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Influence of maleic hydrazide (MH) induced dormancy on various seed quality attributes controlling storability of groundnut seeds

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Abstract
An investigation was undertaken during kharif 2017 at the Central Research Station and Department of Seed Science and Technology, OUAT, Bhubaneswar to find out the influence of maleic hydrazide (MH) induced seed dormancy on various seed quality attributes controlling storability of groundnut seeds. The experimental material consisted of three groundnut varieties namely, TG 37 A, TG 38 B and Devi and six treatments namely, MH @ T_0 (0 ppm), T_1 (250 ppm), T_2 (500 ppm), T_3 (750 ppm), T_4 (1000 ppm) and T_5 (1250 ppm) applied as foliar spray at 70 and 90 DAS. The storability of seeds was assessed basing on the results of germination and vigour tests (SVI-I, SVI-II) conducted at monthly intervals. Among the varieties, Devi responded well to dormancy induction treatments and exhibited high germination, vigour or storability followed by TG 38 B and TG 37 A during all three months of storage. The rate of deterioration was higher in control in comparison to MH treatments. After two months, the highest germination (84.33%) was observed in T_5 followed by T_4 (82.33%) and T_3 (81.00%) while, the lowest germination of 73.67% was observed in untreated seeds (control). Application of MH @ 1250 ppm (T_5) was the only treatment that maintained seed germinability above the certification standard (70.67%) after three months of storage while germination was lower (57.67% to 69.33%) in all the other treatments. Significant differences in respect of seed vigour indices (SVI-I and SVI-II) were absent among the varieties, treatments and also among the interaction effects during the entire period of storage indicating similar response of all the three varieties and MH treatments on these two vigour parameters. Thus, the foliar application of MH induced dormancy @ 1250 ppm helped in maintaining higher germinability and vigour of seeds during storage as compared to the untreated seeds. There exists a positive association of seed dormancy with seed longevity in different crops which could be made use in enhancing storability of groundnut seeds.

Keywords: Dormancy, maleic hydrazide (MH), germination, vigour, SVI-I, SVI-II and storability

1. Introduction
Groundnut (*Arachis hypogaea* L.) is an important food and oilseed crop. It is commonly called as the king of vegetable oil seeds or poor man's nut. It belongs to the family *Papilionaceae*, which is the largest and most important of the three divisions of *Leguminosae*. Groundnut appears to have been originated in the South America i.e. North-West of Brazil, the secondary centre of its cultivation is in Africa (Vavilov, 1951) [18]. Groundnut is grown throughout the tropical and warm temperate regions of the world.
The botanical name for groundnut, *Arachis hypogaea* Linn., is derived from two Greek words, *Arachis* meaning a legume and *hypogaea* meaning below ground referring to the formation of pods in the soil. Different cultivars of groundnut are broadly classified into two following groups.

- **Virginia:** having bunchy, semi-spreading or spreading growth habit
- **Spanish:** having bunch growth habit

Groundnut seeds contain high quality edible oil (50%), easily digestible protein (25%) and carbohydrates (20%) (Weiss, 1983) [19]. Oil cake is a high protein livestock feed, it can be used for human consumption. It contains 7 to 8 per cent of N, 1.5 per cent of P_2O_5 and 1.2 per cent of K_2O and is used as a fertilizer. It is also consumed as confectionary product. The haulms (plant stalks) are fed (green, dried or silage) to livestock. Groundnut shell is used as a fuel for manufacturing coarse boards, cork substitutes etc. Groundnut is also valued as a rotation crop. Being a legume with root nodules, it can synthesize atmospheric nitrogen and therefore improves soil fertility.

It is an excellent source of thiamine and vitamin E and small quantities of vitamin A, C and D (Weiss, 1983) [19]. Groundnut oil is used in medicine as it is highly nutritive and laxative too.

Although groundnut production in India suffers from instability and low yields, groundnut is considered as a crop of remarkable adaptability. Being adaptable to varied agro climatic conditions, it is grown in most states of the country. Out of the nine oilseed crops grown in India, groundnut accounts for 45% of the total area under oilseeds and 40% of the total oilseed production.

Groundnut varieties exhibit a wide variability in their germination behaviour. The cultivated groundnut *Arachis hypogaea* L. has two sub species: subspecies hypogaea (Virginia Bunch and Virginia Runner varieties) and subspecies fastigiata (Spanish and Valencia varieties). The kernels of Spanish and Valencia bunch types are usually non-dormant, whereas those of Virginia bunch and runner varieties are dormant (Rao, 1976) [13]. The non-dormant character in Spanish and Valencia bunch type is undesirable for its cultivation in summer season. In the country, groundnut is grown as a rainfed crop in the *kharif* or rainy season. In Odisha, the *rabi* groundnut is grown under irrigation or residual moisture after early paddy. The area under *rabi* groundnut depends on the availability of quality seed which is required from the second week of September. As the seed is procured from the *kharif harvest*, seed availability is often delayed beyond September and stands as a constraint in extensive coverage of area under groundnut. The area would be further reduced if seed is not available from *kharif harvest* owing to delayed sowing of the crop beyond first week of June. This problem could be avoided if the seed harvested in May can be stored and carried over for sowing in the next *rabi* season. It has been found that groundnut seed losses viability quite rapidly during the period from May to September when stored under ordinary / ambient conditions.

Several reasons could be ascribed to its low productivity of which nearly 20 – 50 percent losses in the field is by the in-situ germination due to the lack of seed dormancy (Reddy, 1982; Ramanathan, 1987; Nagarjun and Radder, 1983a) [14, 12, 10]. Again, being an oilseed crop, groundnut is a poor storer. Sometimes the germination per cent comes to below IMSCS level within 3 to 4 months depending on the ambient storage conditions. Hence, it is appropriate to study the techniques of dormancy induction by application of certain dormancy inducing chemicals.

Seed dormancy is defined as a state in which seeds are prevented from germinating even under environmental condition normally favourable for germination. These conditions are a complex combination of water, light, temperature, gases, mechanical restrictions, seed coats and hormone structures.

Seed dormancy is an important factor in commercial groundnut production. It can be beneficial when dormancy prevents mature seeds from sprouting before harvest and improving the storability of crop seeds. It can be detrimental when dormancy reduces stand or hampers taking a second crop immediately after harvest. The search for investigation of non-conventional methods of inducing dormancy in bunch types to save the produce from pre-harvest sprouting in the field and to retain the seed quality attributes controlling storability of groundnut seeds are of greater importance. For inducing seed dormancy in groundnut, a number of methods have been developed, out of which foliar application of maleic hydrazide (MH) at variable concentrations and at different stages of crop growth has been successfully used. (Shelar *et al.*, 2014) [15].

Storage of groundnut seeds under dehumidified refrigerated conditions though expensive, is effective for maintaining high Germinability, but the real problem in this case is that the seed is to be sown immediately after removal from controlled storage, which is often not possible in the present system of seed distribution. A solution to the problem would be to select and grow varieties possessing better storability as a genetically controlled trait. Dormancy in seed is considered to be a resting period during which there is very little deterioration of seeds in storage. There are reports of positive association of seed dormancy with seed longevity in different crops. Such an association could be made use in enhancing storability of groundnut seeds.

Maleic hydrazide, a growth inhibitor has been successfully used to inhibit seed germination and to control sprouting of tubers, roots and bulbs thereby helps in enhancing storability of most seeds. The key idea in the use of growth regulators is to control some aspects of growth, regulate the balance between source and sink, which is the final analysis results in the higher yield of desired product. The present investigation "Influence of maleic hydrazide (MH) induced dormancy on various seed quality attributes controlling storability of groundnut seeds" was undertaken.

2. Materials and Methods

The present investigation entitled "Influence of maleic hydrazide (MH) induced dormancy on various seed quality attributes controlling storability of groundnut seeds" was conducted during Kharif, 2017 in the Department of Seed Science and Technology, OUAT, Bhubaneswar. The details of materials and methods adopted for these investigations are described below.

2.1 Field tests

Experimental site and climatic conditions

The Experimental plot was cited in the Central Research Station, OUAT, BBSR located at 20°15' North latitude 85°52' East longitude. Proper climatic conditions were maintained during the experimental period.

Land preparation

Fairly well leveled and uniform fertile land was selected for conducting the experiment. The field was brought to good tilth by ploughing once and harrowing twice and by collecting stubbles and debris of the previous crop before carrying out the experiment.

Experimental material

The experimental material comprised of three bunch type groundnut cultivars-*viz*., Devi, TG 37 A and TG 38 B. Seeds of these varieties were obtained from the AICRP (groundnut), O.U.A.T. Bhubaneswar. The seeds were well protected in sealed gunny bags before collection for the experimental purpose.

Seed sowing

The seed crops of these varieties were sown in Kharif, 2017. Pure seeds of these varieties were obtained and the kernels were hand dibbled in the 6 row plots of size 9 × 7 m^2 at a spacing of 30 ×10 cm with one seed per hill for all treatments. Appropriate seed production technology was adopted to raise the crop (Agrawal, 1993) [2]. The meteorological conditions

were suitable for raising the seed crops.

Fertilizer management
Farmyard manure @10 tonnes per hectare was uniformly spread in the field before harrowing. The fertilizers in the form of urea, single super phosphate and muriate of potash were applied @ 20 kg N, 40 Kg P and 40 Kg K and 250 kg of gypsum at the time of sowing. Prophylactic plant protection measures were adopted to protect the crops from weeds, diseases and pests' attack.

Irrigations
First pre-sowing irrigation followed by second irrigation was given immediately after sowing. There after irrigation was given as and when required till harvest of the crop.

Foliar application of MH
Six treatments of maleic hydrazide, a dormancy inducing chemical was given as foliar spray solution of different concentrations along with a control. This dormancy inducing chemical is a growth and respiratory inhibitor. In order to prepare a solution of 250 ppm, 500 ppm, 750 ppm, 1000 ppm, 1250 ppm concentrations, 0.25 g, 0.5 g, 0.75 g, 1 g, 1.25 g of the chemical was dissolved in 1 litre of distilled water respectively. In the beginning, 250 ppm of MH spray solution was prepared by dissolving 250 mg of MH powder in one litre of distilled water. Then mixture was solubilized by adding KOH pellets with the use of magnetic stirrer. Likewise, the spray solution of 500 ppm, 750 ppm, 1000 ppm and 1250 ppm were prepared. Care was taken while spraying to check the carryover of the drift of solution to the adjoining plots. Maleic hydrazide was sprayed at two different stages of crop growth i.e. 70 and 90 DAS. In case of control (T_0), only distilled water was given as foliar spray.

2.2 Laboratory tests
Assessment of seed quality attributes controlling storability of groundnut seeds
The harvested seeds of different varieties and treatments after thorough drying to 9% moisture content were packed in small gunny bags and stored under ambient conditions in the laboratory. In the present investigation, the storability of seeds of three groundnut varieties receiving MH treatments was assessed by different seed quality attributes in respect of germination, seedling growth (seedling length and seedling dry weight) and vigour (SVI-I and SVI-II) conducted at monthly intervals up to 3 months.

Performance tests
The performance of seeds and seedlings of different varieties and treatments were assessed in terms of germination, seedling length, seedling dry weight and seed vigour index following the standard procedure..

Seed germination
The four replicates of 100 seeds each of different varieties receiving different treatments were sown in between two layers of moist kraft paper, which were again covered by another layer of non-absorbent, wax paper. The entire set was rolled, labelled and kept inside the germinator in upright position. The test conditions of 25 ± 2^0 C and 95 ± 2% RH were maintained in the germinator. At the end of the tenth day, the number of the normal seedling (seedlings showing normal root and shoot development) were counted and the mean was expressed in percentage (ISTA rules, 1999). Basing on this procedure the seed germination percentages of three groundnut varieties receiving various MH treatments over a period of three months of storage was calculated

$$\text{Germination (\%)} = \frac{\text{Number of normal seedlings}}{\text{Total number of seeds}} \times 100$$

Seedling length
From the standard germination test, 10 normal seedlings were randomly selected and the seedling length from the root tip to the shoot tip was measured by help of one meter scale and expressed in centimetres.

Seedling dry weight
The ten normal seedlings selected for seedling length measurement were also used for measuring the seedling dry weight. After removal of the cotyledons, the seedlings were dried in an air oven at 80 °C for 24 hrs. Weight of the oven-dried seedlings was taken in an electronic balance and mean dry weight of seedling was expressed in grams.

Seed vigour
The seed vigour was assessed in terms of seed vigour index (SVI) using the observation data of mean seedling length and dry weight as per the following formula. (Abdul-Baki and Anderson, 1973) [1].

SVI-I = Seed germination (%) × Mean seedling length (cm)
SVI-II = Seed germination (%) × Mean seedling dry weight (g)

Statistical analysis
The data obtained from various experiments were statistically analysed by using Factorial RBD method following the principles and procedures outlined by Panse and Sukhatme (1978) [11]. Arcsine and square root transformation of the data were made (Gomez and Gomez, 1984) [6], wherever necessary. The significance of difference between any two means was tested through computation of critical difference (CD) and differences between the treatments were worked out at five per cent significance (Snedecor and Cochran, 1967) [16].

3. Results
Effect of MH induced dormancy on various seed quality parameters during storage
Storability of seed is an important physiological trait which is affected by genotype and environmental conditions during seed production and storage. In the present investigation, the storability of seeds of three groundnut varieties receiving MH treatments was assessed by germination and vigour tests conducted at monthly intervals.

3.1 Seed germination
The mean germination percentages of three groundnut varieties receiving various MH treatments over a period of three months of storage are presented in Table.1. The results indicated presence of significant genotypic variation only at the initial months of storage while variations among the varieties were non-significant during the subsequent months of storage. Among the three varieties studied, the highest (92.67%) and lowest (89.33%) germination were observed in Devi and TG 37 A, respectively during the entire period of storage. The varietal differences in respect of seed germination were not observed during the subsequent period of storage.

The initial mean germination percentage of seeds of all varieties was 91.17% which was decreased to 87.33% after one month, further decreased to 79.44% and 63.39% after second and third month of storage, respectively. There was presence of significant variations among the treatments at all the stages of storage. The initial germination percentage of seeds of different treatments ranged from 89.00% (T4) to 94.00% (T0) with an overall mean value of 91.17% indicating low germination of MH treated seeds in comparison to the control.

After one month, the mean germination percentage was reduced to 87.33% from 91.17%. The germination percentage of seeds of all the treatments was found to be higher in comparison to the control (82.67%) and germination percentage was increased with increase in the dose of MH applications. After 2 months of storage, all the treatments including control were found to maintain germination above the certification standards and the mean value ranged from 73.67% (T_0) to 84.33% (T_5) indicating significant positive influence of MH treatments on maintenance of higher Germinability of stored groundnut seeds. Like, the previous month an increasing trend in germination is observed with increase in the dose of MH application.

After three months of storage, none of the treatments except T_5 were able to retain germination equals to IMSCS (70%) certification standard of groundnut seed. The highest germination of 70.67% was observed in the seeds receiving foliar application of MH @1250 ppm while the highest reduction in germination was observed in the control (T_0) maintaining 57.67% germination after 3 months of storage. Thus, it is clear that foliar application of MH were effective in inducing seed dormancy and reducing the rate of deterioration thereby maintaining higher germinations of seeds during storage in comparison to the control. During storage, the seed germination values showed an increasing trend with increase in the dose of MH applications. The results indicated absence of signification variations among the interaction effects during the entire period of storage.

The longer storability of dormant seed might be due to the reduced metabolic activities during the period of dormancy thereby extending the longevity of seeds. Positive association between post-harvest dormancy and seed longevity in storage has been reported by Lin *et al.* (1993) [8] in spinach, Swain (1999) [17]; Manonmani (2002) [9] and Bajpai *et al.* (2017) [5] in groundnut.

3.2 Seedling length

The mean seedling length values of different varieties receiving different treatments over a period of 3 months of storage are presented in Table-2. The results indicated absence of significant variations among the varieties, treatments as well as the interaction effects. There was gradual decrease in seedling length with advancement in period of storage. The results indicated a gradual decrease in seedling growth with advancement of storage time. The mean length of seedlings, which was 20.09 cm initially decreased to 19.81 cm, 18.89 cm and 17.74 cm after one, two and three months of storage, respectively.

3.3 Seedling dry weight

The mean seedling dry weight values of different varieties receiving different treatments over a period of 3 months of storage are presented in Table-3. The results indicated absence of significant variations among the varieties, treatments as well as the interaction effects except at 2 months of storage. There was gradual decrease in seedling dry weight values with advancement in period of storage. The mean seedling dry weight was decreased from 2.09 g (0 month) to 1.76 g (3 month). During the initial month of storage, the mean seedling dry weight values among the treatments ranged from 2.03 g to 2.15 g. After one month of storage, the mean seedling dry weight values among the treatments ranged from 1.92 g to 2.05 g. After two months of storage, the mean seedling dry weight values among the treatments ranged from 1.84 g to 1.90 g. After three months of storage, the mean seedling dry weight values among the treatments ranged from 1.75 g to 1.79 g.

Table 1: Effect of MH application on seed germination (%) at monthly intervals during storage

Variety / Treatment	Months after storage															
	0				1				2				3			
	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean
T_0 (Control)	91.00 (72.64)	95.00 (77.14)	96.00 (78.55)	94.00 (76.11)	81.00 (64.22)	83.00 (65.69)	84.00 (66.58)	82.67 (65.50)	72.00 (58.23)	74.00 (59.41)	75.00 (60.00)	73.67 (59.21)	54.00 (47.31)	59.00 (50.21)	60.00 (50.79)	57.67 (49.44)
T_1 (250 ppm)	91.00 (72.78)	93.00 (74.70)	94.00 (75.87)	92.67 (74.45)	84.00 (66.51)	84.00 (66.43)	86.00 (68.08)	84.67 (67.01)	74.00 (59.78)	76.00 (60.99)	78.00 (62.08)	76.00 (60.95)	56.00 (48.46)	60.00 (50.77)	61.00 (51.36)	59.00 (50.20)
T_2 (500 ppm)	89.00 (70.80)	92.00 (73.69)	93.00 (74.70)	91.33 (73.06)	85.00 (67.39)	88.00 (69.80)	88.00 (69.80)	87.00 (69.00)	78.00 (62.17)	80.00 (63.54)	80.00 (63.78)	79.33 (63.17)	59.00 (50.19)	61.00 (51.38)	62.00 (52.04)	60.67 (51.20)
T_3 (750 ppm)	89.00 (70.65)	89.00 (70.80)	91.00 (72.57)	89.67 (71.34)	87.00 (68.99)	89.00 (70.70)	90.00 (71.65)	88.67 (70.45)	80.00 (63.54)	81.00 (64.35)	82.00 (65.10)	81.00 (64.33)	62.00 (51.98)	63.00 (52.60)	64.00 (53.18)	63.00 (52.58)
T_4 (1000 ppm)	87.00 (68.92)	90.00 (71.59)	90.00 (71.59)	89.00 (70.70)	88.00 (69.80)	90.00 (71.76)	92.00 (73.60)	90.00 (71.72)	81.00 (64.17)	82.00 (64.93)	84.00 (66.51)	82.33 (65.20)	69.00 (56.19)	69.00 (56.24)	70.00 (56.80)	69.33 (56.41)
T_5 (1250 ppm)	89.00 (70.65)	90.00 (71.59)	92.00 (73.69)	90.33 (71.98)	89.00 (70.80)	91.00 (72.78)	93.00 (74.70)	91.00 (72.76)	83.00 (66.12)	84.00 (66.51)	86.00 (68.08)	84.33 (66.90)	71.00 (57.54)	70.00 (56.84)	71.00 (57.47)	70.67 (57.28)
Mean	89.33 (71.07)	91.50 (73.25)	92.67 (74.49)	91.17 (72.94)	85.67 (67.95)	87.50 (69.53)	88.83 (70.73)	87.33 (69.40)	78.00 (62.33)	79.50 (63.29)	80.83 (64.26)	79.44 (63.29)	61.83 (51.95)	63.67 (53.01)	64.67 (53.61)	63.39 (52.85)
	S.Em (±)		CD (5%)		S.Em (±)		CD (5%)		S.Em (±)		CD (5%)		S.Em (±)		CD (5%)	
Variety	0.727		2.169		0.878		NS		1.391		NS		1.13		NS	
Treatment	1.028		3.067		1.242		3.705		1.967		3.852		1.598		4.768	
V × T	1.781		NS		2.151		NS		3.408		NS		2.768		NS	

Figures in the Parenthesis are angular transferred values

V_1: TG 37 A; V_2: TG 38 B; V_3: Devi

Table 2: Effect of MH application on mean seedling length (cm) at monthly intervals during storage

Variety / Treatment	Months after storage															
	0				1				2				3			
	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean
T_0 (Control)	20.15	20.13	20.13	20.14	19.99	19.23	21.9	20.37	19.01	18.37	19.87	19.08	17.68	17.99	18.11	17.93
T_1 (250 ppm)	20.11	20.11	20.11	20.11	19.98	20.01	19.47	19.82	18.76	18.78	18.98	18.84	17.67	17.67	18.11	17.81
T_2 (500 ppm)	20.14	20.14	20.09	20.12	19.81	19.95	19.18	19.65	18.99	19.16	19.11	19.09	17.03	17.64	17.87	17.51
T_3 (750 ppm)	20.00	20.18	20.06	20.08	19.44	19.64	19.64	19.57	18.78	19.00	18.65	18.81	17.56	17.63	17.78	17.66
T_4 (1000 ppm)	20.17	19.88	19.88	19.98	20.01	19.14	20.22	19.79	18.97	18.59	18.67	18.74	17.89	17.76	17.45	17.70
T_5 (1250 ppm)	20.17	20.14	20.04	20.12	20.12	19.79	19.11	19.67	19.01	18.79	18.59	18.80	17.97	17.64	17.89	17.83
Mean	20.12	20.10	20.05	20.09	19.89	19.63	19.92	19.81	18.92	18.78	18.98	18.89	17.63	17.72	17.87	17.74
	S.Em (±)		CD (5%)		S.Em (±)		CD (5%)		S.Em (±)		CD (5%)		S.Em (±)		CD (5%)	
Variety	0.791		NS		0.295		NS		0.206		NS		0.351		NS	
Treatment	1.119		NS		0.417		NS		0.291		NS		0.496		NS	
V × T	1.938		NS		0.722		NS		0.504		NS		0.86		NS	

V_1: TG 37 A; V_2: TG 38 B; V_3: Devi

Table 3: Effect of MH application on mean seedling dry weight (g) at monthly intervals during storage

Variety/Treatment	Months after storage															
	0				1				2				3			
	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean
T_0 (Control)	2.13	2.12	2.19	2.15	1.99	2.01	2.11	2.04	1.88	1.84	1.98	1.90	1.76	1.72	1.88	1.79
T_1 (250 ppm)	2.11	2.13	2.11	2.12	1.98	1.99	1.90	1.96	1.86	1.86	1.97	1.90	1.79	1.71	1.86	1.79
T_2 (500 ppm)	1.98	2.14	2.12	2.08	1.97	1.987	1.95	1.97	1.87	1.84	1.89	1.87	1.70	1.78	1.78	1.75
T_3 (750 ppm)	1.97	2.11	2.12	2.07	1.89	1.96	1.99	1.95	1.84	1.8	1.87	1.84	1.73	1.77	1.75	1.75
T_4 (1000 ppm)	1.98	1.99	2.13	2.03	1.88	1.98	1.90	1.92	1.88	1.78	1.86	1.84	1.74	1.79	1.74	1.76
T_5 (1250 ppm)	2.11	2.11	2.12	2.11	2.13	1.97	2.04	2.05	1.89	1.89	1.87	1.88	1.75	1.75	1.75	1.75
Mean	2.05	2.10	2.13	2.09	1.97	1.98	1.98	1.98	1.87	1.84	1.91	1.87	1.75	1.75	1.79	1.76
	S.Em (±)		CD (5%)		S.Em (±)		CD (5%)		S.Em (±)		CD (5%)		S.Em (±)		CD (5%)	
Variety	0.114		NS		0.056		NS		0.016		0.047		0.015		NS	
Treatment	0.161		NS		0.08		NS		0.022		NS		0.022		NS	
V × T	0.279		NS		0.138		NS		0.039		NS		0.037		NS	

V_1: TG 37 A; V_2: TG 38 B; V_3: Devi

3.4 Seedling vigour

3.4.1 Seedling vigour index I (SVI-I)

In the present investigation, the seed vigour was assessed in terms of seedling vigour indices (SVI-I and SVI-II), at monthly intervals during storage.

The mean values of seedling vigour indices measured on length basis (SVI-I) among different varieties receiving various MH treatments are presented in Table-4. The initial SVI-I values of the varieties ranged from 1798.21 (TG 37 A) to 1857.84 (Devi) with an overall mean values of 1831.38. The mean vigour values at 0 month of storage was 1831.38 which was decreased to 1730.74 then to 1501.13 and 1123.12 at 1, 2 and 3 months after storage, respectively. After 3 months of storage, the groundnut variety Devi (V_3), showed the maximum vigour (SVI-I) of 1154.25 followed by TG 38 B (V_2), with SVI-I value of 1126.87 and TG 37 A (V_1) with SVI-I value of 1088.23.

Thus, the results revealed a gradual decrease in mean seedling vigour with advancement of storage period in respect of both the vigour parameters and among the treatments, the SVI values were high in T_5 in comparison to other treatments at all the four stages of measurement.

There exists complete absence of significant variations among the varieties, treatments and interaction effects for the SVI-I vigour parameters. Although, significant variations were observed among the treatments in respect of seed germination, non-significant variation for SVI-I vigour index were due to absence of significant influence of MH treatments on seedling growth. Absence of significant influence of induced dormancy through foliar application of MH in three groundnut varieties on their seed vigour during storage also has been reported (AICRP, 2011).

3.4.2 Seedling vigour index II (SVI-II)

The mean values of seedling vigour measured on dry weight basis (SVI II) among different varieties receiving various MH treatments are presented in Table-5. The results indicated absence of significant variation among the varieties at all the stages of storage. On the other hand, the treatment and the interaction effects were non-significant at all the stages of storage. The initial SVI-II values of the varieties ranged from 182.91 (TG 37 A) to 197.61 (Devi). After 3 months of storage, the groundnut variety Devi (V_3), showed the maximum vigour (SVI-II) of 115.75 followed by TG 38 B (V_2), with SVI-II value of 111.87 and TG 37 A (V_1) with SVI-II value of 107.86.

The mean vigour values at 0 month of storage was 190.89 which was decreased to 172.89 then to 148.53 and 111.82 at one, two and three months of storage, respectively.

Among the treatments, the highest vigour was observed in T_5 at all the stages except 0 month of storage. There was also gradual decrease in mean seedling vigour values with advancement of periods of storage. Thus there exists complete absence of significant variations among the varieties, treatments and interaction effects for the SVI-II vigour parameters. Absence of significant influence of induced dormancy through foliar application of MH in three groundnut varieties on their seed vigour during storage also has been reported (AICRP, 2011).

Table 4: Effect of MH application on seedling vigour index I at monthly intervals during storage

Variety/ Treatment	Months after storage															
	0				1				2				3			
	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean
T_0 (Control)	1833.35	1912.25	1932.45	1892.68	1678.77	1680.93	1675.68	1678.46	1373.41	1363.54	1490.14	1409.03	950.42	1061.01	1090.16	1033.86
T_1 (250 ppm)	1839.64	1869.18	1890.23	1866.35	1618.26	1597.03	1846.60	1687.30	1395.24	1430.32	1481.13	1435.56	982.92	1062.10	1103.18	1049.40
T_2 (500 ppm)	1784.84	1854.66	1863.28	1834.26	1685.17	1755.68	1690.08	1710.31	1476.62	1529.52	1528.59	1511.58	1010.05	1078.72	1108.82	1065.86
T_3 (750 ppm)	1778.56	1791.73	1829.52	1799.94	1693.29	1747.46	1766.88	1735.88	1502.84	1539.30	1530.95	1524.36	1083.17	1108.00	1134.77	1108.65
T_4 (1000 ppm)	1756.45	1789.44	1788.78	1778.22	1760.88	1725.15	1860.66	1782.23	1536.41	1523.30	1568.55	1542.75	1231.17	1220.64	1218.44	1223.42
T_5 (1250 ppm)	1796.40	1811.24	1842.76	1816.80	1790.62	1801.19	1779.02	1790.28	1576.99	1575.72	1597.84	1583.52	1271.67	1230.76	1270.15	1257.53
Mean	1798.21	1838.08	1857.84	1831.38	1704.50	1717.91	1769.82	1730.74	1476.92	1493.62	1532.87	1501.13	1088.23	1126.87	1154.25	1123.12
	S.Em (±)		CD (5%)		S.Em (±)		CD (5%)		S.Em (±)		CD (5%)		S.Em (±)		CD (5%)	
Variety	73.024		NS		39.946		NS		39.492		NS		33.536		NS	
Treatment	103.271		NS		56.493		NS		55.850		NS		47.427		NS	
V × T	178.871		NS		97.848		NS		96.735		NS		82.145		NS	

V_1: TG 37 A; V_2: TG 38 B; V_3: Devi

Table 5: Effect of MH application on seedling vigour index II at monthly intervals during storage

Variety/Treatment	Months after storage															
	0				1				2				3			
	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean
T_0 (Control)	194.39	201.32	210.29	202.00	166.89	167.14	163.56	165.86	136.24	135.5	148.54	140.09	95.14	101.68	112.8	103.21
T_1 (250 ppm)	191.41	198.72	198.54	196.22	161.25	166.73	178.08	168.69	141.28	137.84	153.6	144.24	99.99	102.64	113.44	105.36
T_2 (500 ppm)	177.03	197.60	197.28	190.64	168.57	174.802	171.23	171.53	147.04	145.96	151.06	148.02	100.12	108.74	110.2	106.35
T_3 (750 ppm)	175.01	186.17	192.90	184.69	164.78	178.17	174.431	172.46	145.45	147.32	153.24	148.67	107.36	111.63	112.2	110.40
T_4 (1000 ppm)	172.82	179.35	191.66	181.28	165.27	174.38	178.544	172.73	145.84	152.24	156.27	151.45	120.03	124.01	121.74	121.93
T_5 (1250 ppm)	186.78	189.83	194.96	190.52	189.39	179.21	189.65	186.08	158.7	156.59	160.88	158.72	124.49	122.54	124.09	123.71
Mean	182.91	192.17	197.61	190.89	169.36	173.41	175.92	172.89	145.76	145.91	153.93	148.53	107.86	111.87	115.75	111.82
	S.Em (±)		CD (5%)		S.Em (±)		CD (5%)		S.Em (±)		CD (5%)		S.Em (±)		CD (5%)	
Variety	10.609		NS		5.609		NS		3.366		NS		3.662		NS	
Treatment	15.003		NS		7.932		NS		4.76		NS		5.178		NS	
V × T	25.986		NS		13.739		NS		8.245		NS		8.969		NS	

V_1: TG 37 A; V_2: TG 38 B; V_3: Devi

4. Summary and conclusion

The present investigation was conducted during *kharif*, 2017 at the Central Research Station and Department of Seed Science and Technology, OUAT, Bhubaneswar to study the influence of maleic hydrazide (MH) induced dormancy on various seed quality attributes controlling storability of groundnut seeds.

The experiment was laid in factorial RBD with three varieties, six treatments and three replications. The experimental materials consisted of three groundnut varieties *viz*., TG 37 A, TG 38 B and Devi and six treatments *viz*., MH @ 0 ppm, 250 ppm, 500 ppm, 750 ppm, 1000 ppm and1250 ppm. The recommended package of practices was adopted for raising the seed crop.

The harvested seeds of different varieties and treatments after thorough drying to 9% moisture content were packed in small gunny bags and stored under ambient conditions in the laboratory. In the present investigation, the storability of seeds of three groundnut varieties receiving different MH treatments was assessed by different seed quality attributes in respect of germination, seedling growth (seedling length and seedling dry weight) and vigour indices (SVI-I and SVI-II) conducted at monthly intervals up to 3 months of storage.

Among the varieties, Devi responded well to dormancy induction treatments and exhibited high storability followed by TG 38 B and TG 37 A during the subsequent period of storage.

All the three groundnut varieties showed similar storage behavior maintaining germination above the certification standard (70%) only for two months under ambient storage. Although seed germination percentage were lower (89.00% to 92.67%) in MH treated seeds in comparison with the control (94.00%) at the time of harvest, a reverse trend was observed during subsequent period of storage. The rate of deterioration was higher in control in comparison to MH treatments. After two months, the highest germination (84.33%) was observed in T_5 followed by T_4 (82.33%) and T_3 (81.00%) while, the lowest germination of 73.67% was observed in untreated seeds (control). Application of MH @ 1250 ppm (T_5) was the only treatment that maintained seed germinability above the certification standard (70.67%) after three months of storage while germination was lower (57.67% to 69.33%) in all the other treatments.

Significant differences in respect of seed vigour indices (SVI-I and SVI-II) were absent among the varieties, treatments and also among the interaction effects during the entire period of storage indicating similar response of all the three varieties and MH treatments on these two vigour parameters.

In the present investigation, the foliar application of MH induced dormancy @ 1000 ppm to 1250 ppm at 70 and 90 DAS maintained higher germinability and vigour of seeds during storage as compared to the untreated seeds. Since there exists a positive association of seed dormancy with seed longevity in different crops. Such an association could be made use in enhancing storability of groundnut seeds.

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