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Research article

Studies on mutagenic sensitivity of *Vigna radiata* (L.) Wilczek

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Abstract: The chemically treated seeds with Ethyl Methane Sulphonate (EMS), Sodium Azide (SA) and Gamma Irradiated seeds with Co^{60} from BARC, Mumbai were used for the Mutagenic studies in *Vigna radiata* Cultivar-Naval. The seeds were treated with different doses with time intervals, then sowed in the field along with control to study seedling height, seedling injury, pollen sterility, lethality and plant survival at maturity in M_1 generation. The experiment was conducted at New Arts, Commerce and Science College Ahmednagar, MS, India for the year June 2018–2019. The sensitivity of the mutagens was studied on parameters. The results were obtained significantly. The higher dose of treatment showed maximum seedling injury and lethality in each mutagenic treatment compared to control.

Keywords: *Vigna radiata* - Ethyl methane sulphonate - Sodium azide - Gamma radiation.

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INTRODUCTION

Vigna radiata (L.) Wilczek, belongs to family Leguminosae, is the most economic and nutritional crop cultivated throughout the world. In India, it is cultivated in the states such as Rajasthan, Madhya Pradesh, Maharashtra, Bihar, Karnataka, TN, Gujrat, Andhra Pradesh, Odisha and Telangana. In the growing season 2017–2018, 41 Lha area was under mungbean cultivation with production 19 Lt. There is increase in area of cultivation of mungbean in the country since 2015–16 onwards. Rajasthan contributes 42% cultivated area and with 39% production in the total of the crop contribution in the country during growing year 2017–2018. More than 80% of mungbean production comes from states like Rajasthan, Madhya Pradesh, Maharashtra, Bihar, Karnataka, TN, Gujarat, Andhra Pradesh, Odisha and Telangana.

Enhancement in Quality and Quantitative parameters by using Plant Mutation breeding in *Vigna radiata* has great scope due to self-pollinated crop. The characters remain unchanged for several years by Mutation. In short time, number of varieties can be developed. Mutagenic sensitivity is effective in enhancing genetic variability. Gaul (1964) showed mutagenic sensitivity in germination, pollen sterility and plant survival at maturity.

The lethality is also an important parameter in mutagenic sensitivity to know how much damage will occur in the treatments as compared to control. Mutagenic sensitivity is also observed in seedling height as well as seedling injury at the time of field emergence in M_1 generation. Damaged, detached, bent seedlings were observed. The absence of cotyledonary leaf and reduced seedling height, swelling of seedlings with bent shoot scratches on the seedlings were observed. Several researchers were reported for mutagenic sensitivity in various crops by Giri & Apparao (2011) in Pigeonpea; Girija & Dhanvel (2009) in *Vigna anguiculata* (L.) Walp. That is the reason taken into consideration for present study with an objective of Mutagenic sensitivity of *Vigna radiata* Cultivar-Naval by employing chemical mutagens (EMS and SA) and physical mutagen (Gamma Radiation).

MATERIALS AND METHODS

Vigna radiata (L.) Wilczek seeds of Cultivar- Naval were procured from Nirmal Seeds Pvt. Ltd, Pachora, Jalgaon. The cultivar is of *Kharif* seasonal and not for cultivated in summer due to determinate in habit.

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The chemical mutagens Ethyl Methane Sulphonate (EMS) and Sodium Azide (SA) were availed from New Arts, Commerce and Science College Ahmednagar. Gamma Irradiation facility ^{60}Co was provided by Government Institute of Science and Technology, Aurangabad and BARC Mumbai. Treatment doses were prepared to find out LD_{50} value of *Vigna radiata*. Doses like 5, 10, 15, 20 and 25 mM EMS (Bhal & Gupta 1983); 1, 2, 3, 4 and 5 mM SA (Lavanya *et al.* 2011); and doses like 150, 250, 350, 450 and 550 Gy from Gamma Radiation (Bhal & Gupta 1983). Out of these doses, 20 mM EMS; 4 Mm SA and 450 Gy from GR were adjudged the LD_{50} value. The doses 10, 15 and 20 mM EMS; 2, 3 and 4 mM SA; 250, 350 and 450 Gy from Gamma Radiation were selected for seed treatment. Treated seeds were sown in the field to raise M_1 generation using RBD method along with the control as Nil (without treatment) at New Arts, Commerce and Science College Ahmednagar, MS, India.

Treatment Details and Experimental Outline

The Experiment has been carried out at Experimental field, New Arts, Commerce and Science College Ahmednagar in Academic year 2018–2019. Firstly the seeds were washed with distilled water for 2–3 minutes to remove the contaminant from the seed. Then seeds were pre-soaked in D.W. for 2 hrs. Then seeds were Pre-soaked in D.W. for 2 hrs. Presoaked seeds were dried and then deepened in EMS-10, 15 and 20 mM, SA-2, 3 and 4 mM conc. for 6 hrs. The seeds treated with various concentrations of EMS and SA were washed thoroughly with tap water for two hours to terminate the reaction of chemical mutagen and to leach out the residual chemicals. A total of 30 seeds from each treatment was used for seed germination in laboratory. Three replications with 10 seeds per replication kept in petridishes, containing seed germination paper, were used for recording seed germination percent and seedling height on 8th day (temperature 25ºC with humidity 85%). The remaining 600 seeds were sown using RBD method in three replicates along with control to check germination. Germination was count at 5th day after sowing by given formula. The rules of International Seed Testing Association (ISTA) were followed.

$$\text{Seed Germination (\%)} = \frac{\text{Total Number of Seeds Germinated}}{\text{Total Number of Seeds Kept for germination}} \times 100$$

RESULT AND DISCUSSION

Data obtained on seed germination percentage was decreased with increase in dose of mutagens in *Vigna radiata* (L.) Wilczek Cultivar-Naval (Table 1; Figs. 1 & 2) Control showed the germination (83.00%). Seedling injury was measured as reduction in the height of the mutagens treated seedlings as compared to the height of the 8th days old control seedlings. Maximum seedling injury and reduced seedling height was observed in higher concentrations of all treatments. SA- 4 mM dose showed seedling height (17.60 cm) and seedling injury (7.33%), GR- 450 Gy showed seedling height (17.90 cm) and seedling injury (6.67%), EMS- 20 mM showed seedling height (17.80 cm) and seedling injury (8.50%). The seedling height was maximum (29.7 cm) and lower injured (1.67%) seedling was observed in control. The seedling height decreases with increasing doses / concentrations of all the treatments. EMS Showed seedling height 20.10, 19.60 and 17.80 cm in 10, 15 and 20 mM respectively. SA showed seedling height 18.90, 18.50 and 17.60 cm in 2, 3 and 4 mM respectively; and Gamma radiation showed seedling height 19.50, 18.50 and 17.90 cm respectively in 250, 350 and 450 Gy.

Table1. Effect of Mutagenic Sensitivity of *Vigna radiata* (L.) Wilczek Cultivar- Naval.

Treatments	Dose	Ger.%	Seedling Height (cm)	Seedling Injury (%)	Pollen Sterility (%)	Lethality (%)	Survival at Maturity (%)
Control	Nil	83.00	29.70	1.67	5.20	4.17	95.83
Ethyl Methane	10 mM	70.00	20.10	5.67	9.80	31.66	68.33
Sulphonate	15 mM	64.00	19.60	7.33	10.49	35.00	65.00
	20 mM	54.00	17.80	8.50	11.40	40.00	60.00
Sodium Azide	2 mM	70.00	18.90	4.83	5.34	32.84	67.17
	3 mM	65.00	18.50	7.00	6.83	37.50	62.50
	4 mM	58.00	17.60	7.33	10.07	45.83	54.17
Gamma	250 GY	66.00	19.50	4.67	8.48	29.17	70.83
Radiation	350 GY	61.00	18.50	6.00	9.80	31.83	68.17
	450 GY	55.00	17.90	6.67	13.18	35.83	64.17
	SD±	**8.566**	**3.573**	**1.921**	**2.596**	**11.012**	**11.010**
	SE±	**2.711**	**1.131**	**0.608**	**0.822**	**3.485**	**3.484**

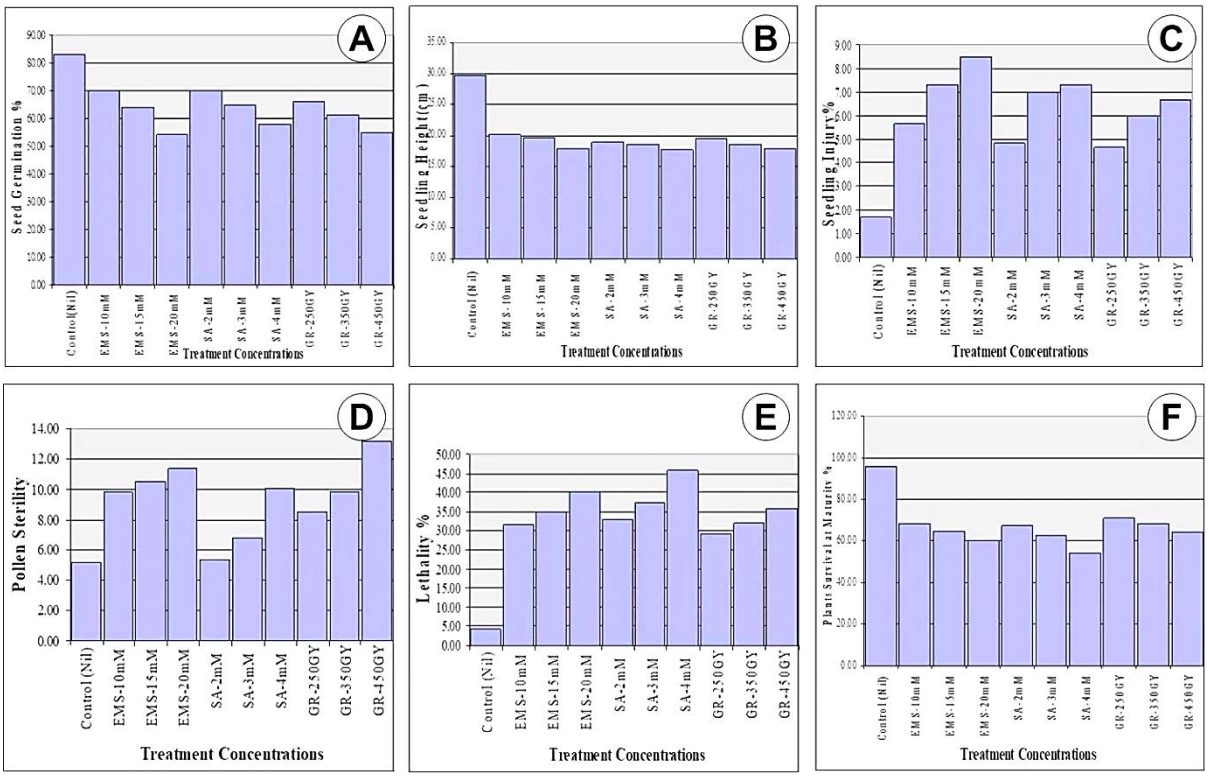

Figure 1. A, Seed germination (%); **B**, Seedling height (cm); **C**, Seedling injury (%); **D**, Pollen sterility (%); **E**, Lethality (%); **F**, Survival at maturity (%).

Figure 2. A & B, Injured seedlings; **C**, Sterile and fertile pollengrains.

Results indicate that the pollen sterility was calculated and found minimum in lower doses. (5.34%) pollen sterility in 2 mM SA. Higher pollen sterility was recorded in 450 Gy (13.18%). EMS showed 9.80, 10.49 and 11.40% pollen sterility in 10, 15 and 20 mM respectively. Similar results were reported by Mishra & Khan (2014) in *Plantago ovata* Forssk.; Danish *et al*. (2018) in *Solanum melongena* L., Giri (2014) in *Cajanus cajan.* Lowered pollen sterility was recorded in SA- 2 mM (5.34%). The pollen sterility was more sensitive to GR than EMS and SA. Lethality was higher with increased order. Highest 45.83% lethality was recorded in SA- 4 mM dose; as compared to control (4.17%). Whereas lethality was more in all treatments over control. Several researchers reported that increased dose ultimately increase in lethality. Same results were obtained by Mishra & Khan (2014) in *Plantago ovata* Forssk., Danish *et al*. (2018) in *Solanum melongena*. GR showed 29.17, 31.83 and 35.83% lethality in 250, 350 and 450 Gy respectively. The survival of plants at maturity (45 days) was more in control (95.83%). Plant survival rate was lower (54.17%) in higher dose of SA (4 mM). 70.83% (Table 1). Plants survived in GR-250 Gy which is lower dose of Gamma Radiation. EMS showed 68.33, 65.00 and 60.00% of plant survived at maturity. Same results showed by Usharani & AnandaKumar (2015) in *Vigna mungo* (L.) Hepper. SA was more effective than EMS and Gamma radiation in a decrease in plant survival at maturity. The rate of survival of maturity was GR > EMS > SA.

CONCLUSION

The present research study indicates that all mutagenic treatments were higher in mutagenic sensitivity in parameters *viz*, seed germination, seedling height, seedling injury, pollen sterility, lethality and plant survival at maturity at higher doses. Mutagenic sensitivity will be helpful to indicate variation in the parameters as compared to control in mutation breeding to identify the effectiveness and efficiency of mutagens. By using

Mutagenic sensitivity, success of the mutagenic treatments can be achieved. In mutation breeding programme mutagenic sensitivity is helpful to create genetic variability in various crops.

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