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Original Research Paper

Evaluation of mungbean genotypes for salt tolerance at early seedling growth stage

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ABSTRACT

Mungbean [*Vigna radiata* (L.) Wilczek] is an important food grain legume. Salt stress adversely affects the yield of mungbean. One hundred and seventeen mungbean genotypes from core collection (NBPGR, New Delhi) were evaluated first time for salt tolerance under five different salinity treatments, i.e. EC_0, $EC_{4.0}$, $EC_{7.0}$, $EC_{10.0}$, and $EC_{16.0}$ (dS/m) at early seedling growth stage. The germination% and seedling growth characteristics, i.e. plumule, radical and total seedling length, and seedling vigor of 4-day old seedlings were investigated. Result showed that all traits decreased gradually with increasing level of salt stress in all the genotypes. The genotypes showed variations for all the measured features within themselves and at different salt stress levels. Seed germination was less affected trait as compared to that of radical length. All the genotypes were categorized in six groups on the basis of percent reduction in seedling vigor. These groups included highly tolerant, tolerant, moderately tolerant, moderately susceptible, susceptible, and highly susceptible genotypes. The tolerant genotypes can be evaluated at later growth stages to identify the promising salt resistant genotypes for efficient breeding programs.

1. Introduction

Mungbean [*Vigna radiata* (L.) Wilczek] is an important pulse crop with remarkable source of high quality protein, essential amino acids, fatty acids, fibers, minerals and vitamins (Keatinge et al., 2011). India is the largest producer of pulses in the world (FAOSTAT, 2013). Mungbean has high economic status due to its nutritive food value, excellent green manure crop (Algan and Çelen, 2011) and ability to fix atmospheric nitrogen in symbiotic association with *Rhizobium* species (Somta and Srinives, 2007). Incorporation of mungbean residue improves soil fertility and crop productivity (Singh et al., 2008). It is also an important crop for various cropping systems (Rahman et al., 2012; Singh and Kaur, 2012).

Salinity stress causes severe yield loss and affects the quality of mungbean (Salim and Pitman, 1988; Saha et al., 2010). Accumulation of sodium ions to higher extent in saline soils results in different physiological abnormalities and thus reduces the final yield (Tavakkoli et al., 2010; Hasanuzzaman et al., 2012). A substantial part of the productive land in the world is affected by salinity which is increasing day by day. World-wide more than 45 million hectares of irrigated land have been damaged by salt and 1.5 million hectares is taken out of production each year due to high salinity levels in the soil (Munns and Tester, 2008). Regardless of the great importance of mungbean, very little work has been done to develop cultivars adapted to salinity until recently (Singh and Singh, 2011).

Salt tolerance is a polygenic, highly intricate trait dependent on genotype and plant developmental stage. Lack of a trustworthy technique and suitable parameter for screening further restrict to develop salt tolerance in mungbean. Low productivity of mungbean highlights the need of its genetic improvement to maintain its production in salt-affected soils. The development of salt tolerant cultivars is the most promising and efficient gateway to reduce the lethal effects of soil salinity on crop production (Epstein et al., 1980). Resistant germplasms within *Vigna* genotypes could be of practical value to study the mechanism governing salt tolerance and for the delivery of genetic resources for salinity in breeding program (Win et al., 2011). Future progress in mungbean breeding requires immediate attention for identification of accessions with favorable agronomic traits.

The present investigations have been carried out to evaluate large number of mungbean genotypes (117 genotypes) for seed

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germination and early seedling growth under saline environment. Such a large number of genotypes have not been screened earlier in a single and continuous study for salt tolerance. The identification of promising and diverse genotypes will help to execute further research on breeding programs for the genetic improvement of mungbean for saline soil.

2. Materials and methods

2.1. Plant material and salinity stress levels

The seeds (1–2 years old) of 117 genotypes of mungbean were procured from core collection at National Bureau of Plant Genetic Resources (NBPGR), New Delhi, for the present study (Table 1). Five different salinity levels (EC_0, $EC_{4.0}$, $EC_{7.0}$, $EC_{10.0}$, and $EC_{16.0}$; decisimen/mho) were used in water for irrigation and imposing the salinity stress in mungbean genotypes. EC_1 is 10 meq (meq is one thousandth, 10^{-3}, of a gram equivalent of a chemical element) of the salts per litre of the solution. 10 meq was prepared by mixing NaCl (5 meq), $Na_2SO_4^{2-}$ (1.75 meq), $CaCl_2$ (2.5 meq) and $MgSO_4^{2-}$ (0.75 meq). The control treatment used (EC_0) was without salts.

2.2. Method used

The seeds of all the mungbean accessions were permitted to germinate on filter paper (80 mm diameter) soaked with 10 ml of saline solutions of different concentrations, i.e. EC_0, $EC_{4.0}$, $EC_{7.0}$, $EC_{10.0}$, and $EC_{16.0}$ (dS/m) in the petridishes consisting of 5 seeds/genotype/treatment. The experiment was carried out with four replicates per salinity treatment with mean temperature of 28 ± 2 °C and relative humidity more than 65%. The petridishes were tightly sealed with parafilm to prevent evaporation of water; thus minimizing changes in concentration of salt solutions. The germination% and seedling growth features, such as radical, plumule and total seedling length, were measured on 4th day. The seedling vigor was calculated as a product of germination percentage and total seedling length. All the observations were mean of four replications per treatment.

2.3. Statistical analysis

The data was further subjected to statistical analysis of variance (ANOVA) appropriate to the experimental design using OPSTAT program (HAU, Hisar, India).

3. Results and discussion

3.1. Seed germination

Seed germination is the most critical stage in seedling establishment that determines fruitful crop production. The results showed that the seed germination significantly delayed under salinity condition in all the genotypes. The susceptible genotypes required more number of days for germination as compared to those of tolerant genotypes (Fig. 1). The average percent reduction in seeds germination ranged from 3.72 (EC_4 ds/m) to 20.17 (EC_{16} ds/m) over control in present investigation (Table 2; Supplementary Table 1). However, at 4th day of germination, 43 genotypes showed 100% germination and 10 genotypes recorded less than 50% germination at $EC_{7.0}$ ds/m or increased salinity levels. Increase in salinity levels significantly reduced germination with varying response (Fig. 2). High accumulation of sodium and chloride ions produced an outside osmotic potential that avoids adequate water uptake in saline environment resulted in poor activation of the hydrolytic enzymes and further reduced the seed germination (Khajeh-Hosseini, et al., 2003; Mohammed, 2007). Increased dormancy of seeds under salinity stress also delayed and decreased the germination of the seeds of sensitive plants (Reddy, 1982; Murillo-Amador et al., 2002). Acceptable growth of plants in arid and semi-arid lands which are under exposure of salinity stress is related to the ability of seeds for best germination under unfavorable conditions, so necessity of evaluation of salinity tolerant genotypes is important at primary growth stage. Germination potential of seeds in saline environments could be

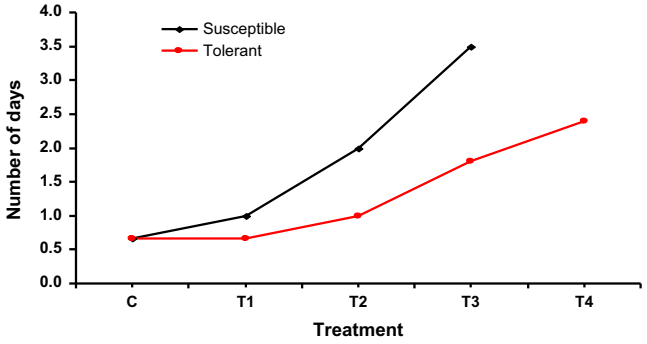

Fig. 1. Number of days on average basis for seed germination (PLM380, PLM562 and IC615 for salt tolerant and IC10492, K851 and MH96 for salt susceptible) under different salinity treatments including control (C), EC_4 (T_1), EC_7 (T_2), EC_{10} (T_3) and EC_{16} (T_4). The values are represented in unit of electrical conductivity (decisimen per mho; ds/m).

Table 1
Grouping of 117 mungbean genotypes according to the percent reduction in seedling vigor under EC_{10} ds/m.

Groups	Salt response	% Reduction	Number of genotypes	Name of genotypes
I	Highly tolerant	25–35	13	PLM380, PLM562, PLM334, PLM891, PLM884, PLM184, PLM538, PLM32, PLM748, WGG37, PS16, IC10489, IC73430
II	Tolerant	35–45	16	PLM468, PLM975, PLM707, PLM734, PLM625, IC615, IC10497, IC618, IC2056, IC8961, EC5478, ET52190, STV2763, STV2768, AKM9243, TAP7
III	Moderate tolerant	45–55	25	PLM303, PLM688, PLM818-A, PLM775, PLM619, PLM541, PLM777, PLM346, PLM666, PLM1056, PLM953, PLM759, EC25997, EC16569, ET52194, ET52200, IC8917, IC24789, IC39245, IC11379, IC114, MGG351, Pusa103, STV2635, STV2685
IV	Moderate susceptible	55–65	23	PLM651, PLM829, PLM231, PLM694, PLM427, PLM340, PLM391, PLM573, PLM111, IC10492, IC22463, IC39342, IC11303, IC10184, IC8592, IC13077, IC11488, EC2513, EC10732, GM-88-35, LGG450, MGG336, STV2762
V	Susceptible	65–75	25	K851, PLM250, PLM726, PLM410, T-44, PLM629, PLM416, PLM694, PLM256, STV2665, STV2669, PDM-11, IC73536, IC73465, IC8961, IC118959, EC261790, EC272450, EC251810, EC251557, EC396523, EC5551, EC314286, MGG348, ET52191
VI	Highly susceptible	> 75	15	PLM1057, MH-96, ET52201, ET52186, ET52187, ET52196, LGG410, LGG407, LGGA60, MGG295, LAM-M2, IC11312, STV2761, EC260608, TM-96-2