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EFFECT OF WATER STRESS ON GROWTH AND YIELD OF MUNG BEAN (*VIGNA RADIATE* L)

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ABSTRACT

Legumes are second only to the Graminae in their importance to humans. Mung bean (*Vigna radiata* L) is one of the most important grain legumes cultivated in Sri Lanka. Drought is a major abiotic stress on Mung bean in the sub-humid, dry and intermediate zones of Sri Lanka. The present reveals the response of Mung bean for the water stress at three different growth stages; three weeks after planting (3WAP), six weeks after planting (6WAP) and eight weeks after planting (8WAP). A pot experiment was carried out at Faculty of Agriculture, University of Ruhuna, Mapalana, Sri Lanka. Plant height, number of leaves, number of floral buds dry matter weight of shoot system, number of lateral roots, length of tap root, number of root nodules, and dry matter weight of root system were measured after one week recovery period in stressed plants at three different growth stages and in relevant control plants. Water stress significantly affects on each measured parameter at 6WAP when the flowering and pod filling stage of Mung bean and only number of leaves was significantly affected at the 8 WAP. Further, all the measured parameters were significantly affected at 3WAP under drought stress other than length of tap root and number of nodules per plant. Number of floral buds and number of pods were not affected by the drought stress at 8WAP though there is no economical value of these characters as the pod filling efficiency is low in Mung bean under drought stress.

Key words: Mung bean, *Vigna radiata*, water stress

INTRODUCTION

The major legumes in Asia are chickpea, (*Cicer arietinum* L), pigeonpea (*Cajanus cajan* L), and Mungbean (*Vigna radiata*). Mungbean is a warm season crop requiring 90–120 days of frost free conditions from planting to maturity. Adequate rainfall is required from flowering to late pod fill in order to ensure good yield. Production of Mung beans are worsening with the rapid expansion of water-stressed areas of the world (Postel, 2000). Yield of Mung bean is more dependent on adequate supply of water than on any other single environmental factor (Kramer and Boyer 1997). Among the favorable characters of growing Mung bean, fast growth, nitrogen fixation capability, soil reinforcement and prevention of soil erosion are in top. Mung bean is popular as inter crop, or as mixed crop with cash crops. The rice-wheat cropping system is practiced on 26 million ha in South and East Asia (Abrol *et al.* 1997; Timsina and Connor 2007). Including Mung bean in the rice rotation system has diversified and strengthened the cropping system, alleviated the disadvantages of the cereal–cereal cropping system, and improved the productivity of the soil. Mung bean enriches the soil and breaks the soil fatigue caused by cereal–cereal rotations. Including Mung bean in a rice rotation has increased the yield of paddy and the income of farmers in Punjab (Weinberger 2003).

Mung bean is one of the important grain legumes in the rain fed farming system in dry and intermediate zones of Sri Lanka which can be grown under low moisture and fertility conditions. In Sri Lanka the total area under Mung bean in 1980 was 14,200ha, production was 12,900t and yield at 908kg/ha. In 1995, production area rose to 33,200ha, production increased to 26,400t, but yield declined to 795kg/ha. The improved varieties have encouraged more farmers to plant Mung bean (Weinberger 2003). Presently, Mung bean is successfully cultivated in the districts of Anuradhapura, Polonnaruwa, Vavuniya, Kurunegala, Puttlam, Killinochchi, Mulathiv, Batticaloa and Jaffna. About 80% of Mung bean crop is cultivated during Maha season as a rain-fed upland crop and the rest is grown in Yala season in paddy fields with supplementary irrigation (Department of Agriculture 2001). Mung bean cultivation has to undergo significant drought period in low country dry zone which is the major constrain of growth and pod filling. Ef-

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fect of drought stress on plant growth, yield and root characters was studied at three different growth stages in the present study.

MATERIALS AND METHOD

Germinated seeds of Mung bean (*Vigna radiata* L) variety *Harsha* were planted after applying recommended basal dressing according to randomized complete block design with 10 replicates for each experiment and 6 plants per each replicate under green house condition. Plants were allowed to grow under normal growth condition and water cut was done for 10 day period at 3 weeks (3WAP), 6 weeks (6WAP) and 8 weeks after planting (8WAP) in separate sets of experiments while control experiment was maintained under normal growth conditions. Plants were re-watered after stress period and plant height, number of leaves, number of floral buds dry matter weight of shoot system, number of lateral roots, number of root nodules, and dry matter weight of root system, were measured after one week recovery period in all three sets of stressed plants and relevant control plants.

To examine the root characters, soil filled pots were dipped in a water basin and pots were slanted under the water. After the soils in the pots were loosen, let the soil remove from the pot with water and plants were slowly uprooted.

Another set of 8 replicates were remained for the final yield evaluation. When the stressed plants attained to maturity, number of floral buds, number of pods/plant, and average yield (g)/plant, were recorded.

Analysis of variance was carried out with the use of Statistical Analysis Systems software (SAS institute 1983) and Duncan's multiple range test was applied to compare the treatment means.

RESULTS AND DISCUSSION

None of the parameters were significantly affected by the 10 day water stress at 8WAP other than number of leaves (Fig. 1, table 1). All the measured parameters were significantly affected at 6WAP while average length of tap root, average number of root nodules and average grain weight per plant were not significantly affected at 3WAP under 10 day drought stress (Table 1, Fig. 1).

Figure 2 Effect of drought stress on different traits at different growth stages (3WAP, 6WAP, 8WAP) of Mung bean a). average plant height, b). Average number of leaves c). Average number of floral buds d). Average number of pods, e). Average yield (g/plant) f). Average length of tap root, g) average number of lateral roots, h). Average number of nodules i) Average dry matter weight of shoots j). Average dry matter weight of root

Average yield of the control Mung bean plant was around 4.08g/plant while it was 1.5g/plant, 0.75g/plant and 2.9g/plant in 3WAP, 6WAP

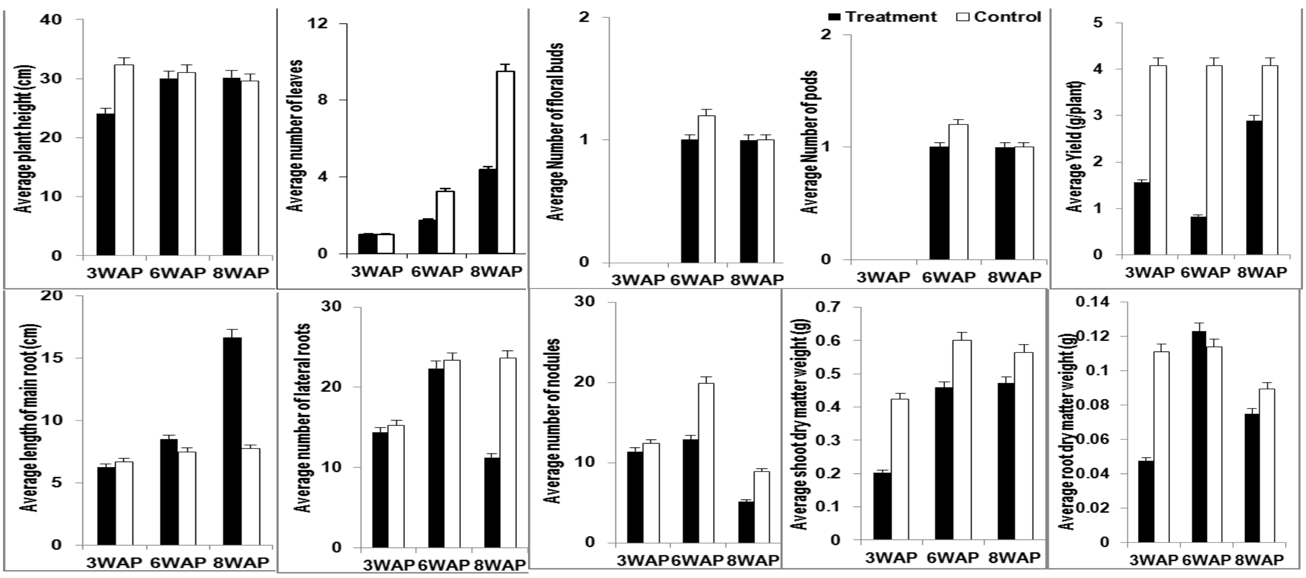

Table 1 Significant level of each character at different growth stages

	P value		
Agronomic character	3 WAP	6 WAP	8 WAP
Average plant height	0.032	0	0.258
Average number of leaves	0	0	0.030
Average length of main root	0.634	0	0.486
Average number of lateral roots	0.005	0	0.403
Average number of root nodules	0.441	0	0.526
Average dry matter wgt of shoots	0.000	0	0.502
Average dry matter wgt of roots	0.000	0	0.521
Average number of floral buds		0	0.523
Average number of pods		0	0.244
Average grain weight (g/plant)	0.065	0	0.34

and 8WAP drought stresses plants consecutively (Fig. 1e). There was a significant difference between control plants and water stressed plants at 6WAP for all the parameters (Table 1). Drought stress at 3WAP and 6WAP significantly affects on shoot dry matter weight (Fig. 2i) and root dry matter weight (Fig. 2j). Parallelly, plant height (Fig. 1a) and average length of root system (Fig. 1f) was also significantly reduced at 3WAP and 6WAP but not at 8WAP. Sangakkaran *et al.* (2000) reported that drought tolerant Mung bean diverted more carbon to roots under moisture stress. When Mung bean is grown under rainfed condition, greater rooting depth helps to acquire stored water from various depths to improve stability in grain yield. Drought stressed plants diverted significantly higher dry matter to roots and stems, while well watered plants diverted to pods and grains (Kumar and Sharma, 2009). It has also been shown that Mung bean genotypes having higher root biomass produced higher pod and seed yield at low level of phosphorous (Boutraa *et al.*1999).

Water stress also affects crop phenology, leaf area development, number of leaves per plant (Fig. 1b) and finally results in low yield (Abdel and Al-Rawi 2011). Number of leaves per plant is directly related with leaf area/plant and with final dry matter weight of shoots. Prasad *et al.* (1989) also found higher straw and grain yield of Mung bean with three irrigations as compared to one or no irrigation.

The average number of lateral roots was also significantly reduced at 3WAP and 6WAP but not at 8WAP (Fig. 1g). The numbers of roots per plant decrease with decrease in water potential (Dhole VJ and Reddy KS 2010). Reduction in average number of lateral roots directly reduces the root biomass.

Drought induces early flowering though it is not economical due to poor pod setting under drought stress. Thomas *et al.* (2004) reported that Mung bean plants under water stress attained maturity earlier than the well-watered treatment. Drought tolerance at the reproductive stage is the most important in terms of economic yield. In the present study average number of floral buds and average number of pods/ plant were badly affected at 6WAP but not at 8WAP (Fig. 1c and Fig. 1d). The development of reproductive organs, which is under the control of photo-assimilate production and partitioning by the source tissues, is at this stage the most critical (Taiz and Zeiger, 2002; Wahid and Rasul, 2004). Therefore, increased drought at this stage has a pronounced effect on fruit development and yield. Dybing *et al.* (1986) and Liu *et al.* (2003) also recorded that in another legume crop soybean; yield was highly affected by drought stress especially when drought overlaps at flowering and early pod setting. The early stage of pod development was characterized by active cell division in the young ovules and rapid pod expansion. The yield loss caused by drought stress was mainly due to an increased rate of floral and pod abortion (Liu *et al.* 2003).

Nitrogen fixation in crop species is sensitive to environment constrains especially for drought (Arrese *et al.* 2009). In the present study, number of root nodules was significantly reduced when the drought overlaps Mung bean at 6 WAP (Fig. 1h). There are several factors limiting N_2 fixation, such as: high temperature, soil acidity (Hungria & Vargas, 2000) and water stress (Hungria & Vargas, 2000; Ramos *et al.* 2003). Water stress can decrease number and shape of root hairs (Worral & Roughley, 1976), and when nodules are formed, drought alters nodule structure and weight (Ramos *et al.* 2003).

CONCLUSION

In Mung bean water stress significantly affects on root system, shoot bio mass production and final yield. Induced drought stress at 3WAP did not influence length of main root and average number of root nodules per plant. But all the parameters were significantly affected by drought stress at 6WAP. Water stress always reduces the development of leaves at any growth stage of Mung bean but significantly reduces final grain yield of the crop regardless when drought hits the crop at 3WAP and 6WAP. Mung bean must be planted in areas under drought threat so that the dry period would not affect at 6WAP. Eight WAP Mung bean is comparatively drought tolerant than other two growth stages; 3WAP and 6WAP. However, yield reduction is significant when the drought overlaps the plant at 6WAP.

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