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Effect of seed hardening chemicals on morpho-physiological attributes in green gram (*Vigna radiata* L.)

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Abstract
The present investigation was carried out to study the effect of seed hardening on morpho-physiological parameters in green gram. The green gram *var.* GAM-5 was imposed with various seed hardening treatments *i.e*., 2% $CaCl_2$, 500 ppm Cycocel, 1000 ppm Cycocel, 25 ppm NAA, 50 ppm NAA, water soaked control and absolute control. The above treated seeds along with control were evaluated for their seed quality parameters, morpho-physiological parameters under laboratory condition. The study revealed that seeds hardened with $CaCl_2$ @ 2% recorded higher germination per cent, root length, fresh weight of shoot, turgor shoot weight, shoot dry weight, root fresh weight, root turgor weight, root dry weight, seed vigour index I & II and root to shoot ratio. The treatments $CaCl_2$ 2% followed by Cycocel 1000 ppm were found to be superior for most physiological parameters as compared to other treatments and control on the basis of lab studies.

Keywords: greengram**,** seed hardening**,** $CaCl_2$, cycocel, NAA, morpho-physiological parameters

Introduction
Mung bean (*Vigna radiata* L.) is commonly known as moong, golden gram, mug, or mung. It belongs to the family *Leguminoceae (Fabaceae)* and had originated from India and Central Asia. Mung bean is one of the important pulse crops and rank third in area and production after pigeonpea and chickpea. Mung bean is grown in almost all parts of the country over a wide range of agro-climatic conditions. India is the largest producer of mung bean in the world. It accounts for almost 65 per cent of area and 54 per cent of production of the world. According to the 3rd advance estimate in the year 2015 in India it is grown on an area of 3.38 million ha with the production of 1.61 million tones and productivity of 474 kg/ha. It is obvious from these figures that the productivity of mung bean is low.

In addition to being an important source of human food and animal feed, pulses play an important role in maintaining the soil fertility in sustainable manner. It is a drought resistant crop and suitable for dry land farming and predominantly used as an intercrop with other crops. It is a very good catch crop in summer and can be grown very well in this season. Mung bean is a short duration, low input requiring crop that matures in 65 to 80 days, photo and thermo-insensitive in nature. It adds about 40 kg N ha^{-1} in the soil by fixing the atmospheric N which is subsequently beneficial to succeeding crops. Mung bean is typically a quantitative short day plant.

Efforts made to maximize yield, is largely hampered by adverse effect of a biotic stress such as salinity and drought. These effects cause a huge loss due to low yield and failure of the crop to establish in some cases. Pre-sowing hardening seed treatment is an easy, low cost and low risk technique and also an alternative approach recently used to overcome the effect of abiotic stresses in agricultural production. It is found to be efficient in improving seed emergence and growth of crops (Sankar Ganesh *et al.*, 2013) [14]. It was reported clearly that the hardening treatment enhance seeds vigour by protecting structure of the plasma membrane against injury during stress (Bewley and Black, 1982 [3]; JunMin *et al*., 2000) [5]. It is a well-established fact that, pre-soaking seeds with optimal concentration of phytohormones enhance their germination, growth and yield of some crop species under condition of environmental stress by increasing nutrient reserves through increased physiological activities and root proliferation (Bozeuk, 1981) [4].

Considering the constraints in the production potential of mung bean it is worthwhile to study the influence of different seed hardening treatments on the production potential of mung bean. It is also of utmost importance to understand the physiological basis of yield variation due to seed hardening of various growth regulators and chemicals.

Materials & Methods

The present investigation was carried out at the Department of Plant Physiology, Anand Agricultural University, Anand to study the influence of various seed hardening treatments on morpho-physiological parameters in green gram. The laboratory trial was laid out in CRD with three repetitions. Seeds of green gram *var*. GAM- 5 were imposed with the following seed treatments.

T1: Absolute Control, T2: Water soaked control, T3: $CaCl_2$ @ 2%, T4: 500 ppm Cycocel, T5: 1000 ppm Cycocel, T6: 25 ppm NAA and T7: 50 ppm NAA.

A day before sowing, under laboratory conditions, seeds of green gram variety GAM-5 were soaked for three hours separately in solutions of distilled water, $CaCl_2$ @ 2%, Cycocel 500 ppm, Cycocel 1000 ppm, NAA 25 ppm, NAA 50 ppm and absolute control. Later seeds were dried under shade for eighteen hours and sown on moist germination paper next day. In each treatment 100 seeds were sown and this was repeated three times. The rolled germination papers were kept in seed germinator at 25^0C at proper moisture. The seeds were inspected at interval and moistened regularly with water.

Ten seedlings from each treatment were selected randomly for the purpose of recording morpho- physiological parameters. Root and shoot length were recorded by measuring the length using a meter scale and the mean value was expressed in centimeter. Randomly selected ten seedling samples were separated into root and shoot and dried in oven at 80°C until constant weight was obtained. After drying the seedlings were used to dry weight measurement. Observation were recorded for germination percentage, shoot and root length (cm), fresh, turgor and dry weight of shoot and root, moisture content (%), relative water content (%), root/shoot ratio on dry weight basis, vigour index-I & II. The data were statistically analyzed using ANOVA.

Results & Discussion

The effect of different seed hardening treatments on germination, seedling growth, vigour was studied in green gram var. GAM-5, under laboratory condition. The result revealed in table 1, that all physiological parameters were significant in different seed hardening treatments, indicating positive influence on these parameters.

The data on morpho-physiological parameters of green gram revealed significantly higher germination per cent (86.66%) and better crop establishment in seed hardening with 2% $CaCl_2$ i.e. treatment T3, where as lower germination per cent observed in absolute control T1 (72.33%). These findings were in accordance with the work of Prajapati *et al.* (2017) [10] in black gram and Patil *et al*. (2014) [9] in cotton. The shoot length was significantly higher (16.28 cm) with treatment T5, cycocel 1000 ppm, followed by T3 (15.68 cm) as compared to T1 (10.08 cm) while root length was highest in T3 treatment (14.80 cm) as compare to other treatments. The values for fresh weight, turgor weight and dry weight of shoot of $CaCl_2$ 2% seed hardening showed significantly highest as compared to absolute control but at par with cycocel 1000 ppm, 500 ppm, NAA 50 ppm and 25 ppm. The $CaCl_2$ 2% treatment showed significantly highest fresh weight, turgor weight and dry weight of root as compared to all other treatments. Seed hardening with 2% $CaCl_2$ increased the germination percentage, this may be due to redistribution of nutrient reserves leading to cell enlargement and increase in normal cell division, greater internodal length and thereby increases the shoot dry weight. These findings were in accordance with the work of Karivartharaju and Ramakrishnan (1985) [6] in finger millet, Misra and Dwivedi (1980) [8], Singh *et al*. (1991) [15] in wheat and Sankar Ganesh *et al.* (2013) [14] in green gram.

The $CaCl_2$ 2% seed hardening recorded significantly higher root to shoot ratio on dry weight basis (0.351) as compared to all other treatments. Solaimalai and Subburamu, (2004) [16] found same results in rainfed crops. The moisture content and relative water content per cent (RWC %) for all treatments showed statistically non-significant results. However, NAA 50 ppm treatment found numerically higher moisture content (2327.56) and RWC per cent (93.59%). These findings were in accordance with the work of Manjunath and Dhanoji (2011) [7].

The analysis of data indicated significant differences were found for seed vigour index I and II due to various treatments. Pre-sowing seed hardening with T3 recorded significantly higher vigour index I (2641.39) as compared to control but remained at par with T5 (2545.92) and T7 (2362.42). Among the treatments, T3 recorded significantly highest vigour index II (2224.56) as compared to other treatments and lower (1236.12) recorded in T1.

Increased in vigour index I & II by seed hardening with 2% $CaCl_2$ was due to higher seed germination per cent and increased in shoot, root length & dry weight. The results obtained from this study were in accordance with those reported by Ananthi *et al.* (2013) [2] in green gram, Rangaswamy *et al*. (1993) [13] in red gram, Punithavathi and Palaniswamy (2001) [12] in finger millet, Surulirajan (2007) [17] in black gram and Prakash *et al.* (2013) [11] in rice seed.

Table 1: Effect of seed hardening on Morpho-physiological parameters in Green gram variety GAM-5

Treatments	Percent germination	Shoot length (cm)	Root length (cm)	Fresh wt. of shoot (mg)	Turgor wt. of shoot (mg)	Dry wt. of shoot (mg)
T1 - Absolute Control	72.33	10.08	9.07	366.66	403.66	15.00
T2 – Water Soaked Control	78.00	10.94	9.84	405.33	448.00	17.00
T3 - $CaCl_2$ – 2%	86.66	15.68	14.80	472.33	501.66	19.00
T4 - Cycocel 500 ppm	82.66	13.35	12.59	442.33	474.00	18.00
T5 - Cycocel 1000 ppm	84.33	16.28	13.91	460.66	496.66	18.66
T6 - NAA 25 ppm	80.00	13.28	11.83	430.66	464.66	18.00
T7 - NAA 50 ppm	82.66	15.37	13.21	459.00	475.00	18.33
S. Em. +/-	1.12	0.89	1.01	20.00	17.58	0.77
CD at 5% C	3.41	2.71	3.05	60.69	53.35	2.35
CV %	2.41	11.44	14.29	7.98	6.46	7.59

Table 1: Continue…

Treatments	Fresh wt. of root (mg)	Turgor wt. of root (mg)	Dry wt. of root (mg)	Moisture content	Relative water content (%)	Root/Shoot ratio on dry wt. basis	Seed Vigour Index-I	Seed Vigour Index-II
T1 - Absolute Control	41.13	47.36	2.09	2281.49	89.77	0.139	1385.12	1236.12
T2 - Water Soaked Control	42.03	57.20	2.27	2233.50	88.12	0.134	1620.84	1503.60
T3 - $CaCl_2$ – 2%	138.13	170.23	6.67	2276.85	90.52	0.351	2641.39	2224.56
T4 - Cycocel 500 ppm	56.63	75.80	2.92	2287.29	85.03	0.162	2144.20	1729.24
T5 - Cycocel 1000 ppm	104.90	127.86	4.77	2311.29	90.18	0.256	2545.92	1975.85
T6 - NAA 25 ppm	51.10	73.03	2.71	2229.24	89.41	0.151	2008.80	1656.80
T7 - NAA 50 ppm	70.90	89.26	3.52	2327.56	93.59	0.192	2362.42	1806.94
S. Em. +/-	2.34	3.39	0.14	94.86	3.21	0.016	148.51	66.38
CD at 5% C	7.11	10.28	0.43	NS	NS	0.048	457.59	204.53
CV %	5.64	6.41	6.89	7.21	6.21	13.69	12.23	6.63

Abdul-Baki and Anderson (1973) [1] (SVI-I= Seedling length X Germination % and SVI-II= Seedling Dry wt. X Germination % formula is most used in studies)

Conclusion

On the basis of above finding it can be concluded that pre sowing seed hardening with 2% $CaCl_2$ and cycocel 1000 ppm played an effective role in improving morpho-physiological characters in green gram. Seed germination and initial growth enhanced which helps in better establishment of seedling during early growth. Improvement of seed quality by seed hardening with 2% $CaCl_2$ or 1000 ppm cycocel is a simple and easy approach to enhance the germination, vigour, overall seed performance and thereby agricultural productivity especially in the dry land and marginal lands of resource poor farmers. This clearly indicates mode of action differs for the chemicals studied.

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