5	6.50	± 2.6873	41.34	7.2219
	10	5.50	± 2.6483	48.15	7.0138
	15	11.75	± 2.8903	24.60	8.3539
	20	13.30	± 3.1794	23.91	10.1091
	25	9.00	± 3.3557	37.29	11.2609
	30	8.73	± 3.2716	37.48	10.7039
	35	3.75*	± 3.3739	89.97	11.3832
Japan Bajra.	0	12.00	± 3.3971	28.31	11.5403
	5	11.25	± 3.3856	28.81	11.4625
	10	10.25	± 3.3233	32.42	11.4441
	15	08.25**	± 3.2510	39.41	10.5690
	20	12.00	± 3.2720	27.27	10.7066
	25	08.50*	± 3.2036	37.69	10.2530
	30	11.50	± 3.2139	27.45	10.3290
	35	11.25	± 3.1849	28.31	10.1437
B-18.	0	9.75	± 3.1275	32.08	9.7814
	5	9.00	± 3.0845	34.27	9.5145
	10	8.00	± 3.0449	38.06	9.2715
	15	10.00	± 3.0172	30.17	9.1038
	20	7.25*	± 2.9886	41.22	8.9321
	25	6.75*	± 2.9690	43.99	8.8149
	30	10.25	± 2.9015	28.31	8.4190
	35	13.50	± 2.9912	22.16	8.9476

* & ** Denote significance at .05 & .01% level of probability.

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