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Effect of seed hardening on morpho-physiological and yield parameters in black gram (*Vigna mungo* L.)

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Abstract

The present investigations were carried out to study the effect of seed hardening on morpho-physiological and yield parameters in black gram. The black gram *var.* GU-1 was imposed with various seed hardening treatments *i.e*., $CaCl_2$ @ 2%, 500 ppm Cycocel, 1000 ppm Cycocel, 25 ppm NAA, 50 ppm NAA, 150 ppm KNO_3, 150 ppm KCl and Absolute Control. The above treated seeds along with control were evaluated for their seed quality parameters, morpho-physiological and yield parameters under field condition. The study revealed that seeds hardened with $CaCl_2$ @ 2% recorded higher plant height (36.40 cm), leaf area (544.40 cm^2), leaf dry weight (10.64 g), shoot dry weight (24.81 g), total dry weight (35.10 g), seed yield (4.36 g/ plant), 100 seed weight (4.74 g) and seed yield (821 kg/ha) at harvest as compared to other treatments and control.

Keywords: Black gram**,** Seed hardening**,** 2% $CaCl_2$, Cycocel, Morpho-physiological and yield characters

Introduction

Pulses have great importance in Indian agriculture as they are rich source of protein as compared to that of cereals. Keeping in view many benefits of pulses for human health, United Nations has proclaimed 2016 as the International Year of Pulses. Thus, due attention is required to enhance the production of pulses for not only meet the dietary requirement of protein but also to raise the awareness about pulses for achieving nutritional, food security and environmental sustainability. Pulses are important component to sustain the agricultural production as the pulse crops possess wide adaptability to fit into various cropping systems, being leguminous in nature improve the soil fertility and physical health of soil while making soil more porous due to tap root system. India is producing 14.76 million tons of pulses from an area of 23.63 million hectare, which is one of the largest pulses producing countries in the world. In Gujarat, area under black gram cultivation is 0.58 million ha and productivity is 671 kg/ha. (Anon., 2016) [1]. Thus, there is a need to increase production and productivity of pulses in the country by more intensive interventions.

Rapid and uniform field emergence is the essential pre-requisites for the increased yield and quality. Rainfed agriculture is one of the adverse agro ecological situations where the success of crop depends on proper management practices to resist against drought. The area under cultivation for various crops has almost reached a saturation point in current years. Scientists are focusing their research towards regulation of plant growth as an important factor in improving the yield and quality with application of plant growth regulators are in practice. The various efforts are being made to boost the yield of black gram but the achievement is not up to expectation in spite of all these efforts. 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 is one of the methods of pre-sowing treatment to the seeds, which results in modifying the physiological and bio-chemical nature of seed so as to get the character that favours drought resistance. Hardening induces early germination, better root and seedling growth, reduces seedling mortality, increases crop population and thereby enhances the yield potential of the crop varieties.

Materials & Methods

The present investigations were 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 black gram. The trial was laid out in RBD with four replications. Seeds of black gram *var*. GU- 1 were imposed with the following seed treatments.

T_1: $CaCl_2$ @ 2%, T_2: 500 ppm Cycocel, T_3: 1000 ppm Cycocel, T_4: 25 ppm NAA, T_5: 50 ppm NAA, T_6: 150 ppm KNO_3, T_7: 150 ppm KCl and T_8: Absolute Control.

A day before sowing, seeds of black gram variety GU-1 were soaked for three hours separately in solution of $CaCl_2$ @ 2%, Cycocel 1000 ppm, Cycocel 500 ppm, NAA 50 ppm, NAA 25 ppm, $KNO_3$150 ppm, KCl 150 ppm and absolute control. Later seeds were dried under shade and used for sowing.

Five plants from each plot were selected randomly and tagged for the purpose of recording morpho- physiological, biochemical and yield parameters at different stages of growth period. Plant height was recorded by measuring the height of plant from ground level to the tip of main branch using a meter scale and the mean value was expressed in centimeter. Randomly selected five plant samples were separated into leaf, stem and reproductive parts and dried in oven at 80˚C until constant weight was obtained. Total dry matter was calculated by adding dry weight of different plant parts and expressed as grams per plant at different intervals of crop growth period. Leaf area/plant was taken with the help of Leaf area meter (Model- 3100).

The leaf area index was calculated by dividing the leaf area per plant by land area occupied by the plant (Sestak *et al*., 1971) [17]. Leaf area ratio was worked out as per the procedure given by Radford (1967) [16] and expressed in cm^2/g. Crop growth rate is the increase in dry matter accumulation of any plant part or whole plants per unit time per area. It is expressed in g/m^2/day. It is first studied by Watson in 1956.

Four replicates of 100 seeds were drawn from each treatment randomly, weighed in an electronic balance and the mean weight was expressed as 100 seed weight in grams. The five tagged plants were uprooted at maturity and processed for seed yield from which the average was calculated and expressed as seed yield per plant (g). The plants harvested from net plot were threshed, clean, sun dried for five days and then grain weight per plot was recorded separately for each treatment. This was further converted on hectare basis. Harvest index is the ratio of economic yield to the biological yield. It was calculated by using following formula suggested by Donald and Hamblin (1976) [4].

Results & Discussion

Morpho-physiological parameters

The data on morpho-physiological parameters of black gram revealed significantly higher plant height (36.40 cm) in seed hardening with 2% $CaCl_2$, where as lower plant height in control (30.15 cm) at harvesting stage. This clearly indicates mode of action differs for the chemicals studied. Seed hardening with 2% $CaCl_2$ 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) [10] 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 2% $CaCl_2$ as compare 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 calcium chloride leads to redistribution of nutrient reserves which results in the greater internodal length and thereby increases the shoot dry weight. These results are conformity with finding of Misra and Dwivedi (1980) [12] and Singh *et al*. (1991) [6] in wheat. Seed hardening with 2% $CaCl_2$ significantly increased total dry matter production. The increase in TDM towards maturity may be due to indeterminate growth pattern, higher rate of CO_2 fixation and RuBP carboxylase activity during crop growth. The association of TDM with grain yield was more significant at all the stages of crop growth. Similar results were also recorded by Arjunan and Srinivasan (1989) [2] in groundnut. These results are conformity with the finding of Ginzo *et al.* (1977) [5] in chick pea, Karivartharaju and Ramakrishnan (1985) [10] in red gram.

In addition higher leaf area (544.40 cm^2) was recorded with seed hardening with 2% $CaCl_2$. This might be due to increase in cell division, cell enlargement as well as induce more extensive and denser network of veins and ribs and there by increased foliar leaf area. These results are conformity with the findings of Ginzo *et al.* (1977) [5] in chick pea and Prakash *et al.* (2013) [14] in rice. Thus, TDM and its partition and leaf area were important parameters to boosting the source sink relationship, which is evident from the improvement in the yield and yield parameters.

Yield parameters

Significantly higher seed yield was recorded in seed hardening with 2% $CaCl_2$ (821 kg/ha) followed by Cycocel 1000 ppm (764 kg/ha) over control. Grain yield is the manifestation of morpho-physiological, biochemical and growth parameters. The improvement in yield according to Humphries (1979) [8] could happen in two ways *i.e*., adopting the existing varieties to grow better in their environment or by altering the relative proportion of different plant parts so as to increase the yield of economically important parts.

Table 1: Influence of seed hardening treatments on morpho-physiological and yield parameters in black gram *var.* GU-1

Treatments	Morpho-Physiological parameters							Yield attributing characters		
	Plant height (cm)	Leaf area (cm^2)	Leaf dry weight (g/plant)	Shoot dry weight (g/plant)	Total dry matter (g/plant)	Leaf area index	Crop growth rate ($g/m^2/day$)	Seed yield (g/plant)	Seed yield (kg/ha)	100 seed weight (g)
T_1: 2% $CaCl_2$	36.40	544.40	10.64	24.81	35.10	1.815	32.85	4.36	821	4.74
T_2: 500 ppm ycocel	33.41	434.27	8.47	21.35	29.99	1.448	27.93	4.15	661	4.51
T_3:1000 ppm Cycocel	35.60	512.58	10.35	23.66	33.40	1.709	31.26	4.34	764	4.72
T_4: 25 ppm NAA	31.80	415.25	8.48	20.56	28.98	1.384	27.12	4.14	641	4.50
T_5: 50 ppm NAA	34.50	443.63	8.66	21.49	30.34	1.479	28.39	4.29	679	4.66
T_6: 150 ppm KNO_3	35.20	494.76	8.71	22.58	31.84	1.649	29.80	4.33	720	4.71
T_7: 150 ppm KCl	30.80	412.15	8.25	20.53	28.83	1.374	26.98	4.06	631	4.41
T_8: Absolute control	30.15	392.64	7.88	20.48	28.76	1.309	26.91	3.98	624	4.33
S.Em. ±	0.93	24.16	0.49	0.75	0.95	0.081	0.81	0.09	4.4	0.10
C.D. @ 5%	2.74	71.06	1.43	2.19	2.78	0.237	2.39	0.26	13.1	0.29
C.V. %	5.58	10.59	10.92	6.79	6.12	10.592	5.63	4.27	12.8	4.26

The increased seed yield may be attributed to higher dry matter production and its partition in reproductive parts so increased yield components mainly 100 seeds weight, seed yield per plant. The increase in seed yield with respect to seed hardening treatments was probably due to maximum water absorbing capacity of seeds, more intense photosynthetic activity as well as more tissue hydration and thereby, enabling the plant to resist soil moisture stress more efficiently recorded by Henckel (1964) [7]. It also enhanced protein and proline content. Similar findings have been reported by Kadam *et al*. (2008) [9] in black gram, Prasad and Shrihari (2008) [15] in okra, Manjunath (2011) [11] in chick pea, Prakash *et al.* (2013) [14] in rice, Patil *et al.* (2014) [13] in cotton and Chavan *et al*. (2014) [3] in soybean.

Conclusion

On the basis of above finding it can be concluded that pre-sowing seed hardening with 2% $CaCl_2$ played an effective role in improving morpho-physiological and yield attributing characters in black gram. Improvement of seed quality by seed hardening with 2% $CaCl_2$ is a simple and easy approach to enhance the seed performance and agricultural productivity especially in the dryland and marginal lands of resource poor farmers.

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