*Journal of Crop and Weed, **8**(2):130-131(2012)*

Effect of gamma rays and ethyl methane sulphonate on germination, pollen viability and survival of okra [*Abelmoschus esculentus* (L.) Moench]

P. A. JADHAV, H. V. KALPANDE, M. N. KATHALE AND G. P. DAHALE

Dept. of Agril. Botany
College of Agriculture, Marathwada Krishi Vidypeeth
Parbhani-431402, Maharashtra, India

Received: 14-07-2012, Revised: 08-10-2012, Accepted :15-11-2012

***Key words*:** Biological traits, mutagens, pollen vialbility

Induced mutation has been established as an important tool for improvement of certain traits in the existing germplasm. Mutations are of two types *viz.*, natural and artificial or induced mutation. Frequency of natural mutation is very low and hence, artificial mutation with application of mutagens is followed to get better genetic variability. Various types of chemicals capable of inducing mutation in plants had been found out. They are ethyl methane sulphonate (EMS), methyl methane sulphonate (MMS), diethyl sulphate (DES), ethylene imine (EI), hydroxyl amine (HA), n-nitroso-n-ethyl urea (NEU), nitrous acid (NA), sulphur mustard, 5-bromouracil, sodium azide (SA) etc. Among these, EMS is a potent mutagen belongs to the category of alkylating agents with a chemical formula $C_2H_5OSO_2CH$. Its potential of inducing mutations was confirmed in *Drosophila*, *Neurospora*, bacteria and in some of higher plants.

Among physical mutagens, ionizing gamma rays are capable of inducing mutation in plants and animals. They are the electromagnetic radiations similar to X-rays in their physical nature and action on the organism. Most of the gamma rays have wavelength less than $0.01A^0$ as compared to $0.5A^0$ in X-rays.

Considerable progress has been made on induce mutations of okra [*Abelmoskhus esulentus* (L.) Moench] for improvement of their certain characters, but detailed studies are lacking. The characters like germination, pollen sterility, and mortality are much affected by mutagenic treatment. Therefore, an attempt has been made to study the effect of mutagenic treatment on biological characters of okra in M_1 and M_2 generations.

MATERIALS AND METHODS

The experiment was conducted in RBD with three replications at the Experimental Farm of the Marathwada Krishi Vidyapeeth, Parbhani during *kharif* 2010 and summer 2011. Two mutagens, gamma rays (15 kR, 30 kR, 45 kR and 60 kR) and ethyl methane sulphonate (0.2 %. 0.4 %, 0.6 %, 0.8 %, and 1.0 %) were used here. For each treatment five hundred seeds of okra variety Parbhani Kranti were irradiated with Co^{60} gamma rays at BARC, Trombay, Mumbai. For EMS five hundred seeds were presoaked in water for 12 hrs and then put in EMS solution for 6 hrs. The seeds were then washed thoroughly in running tap water for 30min. Five hundred unirradiated seeds of Parbhani Kranti were used as a dry control and five hundred seeds of Parbhani Kranti were soaked in water for 12 hrs and used as wet control. Pusa Sawani was used as a susceptible check. The treated seeds along with controls and Pusa Sawani were sown immediately after treatments to grow the M_1 generation. M_2 generation was raised from selfed seeds of healthy, disease free individual of M_1. The data was recorded from five plants selected at random from each treatment and mean per plant was worked out. The observations were recorded on germination, pollen sterility, mortality, days to first flower initiation, days to 50 per cent flowering, number of fruits per plant, average fruit length and yield per plant and number of seeds per fruit.

RESULTS AND DISCUSSION

The effect of various treatments of EMS and gamma rays on germination, mortality and pollen sterility in M_1 and M_2 generations are presented in table-1. Reduced germination percentage in all the treatments was observed in M_1 generation as compared to controls. Treatment T_6 (1.0% EMS) and T_{11} (60 kR) recorded the highest reduction in germination percentage (62.10 % and 64.60 %, respectively), while it was lowest in the treatment T_2 i.e 0.2% (73.14%) and T_8 i.e 15 kR (76.23%). Singh and Singh (2000) reported reduction in germination in M_1 okra treated with EMS and gamma rays mutagens. Dhankhar and Dhankhar (2003a) reported the effect of gamma rays (at 0.6 and 0.7 kR) on okra red stem line MR 54-20 seeds. In M_1 progeny decrease in germination was higher with 0.7 kR than 0.6 kR dose. Similar results were also reported by Kumar and Mishra (2004) and Ghai *et al*. (2004) in okra irradiated with gamma rays and treated with EMS.

The mortality percentage was increased with age of okra seedling in M_1 and M_2 generations. T_4 in M_1 and M_2 generations and T_{10} in M_2 generation recorded least mortality owing to EMS and gamma treatment. This indicates that variety responded differentially to two groups of mutagens. Malani *et al.*

Short Communication
Email: friendsformahesh@gmail.com

(1993) reported effectivity of gamma rays induced mutations in okra cv. selection 2-2 with gamma irradiation (10 to 60 kR). The germination percentage decreased and mortality increased with increase in gamma rays doses. Similar results were reported by Majid (1973) in tomato with gamma rays and chemical mutagens and Thakur *et al*. (1980) in chilli with X-rays.

In M_1 generation, the highest mortality (9.84%) of okra cv. Parbhani Kranti was recorded in 60 kR gamma radiation, while the lowest (5.17%) was observed in 0.6% EMS treatment as compared to their controls (1.32 % and 1.54%, respectively). Except T_4 (0.6% EMS) mortality increased with increase in concentration of EMS. Mortality also increased with increase in dose of gamma ray.

Pollen sterility increased in all the treatments as compared to their controls in M_1 and M_2 generations (Table 1). In M_1 the highest pollen sterility (7.33%) was recorded in 45 kR gamma radiation (T_{10}) and the lowest in T_2 being, 1.64%. Pollen sterility was increased with increase in doses of EMS and gamma rays. This observation remained in parity with Singh and Singh (2000). Dhankhar and Dhankhar (2003b) reported decrease in fertility of pollen was higher with 0.7 kR than 0.6 kR dose of gamma rays in okra red stem line MR 54.

Table 1: Effect of EMS and gamma rays on germination, mortality and pollen sterility in M_1 and M_2 generations of okra cv. Parbhani Kranti

Treatments	Germinatation %		Mortality %		Pollen Sterility %	
	M_1	M_2	M_1	M_2	M_1	M_2
Wet control (T_1)	82.20	84.27	1.32	0.74	0.32	0.18
0.2% EMS (T_2)	73.14	88.14	5.51	1.47	1.64	0.94
0.4% EMS (T_3)	65.45	86.33	6.11	2.32	2.06	0.84
0.6% EMS (T_4)	69.50	78.29	5.17	1.84	2.27	20.3
0.8% EMS (T_5)	64.25	84.36	6.16	3.17	3.12	2.44
1.0% EMS (T_6)	62.10	75.56	6.40	3.56	4.20	2.74
Dry control (T_7)	81.60	82.20	1.54	0.86	0.42	--
15 kR (T_8)	76.23	86.66	6.53	4.20	4.36	2.16
30 kR (T_9)	67.05	84.23	7.25	6.03	5.82	2.86
45 kR (T_{10})	71.12	82.65	7.31	5.74	7.33	3.19
60 kR (T_{11})	64.60	79.40	9.84	6.15	5.67	2.37
Pusa Sawani (T_{12})	80.50	82.36	1.96	0.80	0.38	0.26
SEm(±)	**0.93**	**1.50**	**0.32**	**0.21**	**0.43**	**0.26**
LSD(0.05)	**2.59**	**4.15**	**1.20**	**1.54**	**1.67**	**1.12**

Induction of gamma ray and EMS as mutagen reduced germination of okra cv. Parbhani Kranti in M_1 generation as compared to controls. In M_2 generation, germination increased in all the treatments. The highest mortality was recorded at 60 kR gamma rays in two progenies of okra. Pollen sterility increased in all the treatments as compared to their controls in both the generations. In M_1 the highest pollen sterility was recorded in 45 kR gamma ray. Higher doses of gamma rays and ethyl methane sulphonate had deleterious effects on seed germination, pollen fertility and plant survival. It was observed that ethyl methane sulphonate treatments caused more physical damage than gamma rays.

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