Genotypic Variations on Yield and Yield Related Parameters of Mung Bean (*Vigna Radiata* (L.) Wilczek) under Water Stress in the Low Country Dry Zone of Sri Lanka

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Abstract

According to several climate predictions, the crop production in the sub humid tropical regions seems to be threatened by climate change mainly by the reduction in water availability due to heated atmosphere and erratic rainfall. Thus, adaptability of crops through identification of genotypes which produce better yields under less water environments especially during minor seasons is important in order to ensure the food and nutritional security of the country. Here, five mung bean genotypes were assessed for their yield and yield related performances under well watered and rainfed (water stress) conditions. Results revealed that the presence of genotypic variations in mung bean on yield and yield parameters under water stress can be used in breeding programs followed by further investigations on the above traits.

Key words: Climate change, Genotypic variations, Mung bean genotypes, Water stress, Yield parameters

Introduction

Sri Lanka has achieved self sufficiency in its major cereal crop, rice and there is an increasing concern on other field crops (OFCs), especially grain legumes because of their nutritive values and other benefits in small holder cropping systems. Mung bean (*Vigna radiata*) is a popular grain legume which is commonly grown in the minor rainy season (*Yala*), of the dry zone and the productivity is mainly limited by unexpected terminal droughts i.e. a water stress period that develops in the middle of the season and gradually increases in magnitude without being relieved until the end of the season (Ludlow and Muchow, 1990) at important growth stages of this crop (De Costa *et al.*, 1999). This unexpected drought incidences are likely to be exacerbated especially during the minor seasons in the tropics due to negative impacts of climate change on rainfall (UNEP, 2012). According to FAO, (2013) climate change match crops are expected to be the major solution for future food and nutritional security issues. Thus, this field study was carried out as a part of screening of mung bean genotypes for future water limited environments via studying their yield related performances under water stress.

Materials and Methods

This field study was carried out at Maha Illuppallama (*8° 6.65' N* and *80° 27.84' E)*, Sri Lanka during the minor rainy season of 2012. Mung bean breeding lines (MIMB 901, MIMB 902 and MIMB 903) and two local varieties (MI 6 and Ari) were evaluated under two irrigation regimes (irrigated and rainfed). The irrigation was given to all plots at four days intervals until the second week after seeding to ensure the proper establishment of crops. After that irrigation was continued to irrigated plots every four days in the first four weeks and every seven days thereafter, until eight weeks after sowing according to the recommendations (Anonymous, 1990). Irrigation was stopped after the second week to the crops in the rainfed regime. All the crops were grown under existing agronomic management package of mung bean given by Department of Agriculture, Sri Lanka except irrigation. Treatments were arranged in a split plot design with three replications.

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Soil moisture was determined gravimetrically over the growth period. During the reproductive growth of mung bean, five plants were randomly selected from the central area of a sub plot and the number of flowers was counted on a daily basis from flowering to one to two weeks before the harvest. Number of successfully formed pods and number of seeds per pod were counted at harvest. Flower abortion percentage was computed as the ratio between the number of flowers failed to form pods and the total number of flowers. Hundred seed weight and seed yield were measured at the harvest. The central plot was harvested in three picks and number of plants was counted to estimate the yield. The first pick was done at 54 days after sowing (DAS), the second at 64 DAS and the final pick was at 78 DAS. Harvest index was calculated as the ratio between sum of seed dry weights of all three picks and the total plant dry weight at final harvest which included pod husk weights from all picks. The data were analyzed by analysis of variance procedure and least significant differences (LSD) at 0.05 probability was used for mean separation by using SAS 9.1 software package.

Results and Discussion

The gravimetric soil moisture content in the rainfed plots reduced from second week after sowing since there was no irrigation (Figure 1). The cumulative total of the rainfall from seed sowing to harvest was 2.3 mm (Source: Department of Meteorology, Maha Illuppallama). Thus the drought under the rainfed condition could be considered as terminal drought.

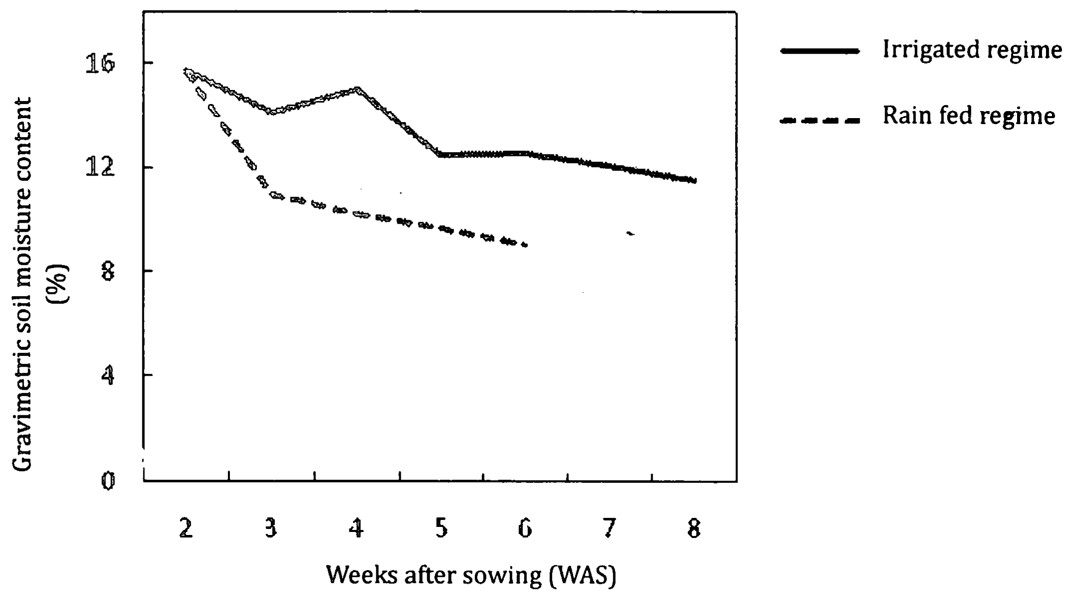

Figure 1. The changes in gravimetric soil moisture content (%) in the adopted irrigation regimes

Table 1. Seed yield and yield related parameters of mung bean genotypes as affected by irrigation regimes

	Percentage of flower a bortion		**Number of pods per plant**		**Number of seed per pod**	
Genotype	**Irrigated**	**Rainfed**	**Irrigated**	**Rainfed**	**Irrigated**	**Rainfed**
MI 6	$20.9^{ab} \pm 8.3$	$42.7^{ab} \pm 5.6$	$13.97^{bc} \pm 1.55$	$7.77^{a} \pm 1.35$	$8.48^{a} \pm 1.07$	$7.36^{a} \pm 0.80$
ARI	$10.8^{b} \pm 5.5$	$44.1^{b} \pm 6.1$	$22.33^{a} \pm 0.90$	$8.63^{a} \pm 1.86$	$8.61^{a} \pm 1.04$	$6.73^{a} \pm 1.06$
MIMB 901	$28.8^{ab} \pm 12.5$	$42.4^{b} \pm 9.7$	$15.67^{bc} \pm 2.87$	$7.87^{a} \pm 1.02$	$10.22^{a} \pm 1.15$	$7.19^{a} \pm 0.99$
MIMB 902	$42.3^{a} \pm 12.5$	$55.2^{a} \pm 7.5$	$13.47^{c} \pm 1.51$	$6.50^{b} \pm 2.25$	$8.19^{a} \pm 1.35$	$6.08^{a} \pm 0.72$
MIMB 903	$28.3^{ab} \pm 18.2$	$38.4^{ab} \pm 6.8$	$18.23^{ab} \pm 4.32$	$7.73^{a} \pm 0.45$	$8.37^{a} \pm 1.05$	6.52 ± 1.04
Mean	26.24	44.51	16.73	7.7	8.78	6.78
LSD_w	16.17		6.67		1.53	
LSDG	22.21	13.21	4.63	12	2.07	1.69
CV (%)	23.17		14.33		11.85	

	Hundred seed weight (g)		**Seed yield (kg ha^{-1})**		**Harvest Index (%)**	
Genotype	**Irrigated**	**Rainfed**	**Irrigated**	**Rainfed**	**Irrigated**	**Rainfed**
MI 6	$6.79^{a} \pm 0.16$	$7.06^{a} \pm 0.41$	$2138.7^{ab} \pm 187$	$1010.0^{ab} \pm 310$	$29.7^{a} \pm 3.2$	$26.3^{a} \pm 2.3$
ARI	$5.49^{c} \pm 0.32$	$5.64^{c} \pm 0.34$	$2785.0^{a} \pm 162$	$1017.3^{a} \pm 319$	$31.0^{a} \pm 2.6$	$4.0^{ab} \pm 4.4$
MIMB 901	$6.08^{b} \pm 0.32$	$6.37^{b} \pm 0.26$	$2782.7^{a} \pm 522$	$1185.3^{a} \pm 356$	$31.3^{a} \pm 2.5$	$25.7^{a} \pm 1.2$
MIMB 902	$6.27^{b} \pm 0.34$	$6.23^{b} \pm 0.26$	$1526.0^{b} \pm 474$	$731.0^{b} \pm 108$	$27.3^{a} \pm 2.3$	$20.3^{b} \pm 2.9$
MIMB 903	$5.37^{c} \pm 0.32$	$5.77^{c} \pm 0.41$	$2661.3^{a} \pm 368$	$912.7^{ab} \pm 87$	$28.0^{a} \pm 1.7$	$25.3^{ab} \pm 2.5$
Mean	6	6.22	2378.7	971.3	29.5	24.33
LSD_w	0.54		734.1		8.55	
LSDG	0.51	0.42	677.5	278.4	4.6	5.17
CV (%)	2.97		17.5		6	

Note: LSD_G = LSD (p=0.05) for the comparisons of genotypes within a water regime (means with same letters are not significantly different); LSD_W = LSD (p=0.05) for the comparisons of mean values between water regimes

As given in the Table 1, water stress significantly increased flower abortion and significantly reduced number of pods per plant, number of seeds per pod and seed yield in the rainfed crops. In contrast the impact of drought was not evident on hundred seed weight and harvest index. The genotype × irrigation interaction effects were significant on number of pods per plant and seed yield which indicates different genotypes perform differently to well water supply and water stress on those parameters. Even under well watered condition mung bean crops showed about 26% flower abortion on average which is a common phenomenon to most of the legumes according to Liu *et al.* (2003). The genotype MIMB 902 showed maximum flower abortion (more than 50 %) thus resulted lowest number of pods under rainfed regime. Flower drop was lowest to the genotype MIMB 903 under water stress. Genotypic variations were not observed on number of seeds per pod. However, MI 6 had highest seed weight, MIMB 901 and MIMB 902 had moderate while ARI and MIMB 903 had lowest seed weights under water stress regime. Regarding yield performances under rainfed regime, MIMB 903, ARI and MI 6 achieved significantly higher yield as in their order with comparatively higher harvest indices while MIMB 902 had lowest yield with lowest harvest index. In contrast, MIMB 903 developed only a moderate yield even with a comparatively higher harvest index.

Results verified the presence of genotypic variations of mung bean especially on yield and yield related traits under terminal drought that frequently occurs in the minor season (*Yala*) of the low country dry zone of Sri Lanka. The genotypes which develop high number of pods and produce high seed yield with high harvest index while having less flower drop under water stress may be useful to incorporate into breeding programs. However confirmatory studies are required along with the evaluation of other important traits at several locations prior to use these valuable reproductive traits for mung bean crop improvements.

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