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Impact of Chemical Spray on Seed Longevity for Induction of Seed Dormancy in Mungbean (*Vigna radiata* L.)

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ABSTRACT

The present investigation was conducted during *Kharif,* 2022 season at the field of Crop Research Centre (CRC) and Genetics and Plant Breeding Research Lab, School of Agriculture, ITM University, Gwalior, Madhya Pradesh to study the effect of chemical spray on longevity of seed. The experimental material consisted of ten mungbean genotype namely, IPM 2-3, IPM 2-14, Meha, Soorya, Virat, Varsha, Kanika, Vashudha, Heena and Shikha and seven treatments namely, control (water spray), GA3 @ 80 ppm, ABA @ 50 ppm, H_2O_2 @ 10 mM, MH @ 1000 ppm, KNO_3 @ 1 mM and IAA @ 100 ppm applied as foliar spray at 45 and 60 DAS. Longevity of seed observed after storage of 2 months intervals on different parameters like seed viability (TZ test) and electrical conductivity (dS/m). Electrical conductivity (EC) revealed that there was significant difference between the varieties, treatment and their interaction for all the testing months of storage. Numerically lower values were recorded in H_2O_2 @ 10 mm (T_3), irrespective of varieties. In general, higher EC was recorded in MH @ 1000 ppm (T_4). It was found that the EC of the varieties were influenced by their interaction with treatments during all the testing months of storage. Seed viability (TZ test) revealed that there was significant difference between the varieties, treatment and their interaction for all months in storage. Numerically lower values were recorded in MH @ 1000 ppm (T_4), irrespective of varieties. In general, higher seed viability was recorded in control (T_0) in all varieties. There exists a close relationship between induced dormancy on various biochemical parameters which thereby plays a vital role in enhancing longevity of mungbean seeds.

Key words : *Seed dormancy, Green gram, Mungbean, Maleic hydrazide, Longevity, Seed viability (TZ test), Electrical conductivity.*

Introduction

The mungbean (*Vigna radiata* L.) is also known as green gram, maash, mung, golden gram. It is belongs to legume family (Fabaceae). The green gram is a self-pollinating plant with the chromosome 2n=24. With roughly 650 genera and almost 20,000 species, this family is widely distributed as it comprises the third largest family of flowering plants (Doyle, 1994). It is a short-season crop that may be cultivated in a variety of soils and climates (Hanumantha Rao *et al.,* 2016). Due to their intrinsic

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properties, pulses are a significant component of Indian agriculture. Ability to use biological nitrogen fixation (BNF) to fix atmospheric nitrogen (Anonymous, 2011).

It is the third most significant pulse crop in India, behind chickpea and pigeon pea, and is grown for its multiple usage as a vegetable, pulse, fodder, and green manure crop. In terms of production, consumption, and imports of pulses, India leads the globe with 25% of total production, 27% of total consumption, and 14% of total imports. Pulse output in India has not kept pace with demand, necessitating imports of 2.0 to 4.0 million tonnes (Raj *et al*., 2013). Protein content in green gram is typically 22–24%, compared to 8–10% in cereals and also contain 1.3% minerals, 4% fibre and 10.4% moisture. It is a good source of calcium, potassium, phosphorus, and other essential minerals for human health, as well as vitamins A, B, C, and niacin.

In India during 2022-23, about 33.45 lakh ha (82.65 lakh acres) area was covered under greengram as against 34.80 lakh ha (85.98 lakh acres) during the same period in 2021-22. In Madhya Pradesh 1.58 lakh ha (3.90 lakh acres) area covered and are the major producers of greengram in India. According to Government 1st advance estimates, greengram production in 2022-23 is at 1.75 million tonnes. Source: Directorate of Economics and Statistics (DES). Greengram Outlook- December 2022 *(Agricultural Market Intelligence Centre, PJTSAU).*

The majority of previous study has focused on understanding the mechanism driving productivity. Preharvest sprouting in green gram is caused by extra moisture absorbed by the seed during maturity. Seed dormancy is the physiological quiescent or resting stage of a seed. Seed dormancy occurs when a fertile seed fails to germinate under favourable conditions. Dormancy is a crucial component in the commercial production of green gram. When dormancy prevents mature seeds from sprouting before harvest, it can be helpful. When dormancy diminishes stand, it might be harmful.

Seed dormancy is a physiological and ecological adaptation that allows plants to survive in complex environments. Additionally, dormancy supports the survival of plants, the continuation of species, and the development of species by assisting wild plant seeds to preserve their vitality in challenging environmental conditions (Stevens *et al.,* 2020). Dormant fresh seeds are those that, under ideal circumstances, do not germinate after 4-6 weeks (Ensslin *et al.,* 2018).

Dormancy can reduce species competition and ensure population reproduction in challenging circumstances by preventing seeds from germinating in unfavourable seasons (Rubio de Casas *et al*., 2012; Nonogaki, 2019). However, this characteristic creates a problem when a lot of seedlings are needed for horticultural reasons, especially for the quick regeneration of endangered plant populations (Cho *et al.,* 2018; Gao *et al*., 2021).

It might take several seasons for the seeds to become nondormant, which could lead to low final germination percentages for the restoration of endangered populations in the wild. Furthermore, animal foraging, microbial attack, and soil erosion all contribute to the loss of seeds during the dormant period, which makes it difficult for plant populations to recover (Kildisheva *et al.,* 2020; Zida *et al*., 2020).

It is more essentials to investigate non-traditional methods of inducing dormancy in green gram to save yield and maintain seed quality against field sprouting. Some chemicals have the ability to change the dormancy of seeds. The perfect solution to the problem would be to study the techniques of dormancy induction by application of certain dormancy inducing chemicals, maleic hydrazide (Shelar *et al.,* 2014) and to study the impact of a dormancy inducing chemical on various biochemical traits that could be used to predict the seed vigour or its storability.

The storage potential of the harvested seeds from different chemical treatments was studied by storing the seeds in ambient conditions. The freshly harvested seeds were dried under sun to 10-12 % moisture content and stored in laboratory conditions. A number of biochemical characteristics must be examined in order to evaluate seed longevity or seed storability.

The dehydrogenase activity or Tetrazolium test (Perry, 1981) is more frequently used to estimate seed viability (or potentiality to germinate), and a more critical assessment of the intensity and pattern of staining can also offer additional details about the vigor level of a seed lot. The dehydrogenase enzyme activity is essentially measured in a tetrazolium test. By colorimetric estimate of the red-colored product (triphenylformazan) and the extracting agent methyl cellosolve, dehydrogenase activity can also be measured. Using a colorimeter, the intensity of the color is measured at 480 nm once it has been fully

removed. It has been discovered that seed vigor and colour intensity are positively associated.

The EC test measures the condition of the seed's cell membranes. In most crops, low vigor, low-quality field emergence, and subpar storability are correlated with high solute leakage or greater electrical conductivity of seed leachate, (Presley, 1958) an indicative of membrane permeability.

The information on the effect of chemical spray treatment on the biochemical parameter for assessing the longevity of green gram seeds is lacking. The present investigation entitled Impact of Chemical Spray on Seed Longevity for Induction of Seed Dormancy in Mungbean (*Vigna radiata* L.) was undertaken.

Materials and Methods

The present investigation was conducted in Augmented Design during *Kharif,* 2022 season at the field of Crop Research Centre (CRC) for collection of quality seeds further laboratory experiment and laboratory work was conducted in Factorial Completely Randomized Design at Genetics and Plant Breeding Research Lab, School of Agriculture, ITM University, Gwalior, Madhya Pradesh.

Soil and climate

The soil of the experimental field was sandy loam type. The land was prepared for the experiment by harrowing it twice, plowing it once, and gathering the stubbles and waste from the previous crop. Gwalior comes under sub-tropical zone and it is situated at latitude of 26.2124^0 N and longitude of 78.1772^0 E. The average altitude of this place is 478 meters above sea level. Summer and winter are both extremes. The monsoon season starts in late June and lasts until late September. The annual rainfall ranges from 750 to 800 mm.

Experimental materials

The study involving ten genotype viz. IPM 2-3, IPM 2-14, Meha, Soorya, Virat, Varsha, Kanika, Vashudha, Heena and Shikha of mungbean was obtained from the ICAR-Indian Institute of Pulses Research, Kanpur, Uttar Pradesh to estimate induced dormancy, seed weretreated with seven different growth regulators including control.

Foliar application of chemical spray treatments

As per treatment details (Table 1), for the induced or breaking seed dormancy on the mungbean crop, two foliar sprays of each treatment were applied using a knapsack sprayer. At the time of spraying, the necessary chemical concentration for treatments was prepared. The sowing of 45 days after the first spraying was given followed by second spray 60 days after sowing. To avoid spreading the solution's drift to nearby plots, sufficient precautions were followed while spraying.

Table 1. The details of experimental treatments

Sr.No.	Treatment details	Symbol
1.	Control (water spray)	T_0
2.	GA_3 @ 80 ppm	T_1
3.	ABA @ 50 ppm	T_2
4.	H_2O_2 @ 10 mm	T_3
5.	MH @ 1000 ppm	T_4
6.	KNO_3 @ 1 mm	T_5
7.	IAA @ 100 ppm	T_6

Design of laboratory experiment

Laboratory work was conducted in Factorial Completely Randomized Design (FCRD) at Genetics and Plant Breeding Research Lab, School of Agriculture, ITM University, Gwalior, Madhya Pradesh.

Factor A: - Variety
V1: IPM 2-3
V2: IPM 2-14
V3: Meha
V4: Soorya,
V5: Virat
V6: Varsha
V7: Kanika
V8: Vashudha
V9: Heena
V10: Shikha

Factor B: – Treatments
T0: Control (water spray)
T1: GA_3 @ 80 ppm
T2: ABA @ 50 ppm
T3: H_2O_2 @ 10 mM
T4: Maleic hydrazide @ 1000 ppm
T5: KNO_3 @ 1 mM
T6: IAA @ 100 ppm.

Laboratory test

Longevity of seed observes after storage of 2 months intervals on different parameters like seed viability (TZ test) and electrical conductivity (dS/m) following standard procedures.

Seed viability (TZ test)

Tetrazolium testing, as per Lakon (1949) description, was used to determine the viability of the harvested seeds immediately following storage. Three replications of conditioning in distilled water over night with 100 seeds from each treatment. A needle was used to penetrate the seeds through the pericarp into the endosperm near the embryo. A 1.0% aqueous solution of 2, 3, 5-triphenyl tetrazolium chloride was added to the prepared seeds before they were placed in tiny petri dishes with lids. The seeds in the petri dishes were assessed as viable or dead based on the embryonic staining pattern after three hours in the dark.

Electrical conductivity (dS/m)

Randomly chosen from each treatment, three replications of 25 seeds each were soaked in 75 ml of distilled water for 24 hours at 25^{0}C. Before analysis, the mixture of seeds and solution was gently swirled for 10 to 15 seconds. According to Loeffler (1988), the electrical conductivity of the solution was determined using a conductivity meter with a cell constant of 1. The result has been expressed as deci Siemens per meter (dS/m).

Results and Discussion

Seed viability (TZ test)

The analysis of variance of data on seed viability (TZ test) revealed that there was significant difference between the varieties, treatment and their interaction for all months in storage (Table 3). Numerically lower values were recorded in MH @ 1000 ppm (T_4), irrespective of varieties. In general, higher seed viability was recorded in control (T_0) in all varieties. It was found that the seed viability of the varieties were influenced by their interaction with treatments during all the testing months of storage. This is evident from the lower mean values of seed viability (56.900,46.900 and 38.333 % in T_4) MH @ 1000 ppm respectively during all the testing months of storage (2, 4 and 6 MAH).

However, the variety IPM 2-14 were recorded for highest value that is 66.667,52.667,42.667 respectively for the 2nd, 4th and 6th months of storage. Vashudha (48.667,40.000, 33.333) recorded the lowest seed viability during all the months of storage. The present results of the study indicated that the

Table 2. Effect of chemical treatments on electrical conductivity of seed (dS/m) during storage

Variety	(TWO MONTHS AFTER HARVEST)							(FOUR MONTHS AFTER HARVEST)							(SIX MONTHS AFTER HARVEST)						
	T_0	T_1	T_2	T_3	T_4	T_5	T_6	Mean	T_0	T_1	T_2	T_3	T_4	T_5	T_6	Mean	T_0	T_1	T_2	T_3	T_4	T_5	T_6	Mean
V1: IPM 2-3	0.213	0.263	0.217	0.217	0.303	0.19	0.203	0.23	0.15	0.193	0.147	0.147	0.233	0.12	0.127	0.16	0.073	0.137	0.09	0.083	0.16	0.07	0.073	0.098
V2: IPM 2-14	0.197	0.217	0.207	0.203	0.29	0.217	0.237	0.224	0.127	0.153	0.12	0.133	0.21	0.137	0.163	0.149	0.07	0.107	0.08	0.073	0.16	0.077	0.113	0.097
V3: Meha	0.217	0.24	0.247	0.23	0.293	0.237	0.24	0.243	0.15	0.16	0.17	0.157	0.213	0.167	0.167	0.169	0.093	0.103	0.117	0.123	0.16	0.103	0.11	0.116
V4: Soorya	0.257	0.253	0.28	0.203	0.303	0.207	0.217	0.246	0.187	0.177	0.21	0.13	0.25	0.14	0.143	0.177	0.123	0.12	0.15	0.077	0.153	0.08	0.097	0.114
V5: Virat	0.257	0.25	0.267	0.217	0.31	0.24	0.227	0.252	0.187	0.18	0.2	0.147	0.23	0.167	0.157	0.181	0.13	0.12	0.14	0.1	0.15	0.103	0.107	0.121
V6: Varsha	0.28	0.25	0.22	0.217	0.323	0.27	0.25	0.259	0.2	0.17	0.143	0.147	0.243	0.2	0.18	0.183	0.14	0.11	0.09	0.083	0.177	0.14	0.12	0.123
V7: Kanika	0.253	0.21	0.227	0.22	0.277	0.247	0.243	0.24	0.173	0.137	0.157	0.14	0.21	0.173	0.17	0.166	0.123	0.077	0.097	0.09	0.16	0.11	0.103	0.109
V8: Vashudha	0.22	0.267	0.273	0.22	0.297	0.237	0.24	0.25	0.14	0.197	0.203	0.15	0.217	0.16	0.17	0.177	0.08	0.137	0.13	0.11	0.157	0.097	0.12	0.119
V9: Heena	0.21	0.247	0.21	0.223	0.31	0.22	0.267	0.241	0.13	0.167	0.13	0.147	0.24	0.15	0.197	0.166	0.077	0.113	0.07	0.08	0.16	0.09	0.137	0.104
V10: Shikha	0.213	0.19	0.21	0.237	0.31	0.25	0.267	0.24	0.143	0.12	0.14	0.167	0.23	0.18	0.197	0.168	0.093	0.06	0.08	0.097	0.16	0.13	0.147	0.11
Mean	0.232	0.239	0.236	0.219	0.302	0.231	0.239		0.159	0.165	0.162	0.146	0.228	0.159	0.167		0.1	0.108	0.104	0.092	0.16	0.1	0.113	
	C.D.	SE(d)	SE(m)						C.D.	SE(d)	SE(m)						C.D.	SE(d)	SE(m)					
Variety	0.005	0.003	0.002						0.006	0.003	0.002						0.006	0.003	0.002					
Treatment	0.005	0.002	0.002						0.005	0.003	0.002						0.005	0.002	0.002					
Interaction	0.014	0.007	0.005						0.016	0.008	0.006						0.015	0.008	0.005					

viability of seed from foliar spray of MH @ 1000 ppm successfully induced the dormancy in the genotypes which is shown by viability test indicating that, there was a viability, however germination was inhibited due to MH spray. Hence, it can be stated that the MH is safe to induce dormancy in mungbean.

Several author reported that, maleic hydrazide known to act as respiration inhibitor (Paterson *et al.*, 1952). Loss of viability occurs due to an irreversible physiologicaland biochemical changes in seed (Narasimha Reddy and Swamy, 1979).Viability of a seed is lost due to inactivation of enzymes, proteins andloss of reserved food material due to respiration (Pandey and Sinha, 2006). In this situation, maleic hydrazide prevents respiration, stops the loss of food that has been saved, and stops the inactivation of proteins and enzymes. Maleic hydrazide therefore has no negative effects because the viability of the seeds was not lost. The present results are in conformity that the 1000 ppm MH dose is responsible for the significant adverse change on the seed viability as tested by TZ test similarly reported by Nagarjun *et al.,* 1980.

Electrical conductivity (dS/m)

The ANOVA on EC revealed that there was significant difference between the varieties, treatment and their interaction for all the testing months of storage (Table 2). Numerically lower values were recorded in H_2O_2 @ 10 mm (T_3), irrespective of varieties. In general, higher EC was recorded in Malic hydrazide (T_4) in all varieties than control (T_0) during the entire storage period. It was found that the EC of the varieties were influenced by their interaction with treatments during all the testing months of storage. This is evident from the higher mean values of EC (0.302, 0.228 and 0.160 dS/m in T_4) MH @ 1000 ppm respectively during all the testing months of storage (2, 4 and 6 MAH).

However, the variety Varsha (0.323, 0.177) recorded the highest values in all the months of storage except (4 MAH), where Soorya (0.250) had the highest EC value respectively. Kanika (0.277) had the lowest values in Two Month after Harvest. IPM 2-14 and Kanika (0.210) recorded the lowest EC in Four Month after Harvest respectively. Similarly Virat (0.150) had the lowest EC in Six Month after Harvest.

Similar findings were reported byAgarwal, 1995the seeds which give high EC have been found

Table 3. Effect of chemical treatments on seed viability (%) (TZ test) during storage

Variety	(TWO MONTHS AFTER HARVEST)							(FOUR MONTHS AFTER HARVEST)							(SIX MONTHS AFTER HARVEST)						
	T_0	T_1	T_2	T_3	T_4	T_5	T_6	Mean	T_0	T_1	T_2	T_3	T_4	T_5	T_6	Mean	T_0	T_1	T_2	T_3	T_4	T_5	T_6	Mean
V1: IPM 2-3	82.333	79.333	77.667	73.667	59.333	73	79.667	75	72.667	69	67	63.667	49.667	60.667	70	64.667	62.667	59	57.333	53.667	42	51	60	55.095
V2: IPM 2-14	85.667	79.333	68.667	77	66.667	77.333	72	75.238	77.333	66.667	60	67	52.667	67.667	62	64.762	67.333	56.667	50	57	42.667	57.667	52	54.762
V3: Meha	79	72.333	79	69.333	52.667	64.333	70	69.524	69	61	69.333	60	42	52.667	60.333	59.19	59	51	59.333	50	33.667	42.667	50.333	49.429
V4: Soorya	80.333	69	78.333	87.333	57.667	70	68.667	73.048	70.333	59.667	69	77	47	60	58.667	63.095	60.333	50	59	66.667	37	50	50	53.286
V5: Virat	79.667	66.333	69.667	62.333	51.667	77.333	68	67.857	69.667	57.667	60	57	42	67.333	58.333	58.857	59.667	47.333	51	47.667	33.667	57.333	48.333	49.286
V6: Varsha	79.667	68.333	58.667	68	53.333	80	67.667	67.952	69	58.667	51.667	59.333	46.667	70	60	59.333	59	49.667	41	49.333	39.333	62.333	50	50.095
V7: Kanika	79	78.667	67.667	77.333	60.667	72	73.333	72.667	69.333	69.333	59	67	51	62	63.333	63	59.333	59.333	49	57	41	52	53	52.952
V8: Vashudha	80.667	78	70	79	48.667	70.667	78.667	72.238	70.667	69	60	66	40	60.333	68.333	62.048	61	59	50	59.333	33.333	50.333	58.333	53.048
V9: Heena	77	78	69	78.333	60	73.333	74	72.81	66.667	69.333	59	68	50	63.333	63.667	62.857	56.667	57.667	49	58.667	40	53	53.667	52.667
V10: Shikha	83.667	78.667	70	70.667	58.333	78.667	72	73.143	72.667	68.333	60	60.667	48	69	62.333	63	61	58	49.667	51	40.667	59	52.333	53.095
Mean	80.7	74.8	70.867	74.3	56.9	73.667	72.4		70.733	64.867	61.5	64.567	46.9	63.3	62.7		60.6	54.767	51.533	55.033	38.333	53.533	52.8	
	C.D.	SE(d)	SE(m)						C.D.	SE(d)	SE(m)						C.D.	SE(d)	SE(m)					
Variety	1.322	0.668	0.472						1.318	0.666	0.471						1.256	0.635	0.449					
Treatment	1.106	0.559	0.395						1.103	0.557	0.394						1.051	0.531	0.375					
Interaction	3.496	1.767	1.249						3.487	1.762	1.246						3.323	1.679	1.187					

to be correlated with low field emergence. Seeds with very high EC may not be suitable for sowing. The highest EC might be due to inhibitory effect of MH, as it was inhibited the germination of green gram seeds in the genotypes. Among the various chemical treatment sprayed the MH @ 1000 ppm recorded higher EC, it could be attributed to inhibition of germination of seeds. The seed from control recorded the lowest EC as it gave more germination percentage.

Conclusion

The present study concluded that the foliar spray were imposed at two stage 45 and 60 Days after sowing Maleic hydrazide @1000 ppm at flowering and pod initiation stages induced dormancy in mungbean without affecting seed yield and seed quality during storage.

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Competing Interests

Authors have declared that no competing interests exist.

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