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VARIETAL RESPONSE FOR MUTAGEN SENSITIVITY IN SOYBEAN [*GLYCINE MAX* (L.) MERRILL.]

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Abstract

Dry and dormant seeds of soybean cultivars PK-327, PK-564 and JS-335 were treated with 10Kr, 20Kr, 30Kr, 40Kr and 50Kr doses of gamma rays, 0.005% EMS and 0.1% DES. Besides the individual mutagen treatments, all combinations of a gamma dose followed by the EMS or DES treatments were also made. Mutagen sensitivity effects were studied in terms of effects on germination percentage and seedling growth. Most of the treatments had an adverse effect on germination as well as seedling growth. Combined applications of radiation dose and a chemical dose had a more severe effect on both the parameters than single application of either mutagen. However, different cultivars of soybean exhibited varying levels of mutagenic sensitivity for the mutagenic doses or their combinations.

Key words: Mutagen, sensitivity, gamma rays, EMS, DES.

Introduction

Mutagen sensitivity effect induced in M1 generation may serve as an index of effectiveness of the mutagenic treatments. In experiments involving seed treatments, reduced germination and retarded seedling growth are commonly induced by mutagens physical or chemical. However the intensity of these deleterious effects has been found to vary with mutagens and their dose. Varietal response to mutagenic treatments has also been noted in several species. Therefore in becomes necessary to find out the most suitable mutagen/combination of mutagens and their optimum dose for a particular crop variety.

The present study reports the effect of ethyl methane sulphonate (EMS), diethyl sulphate (DES) and varying doses of gamma rays individually and in combinations of a chemical and a radiation dose on three different cultivars of soybean (*Glycine max* (L.) Merrill.).

Materials and Methods

Dry and dormant seeds of soybean cultivars PK-327, PK-564 and JS-335 were treated with 10Kr, 20Kr, 30Kr, 40Kr and 50Kr doses of gamma rays. Some of the irradiated and some fresh seeds were also treated with 0.005% and 0.1% of aquous solutions of EMS and DES respectively for a duration of six hours. A sample of untreated seeds was soaked in water for the same period to serve as soaked control. Thus there were a total of 19 treatment combination for each of the three cultivars as listed in the first column of table 1.

For each cultivar 25 seeds from each of above 19 treatments were sown in sand culture in the laboratory providing adequate moisture to the seedlings. First observations on germination were recorded three days after sowing and successive counts were made at a regular interval of three days upto the 15^{th} days from sowing. Growth of seedlings in terms of seedling height was also recorded at regular intervals of three days. Height of all the surviving seedlings in centimeters was measured from the sand surface to the tip of the seedlings.

Result and Discussion

Observation with regard to the percentage of seed germination and seedling height expressed in terms of percentage in table 1 and 2 respectively.

A perusal of table 1 reveals that most of treatments including soaking in water, brought about a reeducation in the percentage of germination. However in variety PK-327 and JS-335, some doses of gamma rays promoted germination over that in the control. In all the three varieties, the two chemical mutagens proved to be more deleterious for germination than the individual radiation treatments. DES reduced germination to a greater extent

Table 1: Summarising the effect of mutagenic treatments on germination in three cultivars of soybean.

Treat-ment	Days after sowing (PK-327)					Days after sowing (PK-564)					Days after sowing (JS-335)				
	3	6	9	12	15	3	6	9	12	15	3	6	9	12	15
Control	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Soaked Control	21.42	33.33	30.00	30.00	30.00	83.33	72.72	78.26	78.26	78.26	71.42	76.47	76.47	76.47	76.47
Gamma Rays 10 Kr	92.85	105.53	95.00	95.00	95.00	66.67	86.36	86.95	86.95	86.95	71.42	76.47	76.47	76.47	76.47
20 Kr	100.00	105.53	95.00	95.00	95.00	83.33	81.81	78.26	78.26	78.26	121.42	111.76	111.76	111.76	111.76
30 Kr	128.57	122.22	110.00	110.00	110.00	66.67	90.90	86.95	86.95	86.95	92.85	100.00	100.00	100.00	100.00
40 Kr	121.42	100.00	90.00	90.00	90.00	83.33	68.18	65.21	65.21	65.21	128.57	117.64	117.64	117.64	117.64
50 Kr	121.42	94.44	85.00	85.00	85.00	88.89	77.27	73.91	73.91	73.91	114.28	105.88	105.88	105.88	105.88
EMS 0.005%	28.57	38.89	35.00	33.00	33.00	44.44	50.00	47.82	47.82	47.82	42.85	41.17	41.17	41.17	41.17
DES 0.1%	14.28	11.11	15.00	15.00	15.00	50.00	40.90	39.13	39.13	39.13	92.85	82.35	82.35	82.35	82.35
Gamma Rays+ EMS10 Kr+EMS	14.28	16.67.	15.00	15.00	15.00	50.00	59.09	56.52	56.52	56.52	57.14	47.05	47.05	47.05	47.05
20 Kr+ EMS	14.28	16.67	15.00	15.00	15.00	16.67	27.27	26.08	26.08	26.08	35.71	35.29	35.29	35.29	35.29
30 Kr+ EMS	21.42	16.67	15.00	15.00	15.00	11.11	13.63	13.04	13.04	13.04	42.85	41.17	41.17	41.17	41.17
40 Kr+ EMS	21.42	16.67	15.00	15.00	15.00	16.67	13.63	13.04	13.04	13.04	28.57	23.52	23.52	23.52	23.52
50 Kr+ EMS	42.85	38.89	35.00	35.00	35.00	11.11	31.81	30.43	30.43	30.43	42.85	35.29	35.29	35.29	35.29
Gamma Rays+ DES10 Kr+DES	57.14	44.44	40.00	40.00	40.00	11.11	18.18	17.39	17.39	17.39	64.28	76.47	76.47	76.47	76.47
20 Kr+ DES	14.28	11.11	10.00	10.00	10.00	22.22	22.72	21.70	21.70	21.70	57.14	58.82	58.82	58.82	58.82
30 Kr+ DES	42.85	33.33	30.00	30.00	30.00	5.55	9.09	8.67	8.67	8.67	28.57	29.41	29.41	29.41	29.41
40 Kr+ DES	60.17	11.11	10.00	10.00	10.00	5.55	9.09	8.67	8.67	8.67	64.28	58.82	58.82	58.82	58.82
50 Kr+ DES	50.00	38.89	35.00	35.00	35.00	16.67	13.63	13.04	13.04	13.04	78.57	70.58	70.58	70.58	70.58

than EMS in cultivars PK-327 and PK-564 while in var. JS-335, the effect of EMS exceeded that of DES. Combined applications of gamma rays and a chemical mutagen brought about a greater reduction in germination than the individual applications of either mutagen in var. PK-564 and JS-335. But in var. PK-327, the germination percentage in some of the combined treatment involving DES exceeded that in the individual DES treatments.

Like germination, growth of seeding was also adversely affected by almost all the treatments including soaking in water in all the three varieties. In var. PK-327 lowest dose of gamma rays and individual application of DES promoted seedling growth at most stages of observations while some other treatments where promoting effect on seedling growth was noted at first observations did not maintain this trend at later stages. In var. PK-564 seedling growth was promoted by individual EMS and DES treatments at the time of first observation. But this effect was not maintained by EMS after the 9th day and by DES after the 3rd day. On the 15 day a promoting effect on seedling growth was noted in the lowest dose of gamma radiation only. In var. JS-335 combined application of EMS and 10Kr gamma rays induced promoting effect on seedling growth up to the

Table 2: Summarising the effect of mutagenic treatments on Seedling Growth in three cultivars of soybean.

Treat-ment	Days after sowing (PK-327)					Days after sowing (PK-564)					Days after sowing (JS-335)				
	3	6	9	12	15	3	6	9	12	15	3	6	9	12	15
Control	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Soaked Control	57.89	44.01	84.79	96.04	88.80	85.75	82.08	84.91	41.99	90.71	65.69	66.86	79.80	84.66	80.99
Gamma Rays 10 Kr	97.97	91.09	114.01	125.59	101.57	59.01	75.48	99.04	47.45	118.26	94.81	91.85	127.85	107.07	98.54
20 Kr	87.04	80.14	82.72	100.22	90.37	76.45	79.67	82.49	40.84	86.89	73.59	81.73	76.68	95.67	88.25
30 Kr	113.36	82.31	80.91	95.14	83.30	97.67	50.76	51.39	24.55	59.61	50.56	62.10	61.29	62.15	58.04
40 Kr	76.52	49.93	50.02	60.39	47.40	53.78	50.13	53.95	25.77	62.88	75.85	67.06	57.99	63.45	63.08
50 Kr	74.90	33.06	26.57	31.13	27.55	42.15	33.73	49.61	13.51	28.43	68.40	63.93	41.64	53.93	52.06
EMS 0.005%	131.58	48.50	61.12	73.90	65.37	107.56	101.14	101.05	47.40	96.64	67.72	78.15	62.99	142.03	79.30
DES 0.1%	91.09	123.12	102.96	120.51	104.96	101.74	83.80	78.23	41.04	84.64	57.56	92.17	87.86	107.62	91.22
Gamma Rays+ EMS10 Kr+EMS	30.36	53.74	53.59	77.23	67.93	57.27	74.08	87.06	41.83	90.20	36.57	95.63	110.40	121.11	111.93
20 Kr+ EMS	56.68	57.62	73.43	90.39	79.71	61.05	64.29	66.85	34.02	71.43	62.55	81.67	77.64	81.02	76.42
30 Kr+ EMS	106.48	58.03	26.77	58.54	67.64	17.44	24.33	24.37	13.15	29.12	42.89	84.41	55.75	61.15	57.45
40 Kr+ EMS	105.26	52.86	26.77	52.94	47.14	8.72	31.13	24.37	15.41	32.06	39.95	44.81	33.21	37.85	36.11
50 Kr+ EMS	65.59	37.69	27.62	36.78	32.27	50.87	25.92	25.19	13.69	28.10	22.57	39.59	26.89	29.53	27.51
Gamma Rays+ DES10 Kr+DES	89.07	67.28	55.25	83.11	75.59	31.93	41.61	50.30	25.50	53.13	62.53	71.30	66.15	59.11	61.15
20 Kr+ DES	44.53	62.24	59.27	74.86	65.09	61.63	50.82	55.95	27.44	58.88	36.12	17.25	57.58	60.31	55.62
30 Kr+ DES	95.95	56.44	13.81	94.63	82.51	14.53	20.01	12.57	11.84	24.61	36.57	39.66	31.15	32.86	32.45
40 Kr+ DES	56.68	34.01	49.47	38.13	33.40	2.91	28.59	45.05	24.25	50.37	36.82	46.70	33.71	38.64	35.47
50 Kr+ DES	38.06	30.34	29.28	45.25	39.44	32.85	33.23	26.66	11.35	26.39	43.11	45.75	33.71	44.67	40.68

final observation while on the 6th days lowest gamma rays dose individually and the individual EMS treatments also had a promoting effect on this parameter. A dose dependent retardation in seedling growth is a common feature induced by chemical as well as physical mutagen. However treatments at lower does have been found to promote seedling growth in some cases (Sax, 1963; Kumar and Dubey, 1998; Sarada *et al*., 2015; Vedna Kumari *et al*., 2016; Undirwade and Kulkarni, 2019). Growth retardation in mutagenic treatments have been attributed to destruction of apical meristem, partial failure internode elongation (Gunckel, 1965), inhibition of auxin synthesis (Gorden and Webber, 1950) and chromosomal damage or mitotic inhibition (Sparrow *et al*., 1953).

The foregoing paragraph reveals that the three cultivars of soybean used in the present study put up varying response to various mutagenic treatments. In earlier studies genetic differences as well as a single gene difference have been found to show significant changes in radiosensitivity and in frequency and spectrum of recoverable mutation. Usmanov, (1974) found that mutation of an individual gene can substantially change the sensitivity of genotypes to mutagenic influence. In soybean differential genotypic response to varying doses

of gamma rays has earlier been reported by Upadhyay, (1976), Singh and Upadhyay, (1979), Kozlova and Enken, (1982), Mashkin and Prokudina, (1982) and Lu *et al*., 1986. Upadhyay *et al*., (1985) reported differential behavior of soybean varieties for EMS and gamma rays. Hassan *et al.*, (1985), Khan and Tyagi, (2013) observed such a differential response for gamma rays. They also found that growth inhibition was found to increase with increasing radiation doses. While Patil and Sharma, (2015) recorded that physical mutagens were more effective than chemical mutagens in var. JS-335. According to Kusmiyati *et al*., (2017) different doses of gamma rays influenced the germination and seedling growth. Very low to low doses of gamma rays might be used to study the Improvement of soybean diversity.

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