International Journal of Botany Studies
www.botanyjournals.com
ISSN: 2455-541X
Received: 17-12-2021, Accepted: 03-01-2022, Published: 18-01-2022
Volume 7, Issue 1, 2022, Page No. 353-356

Influence of seed hardening techniques on germination and seedling characters of green gram (*Vigna radiata L.*)

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Abstract
A laboratory experiment was conducted to study the influence of seed hardening techniques on germination and seedling characters of green gram at Department of Agronomy, Faculty of Agriculture, Annamalai University during 2021. The present investigation was carried out in completely randomized design which consists of 8 treatments and replicated thrice. Seeds of green gram variety CO-3 were treated with various pre sowing seed priming chemicals *viz.*, 2% KCl, 2% CaCl2, 2% KNO3, 100 ppm ZnSO4, 100 ppm MnSO4 and 5 % nochi (*Vitex sp.*) leaf extract, distilled water and control. The study revealed that seed hardening with 2% CaCl2 improved the germination percentage (98 %), root length (14.80 cm). shoot length (16.31 cm), seedling length (31.11 cm), seedling fresh weight (5.743g), seedling dry weight (0.320g), vigour index I (3071) and vigour index II (31). Lower germination percentage, seedling character recorded in control (T1) treatment.

Keywords: green gram, seed hardening, CaCl2

Introduction

Pulses have a significant role in ensuring food and nutritional security of humans. It supplies the protein, carbohydrates, dietary fibre, vitamins, minerals and phytochemicals. Compared to cereals, pulses provide a cheaper source of protein which is twice to that of cereals. Other than its nutrient qualities it is also a good animal feed as well as a good green manure that enriched the soil through nitrogen fixation. It fixes 40-50 kg of nitrogen/hectare approximately (Hariprasanna and Bhatt, 2002) [6]. Among all the pulses, green gram is also an important pulse that rank third in area and production after chickpea and red gram. Green gram (*Vigna radiata L.*) belongs to the family *Leguminoceae* and is grown in widely all over the world. India is the largest producer of green gram in the world, accounting for 54% of the global green gram production (Bhadane *et al.*, 2021).

The green gram is recommended to the ill or aged person as it is easily digestible and considered as complete diet. It is particularly rich in Leucine, Phenylalanine, Lysine, Valine, Isoleucine, etc (Patel *et al.*, 2017). 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. Green gram 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 (Bhadane *et al.*, 2021) [4].

Drought is one of the most important abiotic stresses in the world. Water stress from anthesis to maturity affects numerous morphological and physiological activities of plant and it reduces crop yield and productivity (Hallajian, 2016). The low productivity in pulses is due to the reason that pulses are grown mostly in marginal and rainfed areas and the main constraint in raising the productivity of pulses in dry lands are the inadequate soil moisture and poor fertility status of the soil (Verma *et al.*, 2018) [19]. In Tamil Nadu, the low productivity of green gram is due to the cultivation of this crop in marginal and rainfed with poor management practices (Ananthi *et al.*, 2017) [3]. Poor crop establishment is a major constraint for green gram production (Rahmianna *et al.*, 2000) [16]. Usually seeds with low vigour produce weak and unproductive plants (Shivanisingh *et al.*, 2017) [17] and high yields can be associated with early vigor (Kumar *et al.*, 2002).

At present several seed enhancement methods are available for quality upgradation. The seed hardening treatment proved to be better for vigour enhancement than the traditional soaking (Manjunath and Dhanoji, 2011) [11]. Seed hardening treatments enhances seeds vigour by protecting structure of the plasma membrane against injury during stress environment (Jun Min *et al.*, 2000). Hardening of seeds resulted in the absorption of more water due to increase in the elasticity of cell wall and development of a stronger and efficient root system (Krishnasamy and Srimathi, 2011). The root system of green gram is mainly located in the upper 20-25 cm depth which, under dry conditions, transformed into short tuberized roots, unable to absorb proper moisture and nutrition for growing plants (Shivanisingh *et al.*, 2017) [17].

Water stress at any stage of growth may causes changes in plant morphology, physiology and consequently affects crop growth and productivity. Seed hardening imparts tolerance against abiotic stresses like drought and salinity, increase seed germination followed by better and quicker seedling emergence (Maamallan *et al.*, 2019). The present investigation was undertaken with the objective to study the effect of seed hardening on germination and seedling characters in green gram crop.

Materials and Methods

The present experiment was conducted at Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu, India (located at 11o24' N latitude and 79o 44' E longitude with an altitude of +5.79 mts above mean sea level) during October 2021 to study the influence of seed hardening techniques in germination and seedling characters of green gram. The laboratory trial was laid out in completely randomized design (CRD) with three replications and eight treatments *viz.*, T1: control, T2: distilled water, T3: 2% KCl, T4: 2% CaCl2, T5: 2% KNO3, T6: 100 ppm ZnSO4, T7: 100 ppm MnSO4 and T8: 5% Nochi leaf extract.

For preparation of 2% chemical solution, 2 g of the chemical was taken and mixed with 100 ml of distilled water. For 100 ppm chemical solution, 100 mg of the chemical was taken and mixed with 1000 ml of distilled water. For nochi (*Vitex sp.*) leaves extract solution, 1 kg of leaves was taken and then grinded after this the matter is mixed with water and then water was strained out in a measuring flask, 50 ml of nochi (*Vitex sp*.) leaves extract solution was taken and made up to 1000 ml with distilled water (Shivanisingh *et al.*, 2017) [17].

Seeds were soaked for 3 hours in chemical solution or leaf extract at 1/3 volume of seed and dried it for 18 hours under the shade at normal room temperature (Bhadane *et al.*, 2021) [4]. Then the seeds were sown on moist germination paper. In each treatment 25 seeds were sown with three replications and the rolled germination paper were kept in a bucket with little water at bottom to keep the paper in moist condition. The seeds were inspected regularly and moistened with water if needed.

Ten seedlings were selected randomly for the purpose of recording morphological characters of the seedling on the 7th day after sowing. Germination percentage, seedling length, shoot length and root length were measured. The seedlings used for recording fresh seedling weight were kept to float on distilled water in a petri dish and allowed to absorb water for four hours. After four hours, the seedlings were taken out and their surface was blotted gently to remove excess water. The weight of the turgid seedlings was recorded and expressed in gram. These randomly selected ten seedling samples were separated into root and shoot and dried in oven at 85°C for 24 hours (Bhadane *et al.*, 2021) [4]. After drying the samples were used to dry weight measurement. And germination percentage, vigour index I and vigour index II were calculated with the help of the following formula given by Abdul Baki and Anderson (1973).

$$1.\ \text{Germination percentage} = \frac{\text{No. of seed germinated}}{\text{Total no. of seeds taken up for sowing}} \times 100$$

2. Vigour index I = Germination percentage × Seedling length in cm

3. Vigour index II = Germination percentage × Seedling dry weight in g.

The collected data were analysed statistically.

Results and Discussion

The seed hardening techniques exerted significant influence on germination and seedling characters of green gram variety Co-3 under laboratory condition.

Among the various treatment tested, T4 (2% CaCl2) recorded the higher germination percentage (Table 1) of 98% followed by T3 (2% KCl) which is 95% compared to T1 (absolute control) which is 76%. Similarly, in the studies conducted on chickpea, seed treated with 2% CaCl2 also has the higher germination percentage (Akshay *et al.*, 2018). Not only germination percentage but the seedling length were also found to be higher in T4 (31.11 cm) followed by T3 (28.71 cm) when compared to absolute control T1 (20.02 cm). Early and higher germination of treated seed or soaked seed maybe due to initiation of pre germination metabolic activity while treating that makes the seeds ready for protrusion (Manjunatha and Dhanoji, 2011) [11] and similar case is also reported in chickpea too (Sujatha, 2014) [18]. During seed hardening process, many physio-chemical changes occurred in seeds that modify the protoplasmic characters of seed which increases the embryos physiological activity that is associated with structure development responsible for seed germination efficiency (Bhadane *et al.*, 2021) [4].

Table 1: Influence of seed hardening techniques on germination percentage, seedling length (cm), fresh shoot and root weight of green gram

Treatment	Germination percentage (%)	Shoot length (cm)	Root length (cm)	Seedling length (cm)	Weight of fresh shoot (gm)	Weight of fresh root (gm)
T1- Absolute control	76	10.95	9.06	20.02	3.259	0.621
T2- Water-soaked control	80	11.74	11.06	22.80	3.451	0.733
T3- 2% KCl	95	15.18	13.53	28.71	4.329	1.113
T4- 2% CaCl2	98	16.31	14.80	31.11	4.530	1.213
T5- 2%KNO3	86	13.74	12.23	25.97	3.836	0.923
T6- 100 ppm ZnSO4	91	14.34	13.33	27.64	4.129	1.035
T7- 100 ppm MnSO4	88	13.93	12.86	26.80	3.936	0.963
T8- Nochi (Vitex sp.) leaf extract	83	13.35	11.60	24.95	3.646	0.833
SE(d)	1.18	0.39	0.61	0.6	0.074	0.026
C.D. (= 0.05)	2.40	0.81	1.25	1.23	0.15	0.054

Seed hardening with CaCl2 (T4) also gave the higher fresh weight of both shoot and root that is 4.530 g and 1.213 g respectively while the absolute control has the lower in both that is 3.259 g and 0.621 g respectively. Excluding the controls, the seed treated with nochi (*Vitex sp.*) leaf extract (T8) has the lower fresh shoot and root weight i.e., 0.364 g and 0.833 g respectively. And T5 (2% KNO3) recorded 3.836 g fresh shoot and 0.923 g fresh root weight remained on par with T7 (100 ppm MnSO4) which 3.936 g and 0.963 g for fresh shoot and root weight, respectively.

Similarly dry weight of shoot and root (Table 2) is higher in T4 *viz.*, 0.248 g and 0.072 g respectively. And the lower in

T1 *viz.*, 0.140 g and 0.035 g. Other than the control seed treated with nochi (*Vitex sp.*) leaf extract (T8) is the next lower dry shoot and root weight *viz.*, 0.169 g and 0.047 g respectively. Increase in shoot and root production combinedly in seeds treated with 2% CaCl2 maybe due to redistribution of nutrient reserves which lead to cell enlargement and increase in normal cell division with greater internodal length which result in increase in both fresh and dry weight of shoot and root (Patel *et al.*, 2017). Similar findings were found in studies conducted by Bhadane *et al.*, 2021 in green gram; Patel *et al.*, 2017 in green gram; Prajapati *et al.*, 2017 in black gram and Patil *et al.*, 2014 in cotton.

Table 2: Influence of seed hardening techniques on seedling fresh weight, dry weight, vigour index I and vigour index II of green gram

Treatment	Dry weight of shoot (gm)	Dry weight of root (gm)	Seedling fresh weight (gm)	Seedling dry weight (gm)	Vigour index I	Vigour index II
T1- Absolute control	0.140	0.035	3.880	0.175	1538	13
T2- Water-soaked control	0.155	0.04	4.184	0.195	1749	16
T3- 2% KCl	0.231	0.067	5.442	0.298	2792	28
T4- 2% CaCl2	0.248	0.072	5.743	0.320	3071	31
T5- 2%KNO3	0.183	0.055	4.759	0.238	2218	21
T6- 100 ppm ZnSO4	0.212	0.062	5.164	0.274	2544	25
T7- 100 ppm MnSO4	0.194	0.057	4.899	0.252	2348	22
T8- Nochi (Vitex sp.) leaf extract	0.169	0.047	4.479	0.216	2023	18
SE(d)	0.006	0.0014	0.074	0.008	96.57	0.69
C.D. (= 0.05)	0.013	0.003	0.150	0.018	195	1.4

Like other parameters, seed hardening with 2% CaCl2 recorded the higher vigour index I (3071) and II (31). This might be due to the increased germination percentage, root length, shoot length and dry matter production of green gram seedlings. In CaCl2 seed hardening treatment, seeds increased the synthesis of protein and soluble sugar in the first phase of germination, which have advantages for earlier germination and in turn produces longer seedlings there by increased the vigour of seedling (Mulsanti and Wahyuni, 2011).

Conclusion

On the basis of present investigation, it was revealed that seed hardening with 2% CaCl2 improves the germination percentage, seedling character and vigour index and may be remunerative for green gram growers.

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