https://doi.org/10.29321/MAJ.10.A03065

Madras agric. J. 65 (4) : 211—217, Apr., 1978

Comparative Mutagenic Effects of Gamma Rays and Diethyl Sulphate in Bhendi (*Abelmoschus esculentus* L., Moench)*

K.S. JEHANGIR[1] and P. CHANDRASEKHARAN[2]

A study was undertaken to observe the induction of chlorophyll and viable mutants in bhendi with physical and chamical mutagens. Dry seeds were irradiated in 30-90 Krads of gamma rays and precoaked seeds were treated in 0.04 to 0.10 par cent dES. Wider spectrum of chlorophyll and viable mutants was observed with gamma rays than with dES. Of all the types of chlorophyll mutants *virescent* was the most common. *xantha* was rare and *albina* was completly absent. The frequency of chlorophyll mutants was more in the two first formed fruits. The majority of viable mutants comprised those affecting height, fruit length, and fertility of seeds. was induced by lower and middle doses. The variability in general was higher only in radiation treatments than chemical mutagen excepting for the number of fruits per plant.

The existing level of variability in Bhendi (*Abelmoschus asculentus* L., Moench) a popular and nutritious vegetable crop of India is rather low. The desired level of improvement has not been achieved merely by following the conventional techniques. In recent years increasing importance is given to mutation breeding programmes; and many useful mutants were obtained by this method (Sigurbjornson and Micke, 1974). Bhendi is a secondary polyploid with a high chromosome number of 2n = 130 (Joshi *et al*., 1957). Consequently severe diplontic selection is expected to cause low mutation frequency. The buffering effect in such secondary polyploids could however, lead to greater recovery of mutations- In order to find out the possibility of inducing useful variability in this crop through induced mutagenesis, studies were undertaken using gamma rays and dES. Information pertaining to chlorophyll and viable mutants recorded in different treatments with the two mutagens on the popular variety Pusa Sawani bhendi is reported in this paper.

MATERIALS AND METHODS

Pure seeds of Pusa Sawani (Pusa makhmali x IC 1542) obtained from the germplasm bank maintained at the Tamil Nadu Agricultural University, Coimbatore were utilized in this study. Various doses of gamma rays and concentrations of dES used are presented in Table I.

Immediately after treatment, the seeds were sown in the field in a ran-

* Forms part of M.Sc. (Ag) thesis work of the Senior Author.

1. Assistant Cotton Breeder, Tamil Nadu Agricultural University, Coimbatore-3.

2. Dean, Agricultural College and Res. Instt., Coimbatore-3.

TABLE I. Details of mutagenic treatments on Pusa Swani

Details	Mutagen treatment	
	Physical	Chemical
Mutagen	Gamma rays (r)	dES
Source	CO^{60} (Gamma unit at Sugarcane Breeding Institute, Coimbatore)	BDH (Mol. Vot. 154-19
Dose (Krad/conc %)	30, 40, 50, 60, 70, 80, and 90	0.04, 0.05, 0.06, 0.07, 0.08 0.09, and 0.1
Pretreatment	dry seed	Pre soaking in distilled water for 10 hrs
Buffer used	–	Phosphate buffer (pH 7.0)
Temperature at treatment time	24 ± 1°C	24 ± 1°C
Duration of treatment	–	8 hrs with post washing in running water
Seeds per treatment	100	100

TABLE II. Details of M_1 and M_2 plants studied

Treatments	M_1		M_2	
	No. of seeds sown	No. of adult plants	No. of seeds sown (5 fruit basis)	No. of adult plants
Gamma rays (Krads)				
30 ,,	100	57	1058	685
40 ,,	100	56	932	562
50 ,,	100	41	1689	1092
60 ,,	100	43	1183	662
70 ,,	100	40	1470	914
80 ,,	100	41	167	86
90 ,,	100	40	364	195
diethyl sulphate (%con)				
0.04 ,,	100	53	3038	2193
0.05 ,,	100	47	3101	2078
0.06 ,,	100	43	2751	1772
0.07 ,,	100	34	3163	1982
0.08 ,,	100	45	1162	702
0.09 ,,	100	44	4935	2895
0.1 ,,	100	34	4173	2356

damised block design with four replications adopting a spacing of 45 cm x 24 cm. The number of M_1 plants studied individually, number of fruit considered for raising fruits progenies in M_2 and number of M_2 plants studied are presented in Table II.

Data on chlorophyll mutants as classified by Gustafsson (1940) and Basu and Basu (1969) such as *xantha*, *virescent*, *Maculata*, *Lutescent*, *Striata* and *xanthastriata* in all the M_2 lines at fortnightly intervals upto 45th day of sowing and on viable mutants for five quantitative traits at harvest were collected and analysed statistically.

RESULTS AND DISCUSSION

Chlorophyll mutations : The particulars of different types of mutants observed in M_2 generation in various treatments are presented in Table III.

TABLE III. Frequency of chlorophyll mutations in M_2 (on M_1 fruit basis)

Doses	Number of plants studied	M_2 Chlorophyll mutants number	M_2 Percentage	Percentage in Xantha 1	Virescent 2	Maculata 3	Lutescent 4	Striata 5	Xantha Striata 6	Percentage on M_2 fruit basis I	II	III	IV	V
Control														
Gamma rays														
30 krads	685	62	8.8	—	2.7	4.1	1.5	0.4	0.1	3.7	3.2	1.6	0.2	0.1
40 krads	562	109	19.4	—	14.2	1.1	2.1	1.1	0.9	5.7	6.4	3.6	2.8	0.7
50 krads	1092	164	15.0	1.6	6.8	2.6	2.0	0.7	1.3	2.1	4.0	4.1	3.1	1.7
60 krads	662	80	12.1	—	5.4	3.5	3.0	0.2	—	3.8	5.4	1.7	0.9	0.3
70 krads	914	102	11.2	—	3.0	4.7	3.3	0.2	—	4.5	3.8	2.0	0.7	0.2
80 krads	86	13	16.3	—	10.5	2.3	3.5	—	—	10.5	3.5	2.3	—	—
90 krads	195	35	17.9	—	11.3	5.1	1.5	—	—	2.6	5.1	3.6	2.6	4.0
Diethyl sulphate														
0.04%	2193	202	9.2	—	4.5	0.9	3.7	0.1	—	1.7	1.9	2.5	1.6	1.5
0.05%	2078	287	13.8	—	7.5	2.4	3.6	0.2	0.1	4.2	3.6	2.8	2.2	1.0
0.06%	1772	174	9.8	—	6.9	0.9	1.9	0.1	—	2.6	2.8	2.1	1.6	0.7
0.07%	1932	250	12.6	—	8.3	0.5	3.7	0.1	—	4.3	2.7	4.4	1.0	0.2
0.08%	702	124	17.7	—	16.9	—	0.8	—	—	4.6	4.7	3.3	3.6	1.5
0.09%	2895	456	15.8	—	9.8	1.1	4.7	0.2	—	3.7	4.4	4.3	2.7	0.7
0.10%	2356	257	10.9	—	6.9	1.1	2.5	0.4	—	2.8	2.5	2.2	2.0	1.4

The spectrum of chlorophyll mutations was very wide in all the six types under gamma irradiation and only five excepting *xantha* under dES treatments. In gamma treated materials, all the six types occurred only in 50 krad which also had the highest number of total chlorophyll mutants. At the highest doses of 80 and 90 krad, the spectrum and frequency of mutations were lower compared to the lowest dose of 30 krad. *Xantha* was the rarest among chlorophyll mutants which occurred only at 50 krad.

Chemical mutagen treated materials recorded comparatively a higher level of chlorophyll mutants than with gamma radiation. Of all the types of chlorophyll mutations, *Virescent* was the maximum in both mutagens, followed by *maculata* in gamma rays and *lutescent* in dES. The per cent of mutation ranged from 8.8 to 19.4 whereas the frequency was maximum at the lowest or high doses in gamma rays and only in certain concentrations of dES. In the present study on bhendi there was total absence of *albina*. Kawaii, (1962)

and Osone, (1966) reported vety high frequency of *albina* in rice irradiated with gamma rays. The difference probably may be explained on the basis of high polyploid status of the bhendi plant as also the direction of diploidization process and stage of its advance (Mackey, 1967). The spectrum of mutations was low for *xantha striata*, but the frequency of others increased under higher concentration. The frequency of chlorophyll mutations was relatively high only in the first and second formed fruits than in later formed ones, in both, physical and chemical mutagenic treatments. The percentage of chlorophyll mutants, however, did not differ significantly due to the dosage of mutagens. Dilution of mutations in latter formed tillers in rice was reported by Siddique aed Swaminathan (1966). Gaul (1958) suggested the intersomic selection as the reason for this dilution. The differences between the spectrum of mutations induced by radiation and chemical mutagens in this study may be due to the intragenic effects of the former while the effect of the latter was mostly intergenic (Nilon and Konzax, 1961).

Induced variance in quantitative traits : The mean value of different metric traits studied are presented in Table IV. along with the co-efficent of variability.

Dwarf as well as tall plants besides intermediate types were observed. The stem was characterised by extreme condensation in the dwarf and extreme elongation in the tall plants. The mean height in M_2 registered a reduction over the control in 30, 40 and 90 krad treatments of gamma rays, while in the other doses, increase in height to the extent of 11.4 to 36.0 per cent over the control was observed. The variation in height in response to dES treatments was not apparent compared to control except in 0.05% concentration. No definite trend was observed in dose response. In certain cases treatments with physical and chemical mutagens showed high coefficient of variability. The number of fruits per plant was increased in certain higher doses of gamma rays and lower concentrations of dES. The differences between treatments were however, not statistically significant. The higher percentage of increase over control was recorded by 70 krad gamma and 0.04% dES treatments. The absence of any particular trend in mean number of fruits for different treatments was evident.

The mean fruit length ranged from 10.4 to 17.8 cm in gamma rays and 11.6 to 14.5 cm in dES treatments. However, the difference in length of fruits was not significant. Very high increase for this character over control was observed in treatments with 70 krad gamma rays and also 0.05% dES. A number of treatments of both physical and chemical mutagens recorded highly negative values over control. Co-efficient of variability for this trait was high at 40 krad in gamma rays and 0.05% concentration of dES.

In the case of plant height and number of fruits, the mean values shifted in the positive direction with higher C.V and C.V. was the maximum only in low and middle doses of mutagens. In respect of number of nodes and fruit

TABLE IV. Effect of Mutagens on Quantitative characters in M_2

	Plant height (cm)			Number of Nodes			Fruits per Plant			Length of fruit (cm)			Seed fertility on pod basis		
	Mean	C.V.	% over control	Mean	C.V.	% over control	Mean	C.V.	% over control	Mean	C.V.	% over control	Mean	C.V.	% over control
Control	22.5	23.7	—	8.5	23.13	—	1.17	3.4	—	12.4	8.30	—	62.4	7.5	—
Gamma rays															
30 krads	22.1	31.2	3.1	8.7	24.77	+ 2.4	1.48	36.4	+26.5	11.9	22.2	— 4.0	64.2	54.5	+ 2.9
40 krads	20.0	32.0	— 12.3	8.3	40.30	— 2.4	1.23	32 5	+ 5.1	10.4	79.5	—16.1	54.6	76.3	—13.5
50 krads	31.0	29.0	+ 36.0	9.3	30.10	+ 9.4	1.78	47.7	+52.1	14.7	50.0	+18.5	61.5	58.5	— 1.4
60 krads	28.0	30.0	+ 22.8	8.4	21.25	— 1.2	1.33	64.6	+13.7	12.4	33.9	—	60.2	66.6	— 3.5
70 krads	45.9	30.5	+101.3	10.8	26.20	+27.1	2.25	32.4	+92.3	17.8	26.3	+43.5	64.2	70.6	+ 2.9
80 krads	25.4	32.7	+ 11.4	9.6	29.70	+12.9	1.18	56.9	+ 0.9	11.5	11.5	— 7.3	59.8	72.4	— 4.2
90 krads	20.2	24.8	— 11.4	7.7	29.54	— 9.4	1.24	59.2	+ 6.0	12.2	15.9	— 1.6	54.9	73.8	—12.0
Diethyl Sulphate															
0.04%	27.4	27.4	+ 20.2	9.8	27.60	+15.3	1.66	72.3	+42.0	14.2	18.3	+14.5	67.1	20.6	+ 7.5
0.05%	33.4	29.9	+ 46.5	10.1	18.00	+18.8	1.60	62.5	+40.0	14.5	24.1	+16.9	57.3	67.6	— 8.2
0.06%	23.6	36.4	+ 3.5	8.8	28.40	+ 3.3	1.25	64.4	+18.3	13.0	14.6	+ 4.8	54.2	71.0	—13.1
0.07%	23.8	13.0	+ 4.4	8.5	25.00	—	1.37	62.0	+29.0	12.1	19.8	— 2.4	48.5	84.8	—22.3
0.08%	23.9	23.0	+ 4.8	8.5	27.02	—	1.34	52.2	+27.5	11.6	19.5	— 6.5	42.7	78.7	—31.6
0.09%	27.0	24.1	+ 18.4	8.7	19.05	+ 2.4	1.29	65.1	+25.0	12.3	15.3	— 0.8	45.0	70.4	—27.9
0.10%	23.9	19.3	+ 4.8	7.9	18.70	— 7.1	1.24	70.9	+ 3.1	12.4	10.0	—	46.6	65.0	—25.3
P	0.01			0.01			0.01			0.01			0.01		
S.E.D.	1.91			0.39			0.28			0.3			4.127		
C.D.	5.69			1.16			0.83			—			12.3		

length, the treatments induced shift of the mean in negative direction. The extent of variability induced by the two mutagens also varied markedly. The variability in general was higher only in radiation treatments except in mean number of fruits per plant.

Gregory (1956), Swaminathan (1965) and Gaul (1965) in their studies on induced mutations showed the increase in genetic variability for many polygenic traits. Decrease in mean, as in the present study, with increases in variability in M_2 was shown by Borojovic (1965), who also held the view that micromutations enhancing the variability formed the base for selection pressure to operate. In this study on Bhendi variability was enhanced for plant height and number of fruits as the result of stimulatary effect of mutagen. This has caused a shift in mean to the positive direction considerably thus, making selection for these traits easier.

The mean seed fertility was lower in gamma radiation treatments than in dES treatments. Co-efficient of variability was the highest in 40 krad of gamma and 0.07% concentration of dES.

Other odd types of mutants such as wrinkle leaved mutant in 0.04% concentration of dES, fasiated seedling in 0.09% concentration of dES and bushy dwarf mutant in 50 krad of gamma rays treatment were also observed in very low frequency.

Judged from the comparative effects of gamma and dES on chlorophyll and viable mutants, the present study has brought out that the effect through the gamma rays in enhancing the variability for quantitative economic attributes in Bhendi is more than dES.

The receipt of Junior Fellowship of the Indian Council of Agricultural Research received by the Senior author is gratefully acknowledged. The authors wish to express their gratitude to Dr. C. V. Govindaswamy the then Dean, Agricultural College and Research Institute, Madurai for his sustained interest and encouragements.

REFERENCES

BASU, A.K. and R.K. BASU. 1969. Cytological effectof X-rays, P^{32} and S^{35} in M_1 population of rice. *Nucleus*, **12** : 136-44.

BOROJOVIC, K. 1965. The effect of irradiation and selection after irradiation on the number of kernels per spike in wheat. *Z. Pflanzenzuckt*. **48** : 505-13.

GAUL, H. 1958. present aspects of induced mutations in plant breeding. *Euphytica*, **7**: 275-89.

GAUL, H. 1965. "The concept of macro and micro-mutations and results in induced micro mutations in barley", and *The use of Induced Mutations* in *Plant breeding*. Report F.A.O./I.A.EA., 1964., (Technical meeting, Rome) Pergamon Press. *Radiation Botany* **5**: (Suppl) : 407-28.

GREGORY, W.C. 1956. Induction of useful mutation in the peanut, *Brookhaven Syn. Biol*. **9** : 177-90.

GUSTAFSSON, A. 1940. The mutation system of the chlorophyll apparatus, *Lunds. Univ. Arsski*. **36** : 1-40.

JOSHI, A.B., H. B. SINGH, B.S. JOSHI, and M.L. HARDAS. 1956. Alloploid nature of Okra *Abelmoschus esculentus* (L) *Moench*. *Nature*, **178** : 1190.

KAWAII, T. 1962. The present status of mutation research and breeding in rice in Japan. *Intern. Rice Comm. Newsletter.* **11**: 10-22.

MacKEY, J. 1967. Physical and chemical mutagenesis in relation to ploidy level. *Induced Mutation and their Utilisation.* Academ. Verlag Berlin pp. 185-97.

NILAN, R.A. and C.F. KONZAK. 1961. Increasing the efficiency of mutation induction "Mutation and Plant Breeding Pub. No 891 NAS-NRC, Washington, D.C. pp. 437-60.

OSONE, K. 1963. Studies on the developmental mechanism of mutated cells induced by irradiated rice seeds. *Japan. J. Breed* **13**: 1-13.

SIDDIQUE, E. A. and M. S. SWAMINATHAN. 1966. Maximisation of the frequency and spectrum of induced mutation in rice and promotion of crossing over in *Indian and Japanica crosses. Second Co-ordinating meeting of the participants in the co-ordinated programme of research on the use of Induced Mutation in Rice Breeding, Manila.*

SWAMINATHAN, M.S. 1965. A comparison of mutation inductton in diploids and polyploids in the use of Induced Mutations in Plant Breeding. Report of the FAO/IAEA 1964 (Technical meeting, Rome) *Radiation Botany,* **5**: (Suppl) 619-41.

SIGURBJORNSSON, B. and A. MICKI. 1974. Philosophy and accompalishments of mutation breeding. *Polyploidy and induced mutations in plant breeding* IAEA, Vienna, 303-43.