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RESEARCH ARTICLE

STUDIES ON EFFECT OF PHYSICAL AND CHEMICAL MUTAGENS ON SEEDLING CHARECTERS IN BRINJAL (*Solanum melongena* L.)

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ABSTRACT

Five brinjal genotypes were chosen to study the effect of physical and chemical mutagens on the induction of variability. The physical mutagen gamma rays and chemical mutagens namely Ethyl Methane Sulphonate and Diethyl Sulphate were employed for treating the seeds to determine the LD_{50} values in brinjal. Germination percentage, shoot length and root length were measured under laboratory conditions. The mutagenic effect of gamma rays was found to be more effective than the chemical mutagens in seedling characters.

INTRODUCTION

Brinjal is an important and popular vegetable crop of India. There is an increasing demand of its varieties for different culinary purpose. Mutation breeding is relatively a quicker method for crop improvement of crops. Many physical and chemical mutagens have been used for induction of useful mutants in a number of crops. Mutation breeding has been extensively followed in other vegetable crops like tomato, chillies etc., (Manuel Gonzalez *et al*., 2002) but only very few studies are reported in brinjal.

Chemical mutagenesis is a simple approach to create mutation in plants for their improvement of potential agronomic traits. Mutations are the tools and being used to study the nature and function of genes which are the building blocks and basis of plant growth and development, thereby producing raw materials for genetic improvement of economic crops (Adamu *et al*., 2007). Mutation methodology has been used to produce many cultivars with improved economic value and study of genetics and plant developmental phenomena (Van, Den-Bulk *et al*., 1990; Bertagne- Sagnard *et al*., 1996).

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It has been demonstrated that genetic variability for several desired characters can be induced successfully through mutations and its practical value in plant improvement programs has been well established.

The main advantage of mutational breeding is the possibility of improving one or two characters without changing the rest of the genotype. Induced mutations have great potentials and serve as a complimentary approach in genetic improvement of crops (Mahandjiev *et al.,* 2001). Induced mutations have been used to improve major crops such as wheat, rice, barley, cotton, peanut and cowpea, which are seed propagated. Various mutagenic agents are used to induce favorable mutations at high frequency that include ionizing radiation and chemical mutagens (Ahloowalia and Maluszynski, 2001). Chemical mutagens are the one cause of mutations in living organism. It is known that various chemicals have positive or negative effects on living organisms. Many of these chemicals have clastogenic (chromosome damaging) effects on plants via reactive oxygen-derived radicals (Yuan and Zhang, 1993). These effects can occur both spontaneously and artificially following induction by mutagens. Chemical mutagen generally produce induced mutations which lead to base pair substitutions. These chemo mutagens induce a broad variation of morphological and yield structure parameters in comparison to normal plants. Many researchers compared the mutagenic efficiencies of different

mutagens on different crops and their results seem to be entirely specific for particular species and even varieties. While many researchers found chemical mutagens are to be more effective than physical ones (Dhanayanth and Reddy, 2000; Bhat *et al.,* 2005a), and many other researchers found the reverse case (Zeerak, 1991). A number of workers (Mashenkov, 1986; Ricardo and Ando, 1998) have reported the role of chemical mutagens in enhancing genetic variability in higher plants because it is the fundamental characteristics to successful breeding programs in vegetatively and sexually propagated plants (Kleinhofs *et al.,* 1978). This variation can occur naturally or can be induced through mutations, using physical, biological or chemical mutagens and has attracted the interest of plant breeders for many decades. The mutants so produced facilitate the isolation, identification and cloning of genes used in designing crops with improved yield and quality traits (Ahloowalia and Maluszynski, 2001). Therefore in the present study, the per cent survival of different genotypes to different dosages of both physical and chemical mutagens and their effectiveness in laboratory was estimated.

Table 1. LD_{50} value for gamma rays in brinjal

Treatment (krad)	Percentage of reduction in germination over control				
	Angoor	Annamalai	Hissar Pragath	PLR 1	Putheri
0	-	-	-	-	-
2	9.3	7.6	8.8	4.9	9.8
4	22.6	18.3	20.6	16.8	26.8
6	32.3	30.7	37.5	30.6	30.7
8	42.6	39.3	42.2	44.8	43.9
10	**52.8**	**51.6**	**50.7**	**53.2**	**52.4**
12	71.7	70.4	72.3	74.6	78.6
14	86.2	89.0	90.4	87.1	83.5
16	96.3	94.7	98.1	97.8	93.8
18	100.0	100.0	100.0	100.0	100.0
20	100.0	100.0	100.0	100.0	100.0

Table 2. LD_{50} value for EMS in brinjal

Treatment (krad)	Percentage of reduction in germination over control				
	Angoor	Annamalai	Hissar Pragath	PLR 1	Putheri
0.00	-	-	-	-	-
0.01	6.4	7.1	5.5	9.6	8.0
0.02	20.7	17.5	24.2	22.7	29.8
0.03	34.6	39.1	40.6	38.6	44.1
0.04	**53.4**	**51.7**	**52.5**	**54.1**	**53.7**
0.05	65.7	69.1	66.3	70.5	72.6
0.06	80.3	73.3	74.9	77.4	79.2
0.07	88.5	81.7	87.4	83.8	86.4
0.08	96.2	87.6	94.6	92.7	90.5
0.09	100.0	100.0	100.0	100.0	100.0
0.10	100.0	100.0	100.0	100.0	100.0

Table 3. LD_{50} value for DES in brinjal

Treatment (krad)	Percentage of reduction in germination over control				
	Angoor	Annamalai	Hissar Pragath	PLR 1	Putheri
0	-	-	-	-	-
0.1	7.3	4.6	8.5	4.7	6.3
0.2	16.2	19.3	17.8	16.8	13.4
0.3	27.4	30.1	29.0	20.6	20.3
0.4	33.9	39.8	37.7	34.7	28.7
0.5	43.4	45.4	41.9	40.3	39.3
0.6	**51.3**	**50.7**	**53.4**	**51.9**	**52.4**
0.7	76.6	68.3	74.0	65.2	70.6
0.8	84.7	80.1	90.7	87.5	87.3
0.9	100.0	100.0	100.0	100.0	100.0
1.0	100.0	100.0	100.0	100.0	100.0

MATERIALS AND METHODS

Five brinjal genotypes namely Angoor, Annamalai, Hissar Pragath, PLR-1 and Putheri were chosen to study the effect of physical and chemical mutagens on the induction of variability. The physical mutagen namely gamma rays and chemical mutagens namely Ethyl Methane Sulphonate (EMS) [CHSO] with a molecular weight of 154.19 and Diethyl Sulphate (DES) [CH SO OC H] with a molecular weight of 124.16 were employed for treating the seeds. Samples of 400 dry, healthy and uniform size seeds in two sets were treated with 2, 4, 6, 8, 10, 12, 14, 16, 18 and 20 krad of gamma ray at Kidway-Cancer Research Centre to determine the LD_{50} value. For chemical treatments, seed samples were pre-soaked in

distilled water for six hours. Then the seeds were treated with 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9 and 1.0 per cent concentration of EMS and 0.01, 0.02, 0.03, 0.04, 0.05, 0.06, 0.07, 0.08, 0.09 and 0.10 per cent concentration of DES for determining the LD_{50} values. After identifying the LD_{50} values, two sets each containing 100 well filled seeds of each genotype was treated with the mutagens. The M_1 seeds were placed in moist germination paper replicated twice for the purpose of laboratory analysis *viz*., germination percentage, shoot length and root length that were measured on seventh day. Emerging of cotyledonary leaf was taken as the indication of germination. Ten randomly selected seedlings in each set were measured from the cotyledonary node to the tip of the shoot and from the cotyledonary node to the tip of the primary root in cm.

Table 4. Effect of mutagens on laboratory analysis in M_1 generation

Genotypes	Treatment (dose/conc.)	Seed germination			Shoot length			Root length		
		Mean (%)	% over control	% reduction over control	Mean (cm)	% over control	% reduction over control	Mean (cm)	% over control	% reduction over control
Angoor	Control	93.00	100.00	-	5.90	100.00	-	2.85	100.00	-
	10 krad gamma	57.20	61.51	38.49	4.30	72.88	27.12	2.70	94.74	5.26
	0.6 %EMS	62.30	66.99	33.01	5.20	88.14	11.86	2.75	96.49	3.51
	0.04 % DES	60.40	64.95	35.05	4.22	71.53	28.47	2.60	91.23	8.77
Annamalai	Control	95.00	100.00	-	6.20	100.00	-	3.20	100.00	-
	10 krad gamma	51.80	54.52	45.48	4.37	70.48	29.52	2.50	78.13	21.87
	0.6 %EMS	68.30	71.89	28.11	5.26	84.84	15.16	2.70	84.38	15.62
	0.04 % DES	70.40	74.11	25.89	5.20	83.87	16.13	2.95	92.19	7.81
Hissar Pragath	Control	91.00	100.00	-	5.21	100.00	-	3.40	100.00	-
	10 krad gamma	62.10	68.24	31.76	4.30	82.53	17.47	2.90	85.29	14.71
	0.6 %EMS	57.80	63.52	36.48	4.62	88.68	11.32	2.60	76.47	23.53
	0.04 % DES	67.10	73.74	26.26	4.17	80.04	19.96	2.72	80.00	20.00
PLR 1	Control	97.00	100.00	-	5.62	100.00	-	3.64	100.00	-
	10 krad gamma	60.30	62.16	37.84	5.13	91.28	8.72	2.40	65.93	34.07
	0.6 %EMS	59.70	61.55	38.45	4.86	86.48	13.52	2.60	71.43	28.57
	0.04 % DES	64.80	66.80	33.20	5.20	92.53	7.47	2.90	73.67	20.33
Putheri	Control	94.00	100.00	-	5.70	100.00	-	2.95	100.00	-
	10 krad gamma	58.80	62.55	37.45	4.12	72.28	27.72	2.50	84.75	15.25
	0.6 %EMS	66.20	70.43	29.57	4.50	78.95	21.05	2.75	93.22	6.78
	0.04 % DES	72.60	77.23	22.77	4.45	78.07	21.93	2.70	91.53	8.47
S.Ed		1.416			0.615			0.429		
C.D (P = 0.05)		2.867			1.246			0.868		

RESULTS AND DISCUSSION

In general as the dose increased, the germination percentage decreased. More than 50 per cent reduction in germination was recorded at 10 krad gamma rays. At 18 and 20 krad, 100 per cent reduction in germination was observed for all the genotypes selected. Below 10 krad, the reduction in germination observed was less than 50 per cent (*i.e*. up to 90.7 per cent survivals were observed). Therefore these doses could also be selected for further experiments (Pillai and Abraham, 1996). Above 10 krad the per cent germination was very poor and observed more mortality and therefore these doses could be rejected. There was a good germination per cent in 0.1 to 0.6 per cent EMS concentration. Above 0.6 per cent concentration, the germination percentage was 0 – 23.4 only and therefore, these concentration could be rejected. At 0.04 per cent DES concentration, the reduction in germination was more than 50 per cent. As in general, an over dose is likely to kill too many treated individuals, even zero per cent survival could also been observed at higher doses. From the experiment, more than 50 per cent reduction in germination was recorded at 10 krad gamma rays, 0.6 per cent EMS concentration and 0.04 per cent DES concentrations. Hence, the optimum dose/concentration of 10krad gamma rays (Table 1), 0.6 per cent EMS (Table 2) and 0.04 per cent DES (Table 3) could be considered as LD_{50} values for inducing viable mutants to all the selected genotypes of brinjal.

The results on the effect of mutagens on seed germination, shoot length and root length of the seedlings are presented in Table 4. The percentage of germination for different treatments was worked out taking the control as 100 per cent. In general a considerable reduction in germination was recorded among the treatments when compared to the control. The maximum reduction in germination was observed at 10 krad gamma (45.48 per cent over control) in Annamalai followed by Angoor (38.49 per cent) and PLR 1 (38.45 per cent) at 0.6 per cent EMS. Reduction in shoot length was observed among the treatments. The seed germination per cent was reduced more in physical mutagen treatment than chemical treatments (Karthika and Subba lakshmi, 2007). However, in chemical treatments, the reduction was maximum at 0.6 per cent EMS.

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