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Effect of seed hardening treatment on seed quality and yield Parameters in black gram (*Vigna mungo* L. hepper) cv. VBN 6.

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ABSTRACT

A field experiment was conducted during the *kharif* season of 2020 at the Plant Breeding Farm, Department of Genetics and Plant Breeding, Annamalai University to study the effect of seed hardening treatment for seed quality and yield parameters in black gram[*Vigna mungo* L.) hepper] cv.VBN 6. Seed hardening is a pre-sowing treatment that involves subjecting seeds to certain chemicals to enhance their germination, growth and overall performance under field conditions. The researchers used various chemicals for seed hardening and these treatments included *i.e.*, FeSO4@ 5%, KH_2PO4@2%, KCl@2%, KNO3@2%, MnSO4@100 ppm, ZnSO4@100 ppm, Cobalt nitrate @ 1%,$CaCl_2$ @2%,GA_3 @ 40%and Control. The study revealed that seeds hardened with MnSO4@100 ppm resulted in the highest values for various parameters *viz.*, plant height, no. of leaves per plant, no. of branches per plant, no. of nodules per plant, days to first flowering, no. of cluster per plant, no. of pods per plant, pod weight per plant, pod length, no. of seeds per pod, no. of seeds per plant, test weight, pod yield per plant, root length, shoot length, seedling length, seedling fresh weight, seedling dry weight, vigour index-I and vigour index-II. The results showed that black gram seed hardening with MnSO4@100 ppm improved higher seed yield and quality parameters when compared to other treatments and control.

Key words: *Black gram, Seed hardening, MnSO4@100 ppm, Seed quality and yield parameters.*

Introduction

Pulses have a great importance in Indian agriculture as they are rich source of protein as compared to cereals. Blackgram is scientifically known as *Phaseolus mungo* and commonly called as urd in India. Pulse crops, being leguminous in nature, can fit well into various cropping systems and have the ability to improve soil fertility and physical health. Their tap root system makes the soil more porous, benefiting overall soil quality. It is the world's largest producer and consumer of blackgram. Pulses are not only meet dietaryprotein requirements but also for achieving nutrition, food security and environmental sustainability goals. In India, it is cultivated in an area of about 46.7 lakh hectares, with production of 23.4 lakh tonnes and productivity of 501Kg ha^{-1} (2020-2021). (agricoop.nic.in). Increasing production and productivity of pulses, particularly black gram is crucial for food security and economic growth in the country. Rainfed agriculture poses a challenge, as it relies heavily on proper management practices to withstand drought conditions. To achieve higher yields and better quality, rapid and uniform field emergence is vital. Pulses are most susceptible for imbibitional injury due to the delicate seed coat character, which can be reduced by seed management practices through hardening.

Hardening modifies the physiological and biochemical nature of the seeds to enhance drought resistance. This treatment induces early germination, improves root and seedling growth, reduces seedling mortality, increases crop population and ultimately enhances the yield potential of the black gram varieties. Seed hardening has been successful and even surprising for many seeds, including legume seeds (Knypl and Khan, 1981 and Bradford, 1986). The benefits of seed hardening extend to faster and more uniform emergence, stronger plants, better drought tolerance and higher seed yield. It also aids to controlling soil and seed-borne fungal diseases and improves the tolerance of crops to diseases and insects during the early stages of growth. Hence, a study was undertaken in black gram *var* VBN 6, with an objective of evaluating the effect of seed hardening using various chemicals on seed quality and yield parameters.

Materials and Methods

The present investigations were conducted during the seeds of black gram (*Vigna mungo* L.) cv. VBN 6 was obtained from the National Pulses Research Station, Vamban, Tamil Nadu formed the basic material utilized in this study.

The seeds were cleaned and graded using BSS 7 x 7 sieves. The retained seeds alone were used for experimentation. The seeds were first preconditioned by keeping them in between two layers of moist gunny bags for an hour. The treatment details of hardening are as follows. The seeds were soaked in the chemicals *viz.,*

Treatment details

T_0- Control

T_1–FeSO4@ 5%

T_2 - KH_2PO4@2%

T_3- KCl@2%

T_4–KNO3@2%

T_5–MnSO4@100 ppm

T_6–ZnSO4@100 ppm

T_7- Cobalt nitrate @ 1%

T_8- $CaCl_2$ @2%

T_9 -GA_3 @ 40%

A field trail was conducted during *kharif* season, 2020 adopting randomized block design with ten treatments and three replications under dry land conditions. The plot size was 3 x 2 m and the crop was raised with a spacing of 30 x 10 cm, the recommended package of practices for black gram was followed uniformly for all the treatments. Five plants were selected randomly irrespective of replication, labelled and the observations on seed and seed yield characters *viz.* Plant height (cm), Number of leavesper plant, Number of branches per plant, Days to first flowering, Number of cluster per plant, Number of pods per plant, Pod length (cm), Number of seeds per pod, Number of seeds per plant, Seed yield per plant (g), Test weight (g) and Pod yield per plant (g) were recorded. plant height, number of branches per plant, number of nodules per plant, days to first flowering, number of pods per plant, pod length, number of seeds per pod, pod yield per plant, seed yield per plant and harvest index.

Germination test was conducted with 4 × 100 seeds of each treatment, in sand media. Germination room was maintained at a temperature of 25 ± 1°C RH of 96 ± 2% with diffused light. The final count based on normal seedling was recorded on seventh day and the mean germination was recorded in percentage (ISTA, 1999). After harvest, standard germination tests for seeds obtained from control and treated plots were carried out between two layers of moist filter paper according to International Seed Testing Association (ISTA, 2011) rules to evaluate treatment effect on seed germination capacity. Observations on seed quality parameters *i.e.* Germination percentage, Root length (cm), Shoot length (cm), Seedling fresh weight (mg/10 seedlings), Seedling dry weight (mg/10 seedlings), Vigour Index-I and Vigour Index-II were recorded. Based on the results obtained, the vigour index values were calculated using the method proposed by Abdul-Baki and Anderson in (1973). The results were reported as whole numbers without any specific unit. The data were analysed statistically using ANOVA Panse and Sukhatme, 1985).

Results

Seed quality parameters

Highlly significant results were obtained at the evaluation of quality characters *viz.,* germination per cent, root length, shoot length, seedling fresh weight, seedling dry weight, vigour index-I, vigour index-II, when tested for variation among the seed hardening treatment.

Among the treatments, $MnSO_4$ @ 100 ppm hardened seeds recorded highest germination percentage (94%), root length (18.50 cm), shoot length (20.20 cm), vigour index-I (3438.00) and vigour index- II (13.50) followed by $CaCl_2$ @2% hardened seeds recorded germination percentage (96%), root length (18.10 cm), shoot length (21.20 cm), seedling fresh weight (1.40), seedling dry weight (0.17), vigour index- I (3636.30) and vigour index- II (15.79), whereas control revealed the lowest for germination percentage (75%), root length (16.70cm), shoot length (17.90 cm), vigour index (2919.20) and vigour index- II (8.25) and lowest value for compared to other treatments and control.

Field evaluation

Higher significant differences were recorded for the seed treatments, MnSO4 @ 100 ppm hardened seeds recorded maximum plant height (40.00),no. of leaves per plant (45.25), no. of branches per plant (11.00), no. of nodules per plant (11.50), days to first flowering (25.50), no. of cluster per plant (11.50), no. of pods per plant (27.00), pod weight per plant (16.80), pod length (5.85 cm), no. of seeds per pod (7.00), pod yield per plant (27.36), no. of seeds per plant (180.20) and seed yield per plant (5.27), test weight (7.35), pod yield per plant (19.29), followed by $CaCl_2$ @2% hardened seeds recorded for mini-

Table 1. Effect of seed hardening treatment with chemicals on field performance with Plant height (cm), No. of leaves per plant, No. of branches per plant, No. of nodules per plant and Days to first flowering in black gram cv. VBN6.

Treatment Details	Plant height (cm)	No. of leaves per plant	No. of branches per plant	No. of nodules per plant	Days to first flowering
T_0	34.40	32.20	6.20	7.50	30.00
T_1	36.50	33.50	7.50	8.20	29.20
T_2	37.00	34.25	8.00	8.60	29.00
T_3	38.50	36.50	8.50	9.00	28.25
T_4	37.50	38.75	8.70	9.50	28.50
T_5	40.00	45.25	11.00	11.50	25.50
T_6	38.80	42.25	9.00	9.25	27.25
T_7	37.25	43.32	8.75	10.00	27.00
T_8	38.30	44.00	10.00	10.20	26.50
T_9	37.20	40.20	9.50	9.25	27.00
MEAN	37.54	39.02	8.71	9.30	27.82
SED	1.1020	0.9465	0.4877	0.6548	0.7064
CD(p=0.05)	2.3141	1.9877	1.0241	1.3751	1.4835

Table 2. Effect of seed hardening treatment with chemicals on field performance with No. of cluster per plant, No. of pods per plant, Pod weight per plant (g), Pod length (cm) and No of seeds per pod in black gram cv. VBN6.

Treatment Details	No of cluster per plant	No. of pods per plant	Pod weight per plant (g)	Pod length (cm)	No. of seeds per pod
T_0	6.50	15.20	10.90	3.69	3.60
T_1	7.55	18.50	13.30	4.70	4.25
T_2	7.80	20.50	14.00	4.60	4.50
T_3	9.25	22.50	14.50	4.67	4.88
T_4	7.22	23.20	14.70	4.77	5.60
T_5	11.50	27.00	16.80	5.85	7.00
T_6	8.50	25.50	13.80	4.50	5.35
T_7	7.95	24.20	13.90	4.70	4.95
T_8	9.70	25.75	15.00	5.02	6.25
T_9	7.85	24.00	14.90	4.88	5.00
MEAN	8.38	22.63	14.18	4.73	5.13
SED	0.4513	0.9284	0.4047	0.3029	0.3946
CD(p=0.05)	0.9477	1.9497	0.8498	0.6360	0.8287

mum plant height (38.80), no. of leaves per plant (44.00), no. of branches per plant (10.00), no. of nodules per plant (10.20), days to first flowering (26.50), no. of cluster per plant (9.70), no. of pods per plant (25.75), pod weight per plant (15.00), pod length (5.02 cm), no. of seeds per pod (6.25), pod yield per plant (27.36), no. of seeds per plant (165.75), seed yield per plant (4.50), test weight (42.00), pod yield per plant (6.90) and lowest value for compared to other treatments and control.

Discussion

Seed hardening is one of the pre-sowing seed treatment techniques, which had a significantly positive effect on different aspects of seed and seedling quality characteristics under laboratory and field conditions. The first and most crucial requirement for increased crop yield is the establishment of seedling in the soil. This mostly depends on the seed vigour and germination potential that is employed for sowing. The key elements for achieving the aim are a holistic strategy, use of reliable technologies, scientific management practices for seed production, and provision of high-quality seeds.

Due to insufficient and unequal rainfall distribution throughout the crop season, black gram, a crop that is primarily farmed as a rainfed crop in India, suffers severely at one or more stages of its growth. The use of low-quality seeds, soil drought, infrequent and variable rainfall, and bad crop management are all major contributors to the low productivity that is typical in the production of black gram. New technologies for seed management have been created to get around these obstacles. One such technology is the hardening of seeds, which offers some degree of drought tolerance during the early stages of seed germination. The following paragraphs address the impact of seed hardening treatment on various seed quality indicators, including germination rate, shoot & root lengths, seedling fresh weight & dry weights and vigour index I and II.

Seed hardening with MnSO4 @ 100 ppm had a higher germination percentage (95%) followed by CaCl2 @ 2% (93%). The least amount of seeds germinated under the untreated control. In the past, Manjunath and Dhaanoji (2011) in green gram, Srimathi *et al*. (2007) and Verma *et al.* (2006) in mung bean reported findings that were comparable. Black gram seeds hardened with MnSO4 also showed improved seedling characteristics, including larger root length (19.29 cm), shoot length (22.20 cm) and vigour index-I (3819.00). According to Dharmalingam and Basu (1999), chemical treatment that may have changed the membrane system in

Table 3. Effect of seed hardening treatment with chemicals on field performance with No. of seeds per plant, Seed yield per plant(g), Test weight, Pod yield per plant(g) and Root length(cm) in black gram cv. VBN6.

Treatment Details	No of seeds per plant	Seed yield per plant (g)	Test weight	Pod yield per plant (g)	Root length (cm)
T_0	120.50	2.58	35.50	5.50	16.70
T_1	135.60	3.00	37.20	6.50	17.00
T_2	144.21	3.15	38.80	6.76	17.25
T_3	150.25	3.20	39.25	6.82	17.50
T_4	152.50	3.40	38.90	6.88	17.90
T_5	180.20	5.27	43.83	7.35	19.29
T_6	155.60	3.60	40.25	6.70	16.90
T_7	156.75	3.72	41.30	6.60	17.90
T_8	165.75	4.50	42.00	6.90	18.10
T_9	160.20	3.80	41.20	6.66	17.80
MEAN	152.15	3.62	39.82	6.66	17.63
SED	0.6194	0.3061	0.4117	0.2482	0.3436
CD(p=0.05)	1.3008	0.6428	0.8646	0.5212	0.7216

Table 4. Effect of seed hardening treatment with chemicals on field performance with Shoot length(cm), Seedling length(cm), Seedling fresh weight(g), Seedling dry weight(g) and Vigour Index-I in black gram cv. VBN6.

Treatment Details	Shoot length (cm)	Seedling length (cm)	Seedling fresh weight (g)	Seedling dry weight (g)	Vigour Index-I
T_0	17.90	35.60	0.98	0.11	2919.20
T_1	18.80	37.70	1.15	0.14	3242.20
T_2	18.99	38.20	1.32	0.15	3438.00
T_3	19.25	38.60	1.21	0.13	3435.40
T_4	19.56	38.40	1.34	0.12	3379.20
T_5	22.20	40.20	1.45	0.19	3819.00
T_6	20.00	38.90	1.28	0.16	3578.80
T_7	20.35	37.96	1.30	0.14	3188.64
T_8	21.20	39.10	1.40	0.17	3636.30
T_9	20.50	38.30	1.27	0.15	3447.00
MEAN	19.87	38.29	1.27	0.14	3408.37
SED	0.3476	0.3716	0.1504	0.0314	0.5216
CD(p=0.05)	0.7300	0.7804	0.3159	0.0658	1.0954

Table 5. Effect of seed hardening treatment with chemicals on field performance with Vigour Index-II, Germination percentage (%), Accumulated speed of germination, Mean daily germination and emergence Index in black gram cv. VBN6.

Treatment details	Vigour Index-II	Germination percentage (%)	Accumulated speed of germination	Mean daily germination	Emergence index
T_0	8.25	75.00	33.24	7.02	2.10
T_1	12.04	86.00	36.34	8.94	2.26
T_2	13.50	90.00	54.31	11.74	2.78
T_3	11.57	89.00	39.81	9.47	2.42
T_4	10.56	88.00	57.75	12.22	3.12
T_5	18.05	95.00	42.32	10.63	2.37
T_6	14.72	92.00	40.53	10.00	2.40
T_7	11.76	84.00	41.22	10.25	2.39
T_8	15.79	93.00	37.87	9.74	2.55
T_9	13.50	90.00	50.87	8.79	2.50
MEAN	12.97	88.20	43.40	9.88	2.48
SED	0.1871	88.20	0.9152	0.2317	0.0503
CD(p=0.05)	0.3929	0.9467	1.9219	0.4866	0.1056

sunflower may have improved germination and vigour.

Data on physiological and morpho-physiological parameters of black gram revealed significantly higher plant height T_5 (40.00 cm) followed by T_8 (38.80), while as lowest plant height in control T_0 (34.40). (Table 1). This clearly indicates mode of action differs for the chemicals studied. Seed hardening with MnSO4@100 ppm increased the plant height this may be due to redistribution of nutrient reserves leading to cell enlargement and increase in normal cell division. These findings were in accordance with the work of Karivartharaju and Ramakrishnan (1985) in finger millet. Increase in TDM, leaf dry matter, shoot dry matter and redistribution of dry matter in reproductive parts is noticed with seed hardening with MnSO4@ 100 ppm as compared to control. Increase in leaf dry weight might be due to metabolic changes like high level of synthesis reaction even during drought, leaves of hardened plants have more starch, higher rate of photosynthesis because of increase in the bound water and higher organic phosphorous and nucleoproteins. The treatment of MnS04@100 ppm leads to redistribution of nutrient reserves which results in the greater internodal length and thereby increases the shoot dry weight.

The seeds of MnSO4 @ 100 ppm had the highest number of pods per plant (27.00) followed by $CaCl_2$ @ 2% (25.75) and the lowest number of pods per plant (15.20) (Table 2). Higher pod yields per plant were achieved with seeds treated with MnSO4 @ 100 ppm (7.35) and $CaCl_2$ @ 2% (6.90), whereas control seeds produced the lowest pod yields per plant. Lower seed yield per plant (2.58 g) was observed in the control, but higher seed output per plant (5.27 g) was reported with the seed treatment of MnSO4 @ 100 ppm followed by CaCl2 @ 2% (4.50 g). Verma *et al*. (2006) found same results in black gram.

Conclusion

The study revealed that seed hardening with $MnSO_4$@100 ppm recorded the higher seed yield and seed quality, when compared to other treatments and control.

Conflict of Interest: None

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