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Research Article

The impact of ethyl methane sulfonate (EMS) on the process of seed germination and the subsequent growth and strength of mungbean seedlings. (*Vigna radiate L.*).

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Abstract

This study looks at what happens to the clean, healthy, and dry seeds of four types of mungbean: IC27367, ICIC282591, IC75468, and IC 282126 when EMS mutagenesis is used. The current study treated moongbean seeds with different concentrations of EMS, specifically 0.00M, 0.02M, 0.03M, and 0.04M, respectively. We observed the impact of this treatment on moongbean seeds in terms of germination percentage, shoot length (cm), root length (cm), fresh weight (g), and dry weight, among other metrics. The study's results show that increasing EMS concentrations decreased the values of all parameters, based on a 50% reduction in germination survival. The current findings clearly demonstrate that we can effectively utilize different EMS concentrations to create variability for various quantitative characteristics.

Key words: Mungbean, EMS, LD50, seed germination, seedling vigor.

Introduction:

Due to its high nutritional content and versatility in a range of agroclimatic situations, people extensively grow green gram, also known as mungbean (*Vigna radiata L.*), a highly valued legume crop. Its seeds are an important part of meals in many civilizations because they are high in proteins, vitamins, and minerals. Breeding is one of the best ways to cause mutations in the plant system. We use it to introduce plants with new personalities. Physical and chemical mutagens are the two categories into which the mutagens employed in the study fail.

Plant breeding techniques have made extensive use of the chemical mutagen ethyl methane sulfonate (EMS) to create genetic variants and hasten the selection of desired features. EMS works by causing point mutations in DNA, which modify gene expression and may result in phenotypic alterations. The assessment of the mutagen's impact on living organisms occurs before the LD50 is established. Various standards were applied in order to examine its efficacy and efficiency. Mutagenic effectiveness is the genotype's reaction to varying mutagen dosages, so mutagenic efficiency was determined by looking for genetic damage (Mohd Rafiq Wani et al. 2011).

The amount of mutagen given to seeds determines how effective they are. *Vigna radiata L*., or mungbean, is one of the most widely consumed sources of protein in the world. In India, it is one of the most significant pulse crops. In the traditional Indian diet, pulses come in second to grains and are the primary source of protein, right behind chickpeas and pigeon peas. It is a significant seed legume that grows in 60–75 days and is essential to the world's ability to satisfy its food and protein needs, both in terms of quantity and quality.

Mungbean seeds digest quickly and provide twenty-four percent of protein. Sundesha et al. (2019) also utilize it as a nutrient-dense bovine feed, which enhances soil fertility by fixing atmospheric nitrogen with the help of Rhizobium species. Understanding how EMS affects plant development in an agricultural setting is essential for breeding and crop improvement initiatives. Researchers hope to learn new lessons about increasing crop resilience and production by examining its impact on seed germination and seedling vigor. This crop's phenotypic traits, such as cleistogamy and tiny floral structure, make hybridization challenging and limit its variety.

Therefore, researchers use the forced mutation method to artificially create genetic variety. The majority of researchers (Warghat et al., 2011, Anbarasan et al., 2013) employed the LD_{50} to calculate the fatal dosage of mutations. Each breeding cycle first establishes the LD_{50}, which then serves as the ideal concentration for subsequent cues.

Material &Method:

This study's primary goal was to ascertain how Ethyl Methane Sulfonate (EMS) affected the germination of muangbean

seeds and the vigor of seedlings. Our goal is to reveal the mystery contained in these legumes' genetic composition. We obtained additional genuine seeds of the following types from the Indian Institute of Pulses Research, Kanpur: IC27367, IC282591, IC75468, and IC282126. Next, using a phosphate buffer solution, we prepare an EMS solution at pH 7.0 in various concentrations. We presoaked pure, healthy, and mature seeds in distilled water for two hours before treating them with the EMS solution.

We treated these pre-soaked seeds for eight hours with a freshly prepared chemical mutagen solution at concentrations of 0.00M, 0.02M, 0.03M, and 0.04M. Following the chemical mutagen treatment, promptly rinse the seeds with tap water. We treated the control seeds with distilled water. All the treated seeds, along with the control, will be immediately shown. During summer 2024, we sowed 25 seeds treatment-wise in trays, ensuring proper plant-to-plant and row-to-row spacing.

We carefully examined the germination of the seeds every day, interpreting the emergence of the cotyledon leaf as the induction of germination, counted the germinated seeds of each treatment eight days after sowing, and measured the shoot length in centimeters after fifteen days of showing. After the fifteenth day of sowing, we recorded the fresh weight (g), measured the shoot and root length in centimeters, and placed the seedlings in an oven at a constant 50-degree centigrade temperature for 48 hours. The fresh weight was then recorded as the dry weight (g). Total numbers of seedlings that survived were counted after fifteen days of sowing, and plant survival percent was also calculated.

Result and Discussion:

The four types tested in this study—IC27367, IC282591, IC 75468, and IC282126—had the lowest mean germination rates (56.4%, 40.3%, 32.8%, and 28.8%) and survival rates (52.3%, 32.8%, and 28.8%) at 0.04M treatment. In the control group, we recorded the highest mean germination percentage (92, 80, 72, and 72) and survival percentage (80, 72, 72, and 68). The mean germination percentage and survival percentage in each of the four types decreased as the quantity of ethyl methane sulphonate (EMS) increased, as shown in Table 1.

Examining the data revealed that both the germination and survival rates declined in tandem with an increase in EMS concentration. Seed damage could be one explanation for the effect on germination. According to several studies (Sundesha et al., 2021; Balai & Krishana, 2009; Kumar et al., 2010; Sagade & Apparoo, 2011), seed damage could be one explanation for the effect on germination. The LD50 value for germination was higher than the EMS treatment's maximum concentration. This meant that there weren't many genotypic differences between the different experiments. This indicates that increasing EMS concentrations from 0.04M is necessary to achieve LD50.

We determined that the LD50 value for the survival percentage of cultivar IC27367 was 0.04 M. The LD50 value for the IC75468 mungbean cultivar was variable. Singh & Singh (2013) found similar results. Cherry & Hageman (1961) reported that treated seeds died due to disrupted mitosis or nearly stopped cell division in the meristematic zone during germination. According to Sato and Gaul (1967), a seedling planted in July will develop slowly and mature early. The outcome suggests that high EMS concentrations significantly reduce germination rates, suggesting that EMS has inhibitory effects on the early phases of plant development. A pattern of decreased seed viability during EMS exposure is evident when comparing these findings to earlier research.

The combined effects of all these variables may explain the decrease in plant survival. We recorded the following values in the control treatment: We measured the minimum shoot lengths (10.6, 10.6, 11.06, and 11.2 cm), root lengths (2.6, 3.3, and 3.5 cm), fresh weights (0.82, 0.83, 0.84, and 0.49 g), dry weights (0.01, 0.11, 0.13, and 0.13 g), maximum shoot lengths (15.24, 15, 14.8, and 14.5 cm), root lengths (7.8, 6.5, 4.6, and 4.7 cm), and fresh weights (1.19, 1.15, 1.08, and 1.03 g) in four different cultivars (IC27367, IC282591, IC75468, and IC 282126, respectively) with 0.04M EMS. All four cultivars showed a reduction in mean shoot and root length, as well as mean fresh and dry weight, with a rise in EMS concentration. In verity IC282591, the control treatment had the highest mean shoot and root length, as well as fresh and dry weight, whereas the (0.04, 0.03M) EMS treatment in IC2825591 had the lowest values. Additionally, the outcome suggested

a deferential reaction to various EMS treatment concentrations.

With the shorter shoot length seen in the flat experiments, scientists have found changes in auxin and ascorbic acid levels, as well as changes in chromosomes and enzyme activity. The flat studies (Gunkel and Sparrow, 1954; Singh, 1974) observed a shorter shoot length. This was due to the changes and issues with mitosis in the meristematic zone of growing seedlings. One possible explanation is that seedlings grown from treated seeds had a lower respiratory quotient (Woodstock and Justice, 1967). Sundesha et al. (2020), Palill (2000), and Nandanwan (2000) have also documented such chromosomal abnormalities caused by the induction of mutations. This discovery has significant agricultural implications for EMS and mungbean seed germination. Enhancing agricultural output and quality can result from knowing how EMS affects seedling vigor. With this information, farmers may maximize the resilience and productivity of their harvests by optimizing their planting tactics.

Conclusion:

The study found that when ethyl methane sulphonate (EMS) concentration increased, the effects on mungbean seed germination percentage, seed survival percentage, shoot and root length, and fresh and dry weight decreased.

The outcome unequivocally shows that there are distinct EMS mutagens. This study advances our knowledge of how to use chemicals, such as EMS, to improve agricultural practices and solve problems pertaining to plant growth and development. In a laboratory setting,

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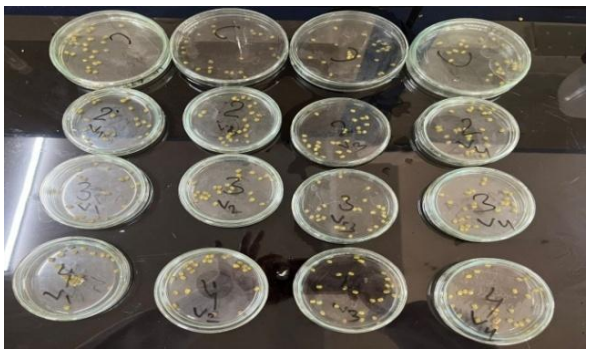
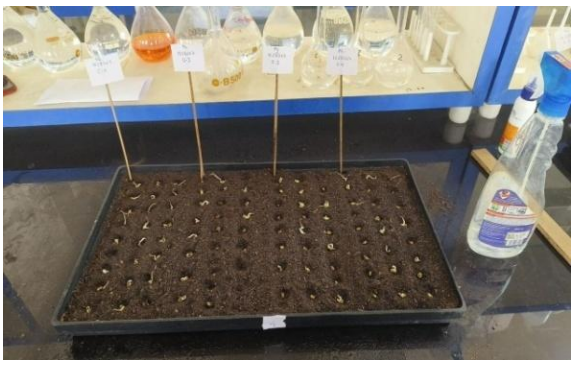
Figure -1. Chemical mutagenesis of mungbean (*Vigna radiate* L.) using EMS treatment.



A



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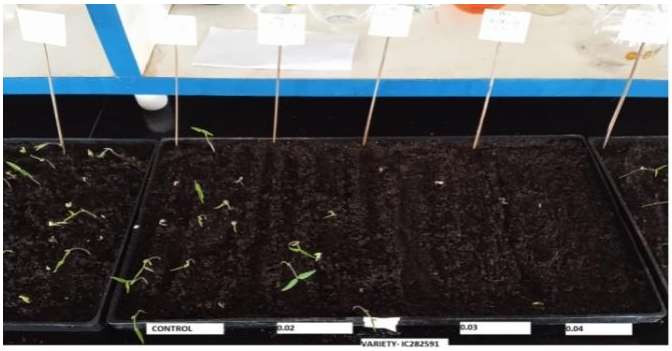

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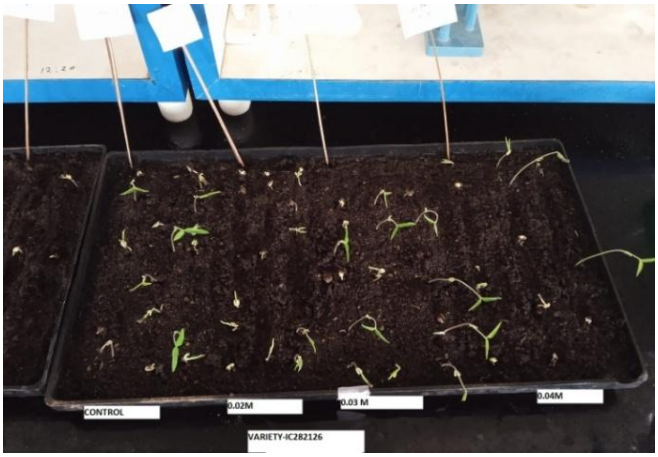

F

G

H

Table-1 Percent seed germination and percent seed survival in mungbean cultivation under different treatment in laboratory condition.

Varieties	Treatment (Conc. of EMS)	Number of seeds sown	Percent seed germination			Percent of seed survival		
			Number of seeds germinated	Mean germination in percent	Reduction over control percent	Number of seeds survival	Mean survival in percent	Reduction over control percent
IC27367	Control	25	23	92	-	20	80	-
	0.02M	25	20	80	13.04	18	72	10
	0.03M	25	17	68	26.08	13	52	35
	0.04M	25	14	56	39.13	13	52	35
IC282591	Control	25	17	68	-	17	68	-
	0.02M	25	10	40	41.17	8	32	52.94
	0.03M	25	8	32	52.94	7	28	58.82
	0.04M	25	7	28	58.82	7	28	58.82
IC75468	Control	25	18	72	-	18	72	-
	0.02M	25	15	60	16.66	12	48	33.33
	0.03M	25	12	48	33.33	11	44	38.88
	0.04M	25	10	40	44.44	10	40	44.44
IC282126	Control	25	18	72	-	17	68	-
	0.02M	25	15	60	16.66	15	60	11.76
	0.03M	25	15	60	16.67	14	56	17.64
	0.04M	25	13	52	27.78	13	52	23.52

Table-2 Percent reduction in shoot length & root length (cm) and fresh weight & dry weight (g) in mungbean cultivation different treatment in laboratory condition

Varieties	Treatment (Conc. of EMS)	Shoot length (cm)		Root length (cm)		Fresh weight (g)		Dry weight (g)	
		Mean (cm)	Percent reduction over control	Mean (cm)	Percent reduction over control	Mean (cm)	Percent reduction over control	Mean (cm)	Percent reduction over control
IC27367	Control	14.50	-	4.5	-	1.08	-	0.69	-
	0.02M	12.70	12.41	3.3	26.67	0.88	18.51	0.26	62.31
	0.03M	13.10	9.65	3.7	17.78	0.94	12.96	0.22	68.11
	0.04M	14.40	6.68	3.8	15.56	0.98	9.25	0..23	66.66
IC282591	Control	15.24	-	3.8	-	1.15	-	0.24	-
	0.02M	11.06	23.88	3.3	13.16	0.95	17.39	0.20	16.66
	0.03M	10.60	30.44	2.6	31.58	0.90	21.73	0.19	20.83
	0.04M	10.60	30.45	3.1	18.42	0.84	26.29	0.13	45.83
IC75468	Control	15.00	-	4.4	-	1.19	-	0.25	-
	0.02M	12.00	20.00	3.5	20.45	1.03	13.44	0.11	56.00
	0.03M	14.10	6.00	3.9	11.36	0.97	18.48	0.01	96.00
	0.04M	11.20	25.33	3.6	18.18	0.90	24.36	0.13	88.00
IC282126	Control	14.88	-	7.8	-	0.87	-	0.40	-
	0.02M	13.80	6.75	6.5	16.66	0.49	43.67	0.50	25.00
	0.03M	13.40	9.45	4.6	41.02	0.82	5.74	0.24	40.00
	0.04M	13.20	10.95	4.7	39.74	0.83	4.59	0.25	37.50

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