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Enhancement on seedling morphological and physiological characteristics of green gram seeds through presowing seed treatment

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Abstract
The present investigation was carried out to study the effect of various presowing seed conditioning treatment on seedling morphological and physiological characteristics of green gram seeds by using various chemicals, biofertilizer and organic product and tested for their seed quality under laboratory condition. Freshly harvested, cleaned and graded seeds of green gram were imposed with the following seed treatments *viz.*,T_0-Control (Untreated dry seed), T_1 - NaCl @ 1%, T_2-Mannitol @ 1%, T_3 = T_1 + T_2,T_4 - Flyash @ 250 gm/kg of seeds, T_5 - Arappu powder @ 250 gm/kg of seeds,T_6 - T_4 + T_5, T_7 - *Prosopis* leaf extract @ 1%, T_8 – Pungam leaf extract @ 1%, T_9 – T_7 +T_8,T_{10} – *Rhizobium* @ 600 gm/ha, T_{11}-*Azospirillum* @ 600 gm/ha, T_{12}-T_{10} +T_{11},T_{13} - $MgSO_4$ @ 100 ppm, T_{14} - $MnSO_4$ @ 100 ppm, T_{15}-T_{13} + T_{14}. From the results, it was found that seed hardened with 1% *Prosopis* + 1% Pungam leaf extract recorded significantly higher values for the speed of germination, germination percent, accumulated speed of germination, Emergence index, Germination value, root length, shoot length, dry matter production, seedling vigour I and seedling vigour II under laboratory test. Thus the present experiment clearly indicated that the promising effect of seed hardening with 1% *Prosopis* and 1% *Pungam* leaf extract followed by $MnSO_4$ (100 ppm) seed priming could be recommended for improving the seed and seedling quality parameters.

Keywords: Green gram, Seed quality, Prosopis and Pungam leaf extract @1, $MnSO_4$.

Introduction
Agriculture in its present form must cater to the food, fibre, fuel and a feed stock need of the increasing world's human population which was 1.5 billion at the beginning of the last century, increased to 6.08 billion today, and is estimated to reach 8.3 billion by 2025 AD. To obtain this target of higher yield from crops without causing any adverse effect to the environment is an essential concern of today which can be achieved by the way of practicing sustainable agriculture, taking into account of the prevailing different eco-systems of our country. A clear understanding of the problems encountered in each eco-system will pave way to use quality seeds by applying appropriate technologies for profitable crop production, since the quality seed is essential and cheapest input in agriculture and it plays a critical role in boosting up the productivity and economy of the country.

Modern agriculture with its bias for technology and precision, demands that each and every seed should readily germinate and produce a vigorous seedlings ensuring high yield. Uniformity of growth and synchrony in development are highly desirable characters for mechanized cultural operations. In India, pulses are largely grown in rainfed areas (87%) and poor crop management. Instability in production are due to the facts such as being rainfed crop, crop experiences drought at critical growth stages, highly sensitive to abiotic stresses (temperature extremities, excessive moisture & salinity), vulnerable to a large number of diseases and infestation with several insect pests. In addition to above facts for low yield and production, the high night temperature coupled with unpredictable weather condition (both high and low) adversely affecting reproductive physiology and grain filling and widening the scopes of spreading diseases and pest incidence in more disastrous form.

Hence, the productivity of green gram could be improved by improving the per cent field emergence. The time from planting to seedling establishment is a crucial phase in the production cycle. The period of imbibition is extremely sensitive to changes in the environment, and slight or sudden changes appear to profound effect on seedling emergence (Khan *et al.*, 1978) [12]. Establishment of seedling in the soil is an important and foremost need for better crop production. This depends largely on the germination and vigour potential of seeds used for sowing. To achieve the goal, holistic approach such as adaptation of sound and proven technology, scientific management practice on seed production and supply of good

quality seeds for achieving higher productivity. Rapid germination and emergence is an important determinant of successful establishment (Heydecker, 1973) [9]. With this background, study was undertaken in green gram to evaluate the influence of various presowing seed enhancement techniques such as seed hardening, seed bio-inoculant, seed pelleting and seed priming on seed quality parameters.

Materials and Method

The collected bulk seeds of green gram ADT3 were manually cleaned to remove unwanted material from the lot and was graded using BSS 8 x 8 sieve for uniformity. After cleaning and grading, seeds were preconditioned by keeping the seeds in between the layers of moistened gunny bags to avoid soaking injury for one hour. After preconditioning, the conditioned seeds were imposed with the following seed treatments.

T_0 – Control (Untreated dry seed)
T_1 – Nacl @ 1%
T_2 – Mannitol @ 1%
T_3 – $T_1 + T_2$
T_4 – Flyash @ 250 gm/kg of seeds
T_5 – Arappu powder @ 250 gm/kg of seeds
T_6 – $T_4 + T_5$
T_7 – *Prosopis* leaf extract @ 1%
T_8 – Pungam leaf extract @ 1%
T_9 – $T_7 + T_8$
T_{10} – *Rhizobium* @ 600 gm/ha
T_{11} – *Azospirillum* @ 600 gm/ha
T_{12} – $T_{10} + T_{11}$
T_{13} – $MgSO_4$ @ 100 ppm
T_{14} – $MnSO_4$ @ 100 ppm
T_{15} – $T_{13} + T_{14}$

Then the seeds were air dried under the shade to bring back to their original moisture content and used for sowing. The experiment was adopted in completely randomized design with 16 treatments along with dry seed (Control) and replicated four times. The treated seed along with control were evaluated for the following seed quality parameters *viz.*, speed of germination (Maguire, 1962) [14], germination percent (ISTA, 2013) [10], accumulated speed of germination (Bradbeer, 1988) [4], Germination value (Djavanshir and Pourbeik, 1976) [7], Emergence index (Scott *et al.*, 1984) [24], root length, shoot length, dry matter production (Gupta *et al.*, 1993) [8], seedling vigour I (Abdul-Baki and Anderson, 1973) [1] and seedling vigour II (Abdul-Baki and Anderson,1973) [1]. The data was analyzed statistically adopting the procedure described by Panse and Sukhatme (1985) [19].

Result and Discussion

In the present study, green gram seeds subjected to various presowing seed treatment using various chemicals, biofertilizer and organic product are tested for their seed quality under lab condition. The initial seed quality parameters were evaluated by estimating its germination percentage, speed of germination, accumulated speed of germination, germination value, Emergence index, root length, shoot length, dry matter production, seedling vigour I and seedling vigour II. Seeds were subjected to various presowing treatment like osmotic priming, seed pelleting, seed hardening, bio-inoculant treatment and nutrient priming. The highest speed of germination (16.00) was recorded in T_9 followed by T_{14} (15.88) and T_7 (15.64) while the lowest speed of germination was recorded in T_1 (10.31). NaCl primed seed registered the lowest speed of germination and germination percent may be due to the disruption of K^+ nutrition and inhibits many enzymes activity which disturb the germination process (Sankar *et al.*, 2006) [23]. This may also leads to the inhibition of cell division and cell expansion which results in differentiation of the embryonic cells.

Increase in speed of germination and germination percent in case of T_9 may be due to the effect of hardening process (Krishnasamy and Srimathi, 2001) [13] which attributed to more absorption of water due to increase in the cell wall elasticity and development of stronger and efficient root system. Due to hydration process in seed hardening and seed priming, there was a greater hydration of colloids and higher viscosity of protoplasm and cell membrane that allows the early entrance of moisture that activates the early hydrolysis of the food material by triggering the hydrolyzing enzyme and also activates the GA_3 in the seed. Mineral nutrients present in the leaf extract of *Prosopis* and *Pungam* could activities GA_3, auxin like substance by synergistically interacting with amino acid like tryptophan to bring about enhancement in speed of germination. This was in conformity with Rathinavel and Dharmalingam (1999) [21].

Beside this, presence of sulphur compound in the priming treatment material induces the DNA synthesis and mRNA repair mechanism (Chiu *et al.*, 1995) [5]. This physiological enhancement during germination process advances the seed furthers quicken the emergenceof radicle and made advancement in seedling emergence. It also reported that manganese accelerate the enzyme activity during germination process (Pandey and Sinha, 1999) [18] and sulphur in SO_4^{2-} helps in energy transfer during germination process, resulted in higher germination percent and high speed of germination (Srimathi *et al.*, 2007) [26]. The probable reason for early and higher germination may be the completion of pre germination metabolic activities, making the seed ready for radicle protrusion.

In case of T_1, speed of germination and germination percent was affected due to toxic effect of ions on embryo viability and also due to the inhibitory effect of NaCl on cell division and enlargement in the growing point. Decrease in germination and speed of germination might be due to hydration of seeds during priming makes the cell wall more permeable to NaCl which inhibits the radicle emergence or due tothe production of weak coleoptile and root growth. Reduction in germination indices like speed of germination percent, accumulated speed of germination, germination value and other values indicates that NaCl could affect germination as by the ionic effect, as by ion cell reaching toxic levels or by combination of both (Jeannette *et al.*, 2002) [11]. These results might be attributed to the reduction of water potential. Decrease in germination percentage was in conformity with Misra and Diwedi (2004) [17] in green gram. Similar trend was registered in other germination indices like mean time germination, mean daily germination and emergence index

Higher values for germination indices in case of T_9 might be due to the stimulating effect of seed hardening and botanicals which increased the conversion of reserve food materials of GA_3 like substance in leaf powder which might have triggered the germination process which leads to the early emergence and reduced the mean time of germination. Increase in germination value may be due to the presence of mineral nutrients in both the leaf extract like N, P, K, Ca, S etc. which indices the germination process as calcium acts as an enzyme cofactor in germination process (Christansen and Foy, 1979).

The presence of saponins, tannins, flavonoids, glycosides and phenolic compounds in *Prosopis* and *Pungam* leaf extract (Behera *et al.,* 2012) [3] would have triggered the germination process earlier and may enhanced the nutrient absorption thereby increase the germination indices (Rathinavel *et al.,* 2000) [22].

The seedlings from T_1 failed to mobilize the reserve food materials from the seeds during the initial period of germination because most of the energy was utilized to maintain the imbalance due to ionic effect of Na^+. But in case of T_9, the seedlings made up the loss by using the improved synthesis of secondary metabolites and increase in other physiological processes that leads to enhanced germination indices. The increase in germination indices may be due to the cumulative increase in germination and speed of germination over other treatments.

The beneficial effect of T_9 on seedling growth, dry matter production and seedling vigour might be due to the cumulative effect of seed hardening and nutrients present in the leaf extract which in the seedling length and dry matter of the seedling. Increased seedling, growth might be due to the early emergence and availability of nutrients like N which favours vigorous vegetative growth and early emergence of seedlings. It also makes the availability of nutrients to the growing seedling without competition from other seedlings. Physiological active substance and growth promoting substances like GA_3 present in both leaf extract might have induces the vigour of the seeds (Rathinavel and Dharmalingam, 1999) [21].

In case of T_1, reduced seedling length, dry matter production and seedling vigour might be due to the growth reduction caused by the declining in the cellular processes and carbohydrate synthesis which leads to behave the plants highly susceptible to water deficit and the growth decrease was a consequence of the turgescence laying down of those cells (Shalhevet *et al.,* 1995) [25]. According to Marur *et al.* (1994) [15], Water restriction slows down the physiological and biochemical processes and weak growing leading to a lower accumulation of dry matter. Water deficit reduced the hypocotyl and root length which directly linked to cell elongation. It might also due to the decrease of water activity and the metabolic pathways can be disturbed causing some imbalance in the energy production and consumption which leads to the lower vigorous seedling and poor dry matter accumulation as sodium chloride affects the growth and development.

In case of T_{14}, increased seedling length, dry matter production and seedling vigour might be due to the metabolic repair during imbibition (Bray *et al.,* 1989) and buildup of germination enhancing metabolites. In nutrient priming, manganese act as a cofactor in enzyme system and participate in redox reactions. It also evolves in auto tropism as primed seeds well in advance in autotrophic stage thereby synthesis their own food. Manganese evolved plays a key role in physiological processes of photosynthesis and respiration (Mengel *et al.,* 2001) [16]. Emergence enhancement and seedling growth may be attributed to metabolic repair processes, a buildup of germination metabolites (Assefa and Hunge, 2011) [2]. Mn activating physiological and biochemical processes results in increased dry matter production it would be due to the key role in auxin metabolism. Similar reports of increased dry matter production with Mn application were reported by Prakash *et al.* (2011) [20] in Blackgram. The micronutrient might have been absorbed by the seed during priming process and have promoted the various enzymatic processes leading faster cell division and radicle emergence besides improving seed germination (Vanangamudi and Kavivaratharaju, 1986) [27]. Mn application increased the translocation of assimilates resulting in increased dry matter accumulation and seedling vigour.

Thus the result clearly indicated that the promising effect of seed hardening with 1% *Prosopis* and 1% *Pungam* leaf extract followed by $MnSO_4$ (100 ppm) seed priming for improving the seed and seedling quality parameters.

Table 1: Effect of pre-sowing seed enhancement treatment on physiological characteristics of seedlings in green gram.

Treatment	Speed of germination	Germination (%)	Accumulated speed of germination	Emergence index	Germination value
T_0	12.73	81.33 (64.43)	44.97	2.80	1294.89
T_1	10.11	62.67 (52.38)	36.16	2.04	796.39
T_2	13.34	78.67 (62.52)	47.57	2.45	1312.22
T_3	13.97	82.67 (65.54)	49.89	2.59	1448.89
T_4	14.78	89.33 (71.01)	52.95	2.83	1650.83
T_5	14.00	85.33 (67.63)	50.07	2.73	1495.56
T_6	14.17	84.00 (66.53)	50.74	2.69	1488.33
T_7	15.50	90.67 (72.29)	55.43	2.79	1757.22
T_8	15.34	89.33 (71.01)	54.84	2.73	1712.78
T_9	16.06	94.67 (76.83)	57.42	2.93	1900.56
T_{10}	15.00	92.00 (73.92)	53.69	2.96	1726.67
T_{11}	14.11	86.67 (68.63)	50.44	2.80	1529.17
T_{12}	14.66	90.67 (72.29)	52.43	2.95	1662.78
T_{13}	14.94	86.67 (68.63)	53.37	2.73	1618.89
T_{14}	15.84	93.33 (75.55)	56.61	2.89	1849.44
T_{15}	14.72	85.33 (67.52)	52.63	2.60	1571.11
Mean	14.33	85.83 (68.54)	51.20	2.72	1550.93
S.E.D	0.2863	1.9734 (1.6188)	1.0285	0.0708	60.9856
CD (P=0.05)	0.5669	3.9073 (3.2052)	2.0364	0.1403	120.7515

Table 2: Effect of pre-sowing seed enhancement treatment on morphological characteristics of seedlings in green gram.

Treatment	Root length (cm)	Shoot length (cm)	Dry matter production (g/10 seedlings)	Seedling vigour index I	Seedling vigour index II
T_0	8.53	16.87	0.1393	2066.09	11.33
T_1	7.21	16.35	0.1273	1478.61	7.83
T_2	9.60	17.22	0.1613	2108.48	12.70
T_3	9.18	17.17	0.1570	2180.56	12.95
T_4	8.42	17.88	0.1607	2349.33	14.35
T_5	7.78	17.55	0.1573	2162.13	13.39
T_6	9.03	18.67	0.1707	2328.08	14.32
T_7	14.83	19.97	0.1940	3154.32	17.58
T_8	14.37	18.91	0.1767	2972.75	15.78
T_9	15.80	20.60	0.2110	3445.60	19.95
T_{10}	10.57	19.33	0.1797	2751.84	16.55
T_{11}	10.03	18.50	0.1613	2507.84	13.99
T_{12}	10.77	19.80	0.2037	2772.57	18.46
T_{13}	9.17	17.30	0.1637	2293.57	14.20
T_{14}	11.63	20.19	0.1970	2970.99	18.38
T_{15}	9.92	17.33	0.1743	2364.89	14.87
Mean	10.43	18.38	0.1709	2494.23	14.79
S.E.D	0.2965	0.4598	0.0043	84.2809	0.4630
CD (P=0.05)	0.5871	0.9104	0.0086	166.8762	0.9167

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