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RADIATION SENSITIVITY ANALYSIS IN GENOTYPES OF WINGED BEAN

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ABSTRACT

Lower doses of gamma rays showed stimulatory effects and higher doses showed graded inhibitory effects with respect to germination percentage, period taken for germination and survival percentage. There existed very high negative, positive and negative correlations for dose with these characteristics respectively. At lower doses, seed viability itself is a good indicator for seedling survival whereas at higher doses, seedling survival reduced drastically in comparison to the reduction of seed viability, eventhough the rate of reduction showed a perfect positive correlation. LD_{50} value was found to lie between 80 K rad and 100 K rad and expected to be 87.39 K rad. LD_{50} for survival was 60 K rad. Cultivars showed differential response to LD_{50} for survival was 60 K rad. Cultivars showed differential response to LD_{50} values and lethality. Cultivars: IT-7 and IT-11 can be classified as radiation sensitive: IT-12 and NBPGR/WB-2 as medium radiation resistant and SLS-21 as radiation resistant.

Key Words : *Radiation sensitivity, winged bean, gamma irradiation, mutation.*

Being a predominantly self-fertilized crop, inherent variability in winged bean is much circumscribed. Creation of variation through the agency of mutagens, in the circumstances, hold out much promise. A knowledge of mutagen specificity and varietal response is a prerequisite for effective utilization of mutation technique. But information on this aspect is lacking in winged bean. A study was therefore initiated to assess the radiation sensitivity of five cultivars of winged bean to gamma ray and the results are reported herein.

MATERIALS AND METHODS

The experiment was conducted at the College of Horticulture, Vellanikkara during 1991. Six hundred healthy and viable seeds in each of five winged bean cultivars viz., IT-7, IT-11, IT-12, SLS-21 and NBPGR/WB-2 were subjected to gamma irradiation at 0, 2, 5, 10, 20, 40, 60, 80, 100 and 120 K rad levels. Planting was done on 150 raised beds of size 3 m x 2.5 m at a spacing of 75 cm x 50 cm. The experiment was laid out using a 10 x 5 factorial RBD with three replications. The following parameters were recorded: germination per cent, number of days taken for the germination and survival per cent. The

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data of the aforesaid observations on the 15th day after sowing were analysed statistically using standard procedures (Snedecor and Cochran, 1967).

RESULTS AND DISCUSSION

Effect of gamma ray dosages differed significantly with respect to germination percentages recorded for winged bean (Table 1). Lower doses of gamma rays (2 K rad and 5 K rad) showed stimulatory effect while the higher doses (10 K rad to 120 K rad) showed graded inhibition. But 2 K rad treatment did not vary statistically from the control. The highest germination was 89.33 per cent at 5 K rad, while it was 78.67 in control. The maximum inhibitory effect on germination was at 120 K rad, which was 44 per cent. Cultivars did not vary significantly with respect to germination percentage. But Cultivar x Dose combinations differed significantly. V_3D_1, V_1D_2, V_3D_2, V_3D_3 and V_5D_3 recorded the highest germination percentage (100 per cent) and hence are the best treatment combinations. V_4D_3 with 86.67 per cent germination did not vary statistically from these five treatment combinations.

A very high negative correlation (r = -0.93) significant at % level was found to exist between dose and germination percentage. The regression equation was calculated as: Germination percentage = 70.1 - 0.23 dose. A deviation from the linear relationship between these two characters have been observed at 2 K rad and 5 K rad which was due to the stimulatory effect. Similar results with stimulatory effect at lower doses and inhibitory effect at higher doses following gamma irradiation were reported by Vadivelu (1979) in bengalgram, Manju (1981) in horse gram and Jayanthi (1986) in redgram. Dose x Variety interaction was found to be significant in mungbean cultivars, J-781 and S-8 (Mehetre et al., 1990).

Stimulatory effect at lower doses of irradiation with gamma ray might be due to the breaking of unfavourable physiological conditions of the seeds. Tarar and Dnyansagar (1983) observed that the lower dose of gamma irradiation stimulated whereas higher doses inhibited DNA synthesis in turners. The inhibitory effect of higher doses of gamma irradiation might be due to damage to DNA.

$LD_{50}$was found to lie between 80 K rad and 100 K rad. Further investigation is required to find the exact LD_{50}dose for winged bean, eventhough, the expected value according to the regression equation for germination percentage is 87.39 K rad. $LD_{50}$for IT-7 and IT-12 was in agreement with the general mean value obtained. But for IT-11, it was in between 40 and 60 K rads; and for SLS-21; it was found to lie between 60 and 80 K rad. For NBPGR/WB-2; an approximate LD_{50} is not obtained in the present investigation. Authors consider that the LD_{50} lies between 60 and 120 K rad and emphasis the need for further investigation in order to get a confirmatory result. Rajasekaran (1973) reported that the LD_{50} for blackgram was between 110 and 115 K rads. LD_{50} was between 40 and 50 K rads for mungbean, cowpea and bengalgram

Table 1. Effect of gamma irradiation on extent of germination of winged bean cultivars

Cultivar	V_1 (IT-12)			V_2 (IT-7)			V_3 (SLS-21)			V_4 (IT-11)			V_5 (NBPGR/WR-2)			Mean		
Dose	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
D_1 (0 K rad)	80.00	7.00	80.00	66.67	100.00	6.00	100.00	66.67	8.33	66.67	80.00	7.00	80.00	78.67	7.33	78.67	7.33	78.67
D_2 (2 K rad)	100.00	5.00	100.00	73.33	4.00	73.33	100.00	5.00	100.00	73.33	5.33	73.33	73.33	5.33	73.33	84.00	4.93	84.00
D_3 (5 K rad)	80.00	5.00	80.00	80.00	5.00	80.00	100.00	4.00	100.00	86.67	4.33	86.67	100.00	5.33	100.00	89.33	4.73	89.33
D_4 (10 K rad)	60.00	7.67	60.00	66.67	6.00	60.00	60.00	7.00	60.00	66.67	6.00	66.67	66.67	6.67	60.00	64.00	6.67	61.33
D_5 (20 K rad)	66.67	8.67	60.00	66.67	8.67	60.00	60.00	4.33	56.67	60.00	7.00	56.67	60.00	8.00	56.67	62.67	7.33	58.00
D_6 (40 K rad)	60.00	8.67	56.67	60.00	8.33	56.67	53.33	7.67	50.00	60.00	7.00	50.00	53.33	6.67	50.00	57.33	7.67	52.67
D_7 (60 K rad)	53.33	9.33	50.00	53.33	9.67	50.00	60.00	6.00	53.33	53.33	8.00	46.67	60.00	9.00	50.00	56.00	8.40	50.00
D_8 (80 K rad)	53.33	9.00	45.00	53.33	7.00	45.00	46.67	9.33	40.67	9.33	40.67	53.33	8.00	50.00	46.67	9.00	40.00	50.67
D_9 (100 K rad)	46.67	8.00	40.00	46.67	9.67	40.00	46.67	9.00	40.00	53.33	9.67	46.67	53.33	9.67	46.67	49.33	9.20	42.67
D_{10} (120 K rad)	46.67	10.00	36.67	40.00	10.00	33.33	40.00	7.5	33.33	46.67	9.67	36.67	46.67	9.67	36.67	44.00	9.37	35.33
Mean	64.67	7.83	60.83	60.67	7.67	56.50	66.67	6.58	63.40	62.00	7.33	58.00	64.00	7.63		59.33		

Treatments	A			B			C		
	V	D	V x D	V	D	V x D	V	D	V x D
F values	1.42	31.04**	1.51*	0.92	4.8**	0.35	10.7**	261.64**	8.36**
CD (0.05)	NS	7.78	17.4	NS	2.05	NS	2.27	3.22	7.19

** Significant at 1% level; * Significant at 5% level

A = Germination percentage; B = Period taken for germination in days; C = Survival percentage

reported by Louis and Kadambavanasundaram (1973), Palaniswamy (1975) and Vadivelu (1979) respectively.

Period taken for germination showed significant difference between dosages (Table 1). The germination was early by three days in lower doses (2 and 5 K rad) when compared to control. But at higher exposures, it was, however delayed gradually and at 120 K rad, the seeds germinated after nine days. Cultivars and Cultivar x Dose interactions were not significant in respect of period taken for germination. A very high positive correlation between the dose and period taken for germination (r-0.98)** is observed. The regression equation is : period taken for germination = 7.11 + 0.02 dose. A deviation from the linear relationship between these two characters have been observed at 2, 5 and 10 k rads; which was due to the stimulatory effect. A very high negative correlation between germination percentage and period taken for germination (r=-0.93 Significant at 1% level) is also observed. The regression equation is: Germination percentage= 130.23 - 8.99 dose.

The mean time taken by red gram seeds for germination in the various treatments of gamma rays dose not appear to have any bearing with dose (Jayanthi, 1986). But in the present investigation, a positive relationship is noticed. This might be due to the early DNA synthesis at 2, 5 and 10 K rad dosages substantiated by the data on early germination. This suggests the possibility that the formation of new enzyme molecules essential for the metabolic activity of the cell might be stimulated due to radiation. The precursors for DNA synthesis might have dependence on the activity of these enzymes as well as on an appropriate energy supply. In the higher doses such as 20 K rad to 120 K rad, the delay in DNA synthesis might be due to the time required for the cell to repair the damage caused by irradiation.

In control, survival of seedlings was 78.67 per cent, while it decreased progressively with increase in exposure at higher levels (Table 1). The percentage of survival was higher in 5 K rad (89.33 per cent) and 2 K and (84 per cent) compared to control. Survival percentage was least at 120 K rad (35.33 per cent). There was a very high significant difference between dosages, between cultivars and between their combinations with respect to percentage of survival. Cultivar, SLS-21 was significantly superior to all other cultivars in respect of survival percentage with the maximum value of 63.4 while IT-7 recorded the minimum survival percentage value of 56.5. Five treatment combinations of Cultivar x Dose were significantly superior to all other combinations with the highest survival percentage of 100 and they were : V_3D_1, V_1D_2, V_3D_2, V_3D_3 and V_5D_3.

The decrease in the seedling survival with increasing doses of irradiation has been attributed by Sudhakran (1967) in **Vinca rosea** and Dhanaraj (1971) in **Solanum khasianum** to the series of events occurring at the cellular level

which affect the vital macromolecules and bring about a physiological imbalance in the cells as a consequence of exposure to ionizing radiations. The lethality of the germinated seeds after irradiation in the present investigation might be an indirect result of the lack of appropriate synthesis of DNA or karyological destruction. It is opined that the decrease in the percentage of survival of seedlings after irradiation was either due to the destruction of auxin, or due to the inhibition of auxin synthesis (Tarar and Dnyassagar, 1983).

Same values for germination percentage and survival percentage were noticed at 0,2 and 5 K rad levels of gamma ray irradiation. At doses above 5 k rad, the characters showed perfect positive correlation (r =1), significant at 1% level. This indicates that, at lower doses, rate of reduction, of seed viability and seedling survival was in a similar manner, eventhough seedling survival reduced drastically in comparison to the reduction of seed viability.

LD_{50} for survival for winged bean was found to be 60 K rad. LD_{50} for survival for IT-7 and IT-12 were also found to be 60 K rad. But for IT-11, SLS-21 and NBPGR/WB-2; it was 40 K rad. LD_{50} for survival ranged between 80 and 85 K rad in black gram (Rajasekharan, 1973). Brunner (1979) recommended that doses resulting in 50 per cent survival in the M_1 generation was most effective in mutation breeding.

There existed a very high negative correlation between dose and survival percentage (r=-0.93) significant at 1% level. The regression equation is: Survival percentage = 68.14 - 0.28 dose. A very high negative correlation also existed between period taken for germination and survival percentage (r = -0.93) Significant at 1% level). The regression equation is: Survival percentage = 139.27 - 10.75 period taken for germination. Similar relationships were noticed for all the five cultivars. The correlation coefficients were: -0.92, -0.99, -0.84, -0.92, -0.88** for IT-12, IT-7, SLS-21, IT-11 and NBPGR/WB-2 respectively. The regression equations for survival percentage were: 72.39 -0.33 dose, 65.35 - 0.26 dose, 85.51 - 0.51 dose, 64.18 - 0.22 dose and 68.61 - 0.29 dose respectively for IT-12, IT-7, SLS-21 IT-11 and NBPGR/WB-2. Similar findings were reported in french bean and soybean by Shirshov and Shain (1966), in mungbean by Khan (1981) and in red gram by Jayanthi (1986).

The differential sensitivity of cultivars of pea to critical dose of mutagen and magnitude of injury is ascribed to the level of differentiation and development of embryo at the time of treatment (Wellensiek, 1965). The present study hold good the said concept. In addition to the constitution of genes or gene systems, cytoplasm might also be related to intervarietal differences in radiation sensitivity. In the present study, the differential response of the five cultivars of winged bean to gamma radiation suggests that the reduction in chromosome volume and heterochromatin content might have exerted chromosomal breakage and influenced the lethality of radiation sensitive cul-

tivars, IT-7 and IT-11. IT-12 and NBPGR/WB-2 were medium radiation resistant and SLS-21 was radiation resistant.

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