Physiological Screening of Green gram (*Vigna radiata* L.) varieties by Seedling germination traits under Salinity stress

ABSTRACT

Among the legumes, pulses are the most important component in India as they have very high protein resources. Green gram (*Vigna radiata*) is the most essential one when compared to other pulses regarding high nutritional value, enriching soil fertility and being a short duration crop. In India, pulses cultivation faces salinity stress which is a most constraint factor on its production. Hence, an experiment was performed with the purpose of analyzing morpho-physiological differences in high difference green gram varieties, which are MH 421,VBN 2,VBN 4,CO8 and CO(Gg) 912 under salinity stress condition. This experiment was done at laboratory condition under various concentration level of Sodium Chloride (Nacl). These levels create different levels of salinity stress, the above five green gram varieties where screened for identifying their salinity stress and the important parameters which include radicle length, shoot length, plant height, germination percentage and seed Vigor were recorded.

Comment [Gh1]: What was the main conclusion of research?

Introduction

India is a major pulse growing country in the world, which shares 33% and 28% of the global area and production respectively. Pulses are the major source of protein in Asia and constitute. An important supplement to the cereal based diet is pulses. With rise in atmospheric temperature, the biotic and abiotic stresses are predicted to become more severe and adversely affect the stability and productivity in pulse crops [5].

Abiotic stress influences the physiological stress of the green gram and affects the production adversely. Among the abiotic factor, salinity stress is more atrocious limiting factor where in high salt concentration affecting the germination of seeds. In general about 23% area of pulses are affected by salinity stress in the world. Green gram is having high protein content when compared to other pulses that has about 24% protein content. The total area under green gram in Tamil nadu is about 1, 70,000 hectares with production and productivity of 77000 tonnes

and 450kg per hectare respectively. The total green gram coverage in Namakkal district is 6500 hectares with the total production of 8000 tonnes (Statistic Handbook of Tamilnadu, 2020). But the supply is less and demand is increasing for the past years majorly due to salinity stress.

Generally abiotic stresses affect the physiological process of pulse crop. Salinity stress controls the photosynthetic efficiency of pulses, affecting the biomass production. Among these stresses, salinity shows the biggest threat leading to heavy economic loss. Rapidly increasing soil salinity has multifarious effects on plant growth and productivity. Salinity stress leads to the adverse effect caused by sodium and chloride ions on pulses. The current irrigation systems have remarkably induced the situation of salinity stress. Being the majority of agricultural crops are saline sensitive, salinity causes huge production losses to the nation, claiming drastic challenges to the world food production[7]. Starting from the cell to field all the physiological process is affected by the salinity stress which leads to reduced production.

Comment [Gh2]: What is the research aim? Gap? And novelty?

Materials and methods

Experiment was conducted as petri plate culture with five varieties in Department of Crop Physiology, PGP College of Agricultural Sciences, Namakkal which is located in the North Western zone of Tamil Nadu during May, 2022. Mung bean seeds of these varieties such as VBN2, VBN4, CO(Gg)912, MH421 were obtained from ADA Office, Namakkal and the latest variety in green gram CO8 were obtained from the Department of Pulses, Tamil Nadu Agricultural University, Coimbatore. The seeds were treated with Bavistin @2g kg^{-1} of seeds for protection against seed borne diseases. The seeds were sown uniformly in the petri plate. The treatment (T1) was maintained with Nacl – Sodium chloride as control. They were given at the different concentration such as 0, 50,100,150,200,250 mg as treatments T1, T2, T3, T4, T5, T6 respectively. Observations were made before plant reaching the permanent wilting point level which was measured to be by 9^{th} day. The physiological parameters and germination traits were recorded under the salt induced stress at seedling stage. The experiment was laid out in Factorial Completely Randomized Design (CRD). The parameters such as germination percentage, vigour index, radicle length, plumule length, radicle fresh weight, plumule fresh weight, Stress tolerance index were recorded.

Germination percentage

The number of germinated seeds were recorded each day (24 hours interval) upto 14 days. Seeds were considered germinated when both plumule and radicle extended to more than 2 mm from the seeds. Germination percentage was calculated using the formula given below.

$$\text{Germination percentage (\%)} = \frac{\text{Number of germinated seeds}}{\text{Number of seeds kept for germination}} \times 100$$

Plant height

Plants were selected randomly in the pots and tagged to measure height of the plant in each treatment under each replication. The height of plant was measured from the base of the shoot to the apical portion of the plant and the mean was worked out and expressed in cm.

Shoot length

Seedlings from each replication, were randomly taken and shoot length was measured on 14^{th} day from the collar region to the longest leaf tip and expressed in cm.

Root length

Root length of seedlings were measured on 14^{th}day from the stem base to the Longest root tip of the seedlings and expressed in cm.

The following formulas were used to compute the shoot and root toxicity of the plants which is expressed in terms of percentage,

$$\text{Shoot toxicity} = (\text{shoot length of control} - \text{shoot length of treatment} / \text{shoot length of control}) X100$$

$$\text{Root toxicity} = (\text{root length of control} - \text{root length of treatment} / \text{root length of control}) X 100$$

Stress Tolerance Index

In order to observe the tolerance capacity of the plants at time of giving stress and at control, the tolerance index of the plants is calculated as follows,

$$\text{Tolerance index (100\%)} = (\text{Mean root length in stress} / \text{Mean root length in control}) X 100$$

Statistical analysis

The collected data on various germination traits, presented with means and standard errors by ANOVA were analysed using SPSS 13.0 (Version 133, LEAD Technologies

Inc.) software

Comment [Gh3]: There is no discussion part

Results and Discussion

A standardization experiment was conducted with the green gram varieties VBN 2, VBN 4, MH 421, CO 8, CO(Gg) 912 to determine the stress level at which the green gram collection could be screened. Highest germination percent was observed in VBN 2 (96%) when compared with all other varieties (Fig.1.). The Root length was measured using ruler and it was noticed that the average plant length of control (T1) seems to be higher than the stress induced T2, T3, T4, T5, T6 (Fig.2.). Salinity induced stress reduced the plant height of all the varieties. The variety VBN 2 recorded lesser reduction of plant height at T3 (100mg NaCl/lit) with a range of 30% when compared with other varieties.

Seedling vigour index of varieties such as Co8, MH 421, VBN 2, VBN 4, CO(Gg)912 at control (T1) are 3007.5, 2320, 2807.5, 2495, 2192.5 respectively. Among these, VBN 2 shows the high vigour index of seed. Hence Seedling vigour index was an important parameter for deciding the ability of the seeds to germinate and to emerge in the soil. In VBN 2, SVI of T1 > T3 >T4> T2 > T5. Respiration of root and soil organism tends to reduce the oxygen and increase the CO_2 concentration. The soil become harder and pore space are less causing less aeration and regarding the growth of plant.[4,5]. Similar trend was followed in Shoot and root length (Fig 3,4).

Tolerance index was also observed in the plants of control (T1) and stressed (T2 and T 3) plants. On comparing the tolerance index of five varieties at various concentration of inducing stress at 0mM ,50mM ,100mM,150mM,200mM and 250mM are CO 8 (T2 93.55, T3 86.87), MH 421 (T2 93.01, T3 84.33), VBN 2 (T2 97.2, T3 90.77), VBN 4 (T2 84.7, T3 69.12) and Co(Gg) 912 (T2 71.76, T3 69.8). The above observed values allowed us to conclude that the variety VBN 2has the ability to tolerate under salinity stress.

In, all the five varieties, root toxicity and shoot toxicity were higher in T6 (250mM concentration). VBN 2 recorded less toxicity in 250mg treatment (Fig.6,7). Similar study were in accordance with{2}. By the help of seedling germination traits, potential indicator and adaptative varieties were identified for further development in field condition. From the present study, it was concluded that, when greengram variety VBN 2 undergoes water stress, showed significant changes in its physiology attributes for its adaptation.

Conclusion

Salinity stress is important limiting factor for the productivity of crops. Plant shows series of reaction towards salt stress conditions that are shown by a range of modifications in the morphology, physiology and biochemical parameters of the plants. However the capability of plants to survive in salinity stress condition significantly varies from one variety to another. By screening the varieties the potential indicators can be identified for sustaining the yield.

Comment [Gh4]: What was the main conclusion of research?

References

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Fig.1. Germination speed of green gram varieties at seedling stage

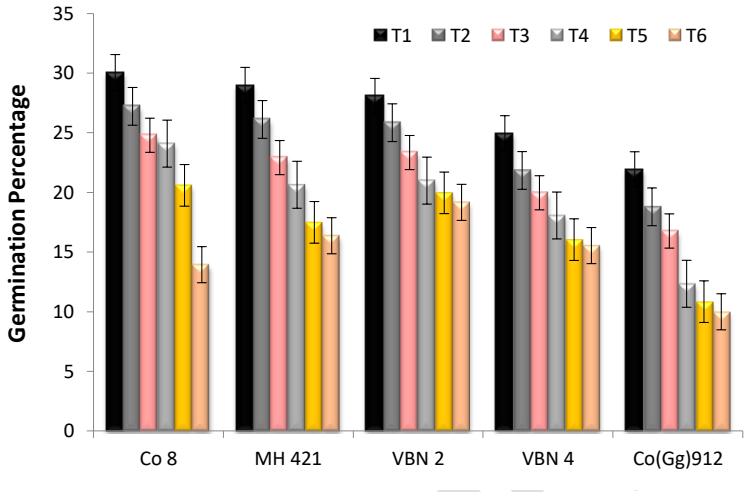

Fig.2. Effect of salinity stress on plant height of green gram varieties at seedling stage

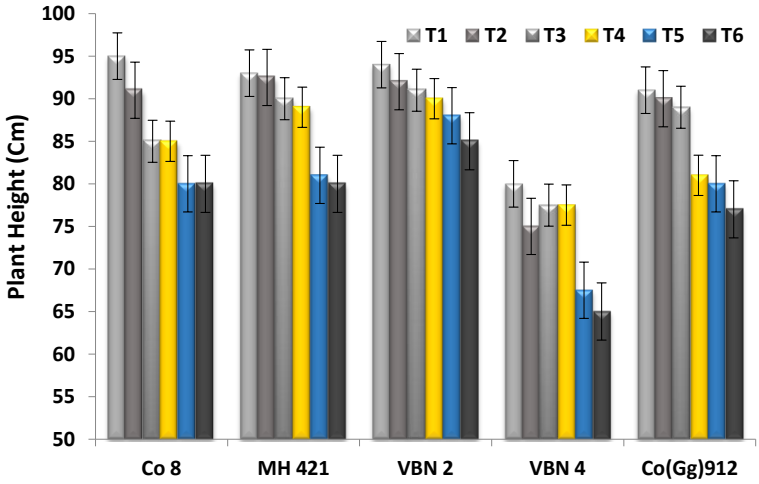

Fig.3. Effect of salinity stress on root length of green gram varieties at seedling stage

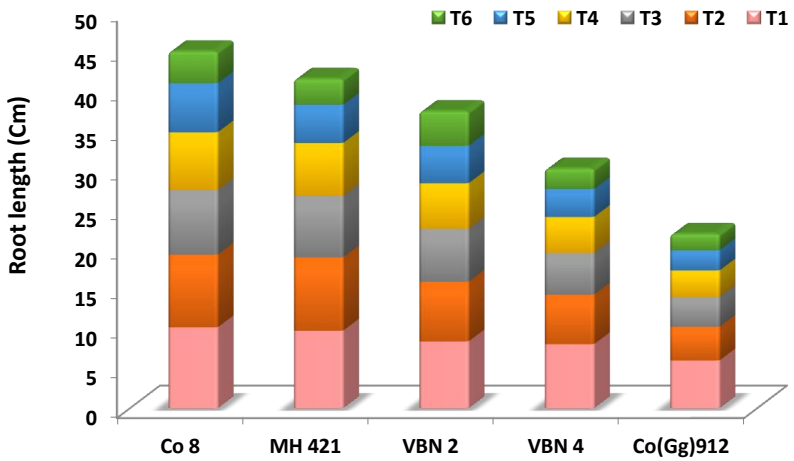

Fig.4. Effect of salinity stress on shoot length of green gram varieties at seedling stage

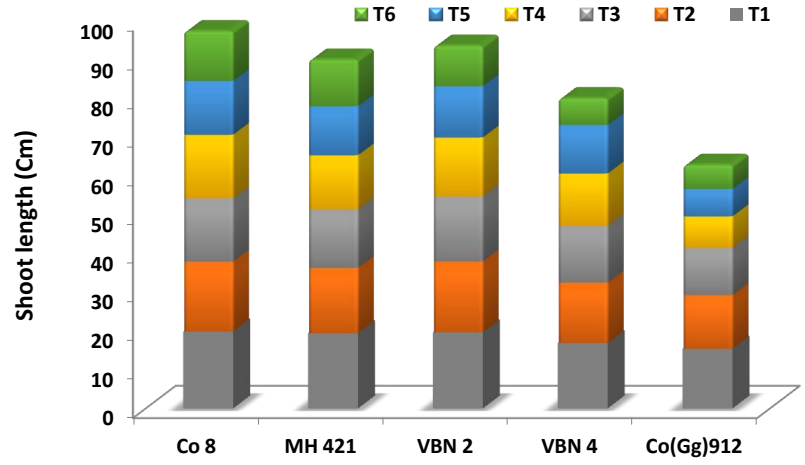

Fig.5. Effect of salinity on stress tolerance index of green gram varieties at seedling stage

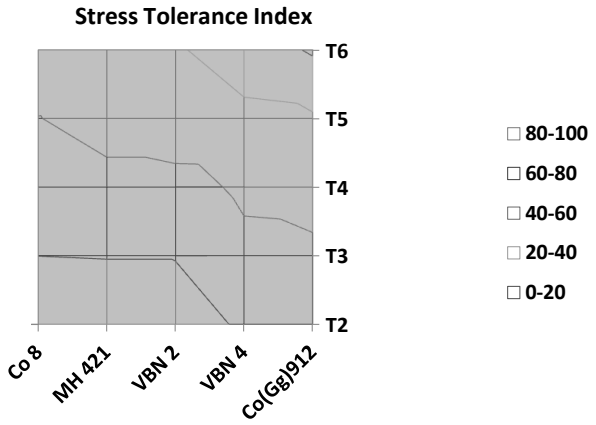

Fig.6. Effect of salinity stress on root toxicity of green gram varieties at seedling stage

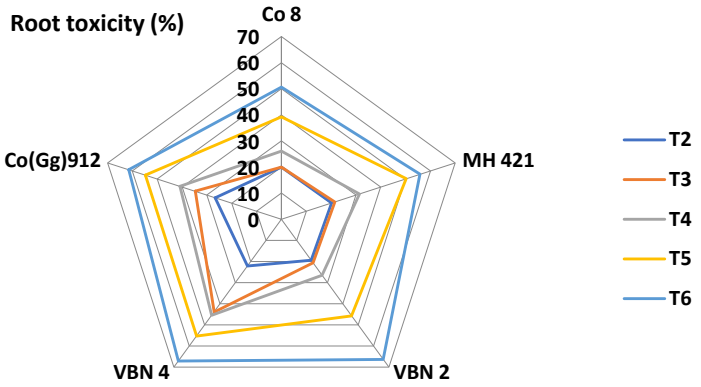

Fig.7. Effect of salinity stress on shoot toxicity of green gram varieties at seedling stage