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Influence of Water Stress and Phosphate Fertile 2 on some characteristics of Mung bean

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ABSTRACT: Mung bean is a short-season summer growing grain legume grown as dry land crop in the center and northeast of Asia. Mung bean is one of the most nutritious grain legumes used in different parts of the world. Mung bean is a drought tolerant crop and performs well under conditions of low soil moisture. Plant can respond and adapt to water stress by altering their cellular metabolism and invoking various defense mechanisms. Phosphorus (P) is among the most needed elements for crop production in most tropical soils, which tend to be P deficient. The field experiment was laid out in randomized complete block design with factorial design with three replications. Treatments included water stress (A1: control, A2: water stress in during vegetative growth, A3: water stress in during reproductive growth) and Phosphate fertile 2 (B1:0, B2:50, B3:100, B4: 150). Analysis of variance showed that the effect of water stress and Phosphate fertile 2 on all characteristics was significant.

Key words: HI, Grain yield, Biological yield, Plant height

INTRODUCTION

The major legumes in Asia are chickpea, (*Cicer arietinum* L), pigeonpea (*Cajanus cajan* L), and Mung bean (*Vigna radiata*). Mung bean 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 filling in order to ensure good yield. Drought problems for Mung beans are worsening with the rapid expansion of water stressed areas of the world including 3 billion people by 2030 (Postel, 2000). Mung bean is a short-season summer growing grain legume grown as dry land crop in the center and northeast of Asia (Majnon Hoseini, 2009). Mung-bean is one of the most nutritious grain legumes used in different parts of the world. Mungbean is a drought tolerant crop and performs well under conditions of low soil moisture (Kochaki and Benayanol, 1990). Like other legumes, mung beans are high in protein, having around 25% of the seed dry weight and its amino acid profile is complementary to cereal grains. Mung bean is produced in tropical and sub-tropical rain-fed environments with little or no impounding of water, and it is prone to drought when soil moisture or rainfall is inadequate to meet plant requirements. It is an important pulse crop in developing countries of Asia, Africa and Latin America where it is consumed as a dry seed and fresh green pods (Karuppanapandian *et al*., 2006). To cope with the increasing food requirements and as drought is a major stress which adversely affects plant growth and productivity; it is important to develop stress tolerant crops (Mahajan and Tuteja 2005). Plant can respond and adapt to water stress by altering their cellular metabolism and invoking various defense mechanisms (Bohnert and Jensen, 1996). Environmental stresses (drought, salinity, heat, cold, etc.) represent a major constraint to meeting the world food demand, which effect of drought, affecting 45% loss in crop yield, is of considerable importance. In Iran, low precipitation (around 250 mm) along with its uneven temporal and spatial distribution led agronomists to select the most effective irrigation methods or drought tolerant cultivars (Soltani and Faraji, 2007). Grain legumes are a major source of protein in arid and semiarid region of world and play a key role in economy of these regions (Singh and Patal, 1996). Mung bean is reported to be more susceptible to water deficits than many other grain legumes (Pandey *et al*., 1984). Water stress reduces photosynthesis; the most important physiological processes that regulate development and productivity of plants (Athar and Ashraf, 2005). Reduction in leaf area causes reduction in crop photosynthesis in plants leading to dry matter accumulation (Pandey *et al*., 1984). Water stress imposed at any growth stage causes reduction in dry matter accumulation depending on the growth stage exposed to stress (Sadasivan *et al*., 1988). According to Sadasivan *et al*. (1988), water stress during vegetative phase reduces grain yield through restricted plant size leaf area and root growth which subsequently the dry matter accumulation, number of pods per plant and low harvest index. Water deficits at the flowering and the post-flowering stages have been found to have a greater adverse impact than that at the vegetative stage (Rafiei Shirvan and Asgharipu, 2009).

The reproductive stage is the most sensitive growth phase to drought (Brown *et al*., 1985) resulting to less yield and poor harvest index under drought stress (Uprety and Bhatia, 1989). Water stress reduces plant growth and yield. However, water stress that exists at the reproductive stage severely affects grain yield of mungbean more than its occurrence at other stages (Thomas *et al*., 2004). In addition, the time of flowering and maturity was shortened under stress compared to well-watered conditions. Leport *et al*., (2006) found that pod production of chickpea was more affected by early podding water stress than by late podding water stress. Tolerance to abiotic stresses is very complex at the cellular levels of the whole plant (Foolad *et al*., 2003 a, b; Ashraf and Harris, 2004). This is in part due to the complexity of interactions between stress factors and various molecular, biochemical and physiological phenomena affecting plant growth and development (Zhu, 2001). Phosphorus (P) is among the most needed elements for crop production in most tropical soils, which tend to be P deficient (Adetunji, 1995). The deficiency can be acute in some soils of the Savanna zone of Western Africa to the extent that plant growth ceases as soon as the P stored in the seed is exhausted (Mokwunye *et al*., 1986). P deficiencies primarily result from either inherent low levels of soil P or depletion through cultivation. Phosphorus, although not required in large quantities, is critical to cowpea yield because of its multiple effects on plant nutrition (Muleba & Ezumal, 1985). Phosphorus does not only increase seed yields but also nodulation (Luse *et al*., 1975; Kang & Nangju, 1983) and thus N fixation. Information on the chemical forms of P is fundamental to understand P dynamics and its interactions in calcareous and acidic soils which are necessary for management of P. Jalali and Ranjbar (2010) observed the reactions of P added to the calcareous soils were quite rapid and water-soluble phosphate was converted to relatively less soluble compounds within a very short time due to high sorbing capacities of the soils. P transformations in flooded soils depend on soil characteristics that may affect P availability. P is generally most available to plants when the soil pH is between 6.0 and 6.5. When the soil pH is <6.0, the potential for P deficiency increases for most of crops. Phosphate ions readily precipitate with metal cations, forming a range of P minerals. The type of mineral formed will depend on the soil pH in the first place as it governs the occurrence and abundance of those metal cations that are prone to precipitate with P ions in the soil solution, namely Ca, Fe and Al. Hence, in neutral to alkaline soils, P ions will rather precipitate as Calcium phosphorus (Ca-P): dicalcium or octacalcium phosphates, hydroxyl apatite and eventually least soluble apatites (Hinsinger, 2001).

MATERIAL AND METHODS

The experiment was conducted at the zabol which is situated between 31° North latitude and 61° East longitude. Composite soil sampling was made in the experimental area before the imposition of treatments and was analyzed for physical and chemical characteristics. The field experiment was laid out in randomized complete block design with factorial design with three replications. Treatments included water stress (A1: control, A2: water stress in during vegetative growth, A3: water stress in during reproductive growth) and Phosphate fertile 2 (B1:0, B2:50, B3:100, B4: 150). Data collected were subjected to statistical analysis by using a computer program MSTATC. Least Significant Difference test (LSD) at 5 % probability level was applied to compare the differences among treatments means.

RESULTS AND DISCUSSION

A. Harvest Index (HI)

Analysis of variance showed that the effect of water stress on harvest index (HI) was significant (Table 1). The maximum of harvest index of treatments control was obtained (Table 2). The minimum of harvest index of treatments reproductive growth was obtained (Table 2). Analysis of variance showed that the effect of Phosphate fertile 2 on harvest index was significant (Table 1). The maximum of harvest index of treatments 150 (kg/ha) was obtained (Table 2). The minimum of harvest index of treatments no Phosphate fertile 2 was obtained (Table 2).

Table 1: Anova analysis of the mung bean affected by water stress and Phosphate fertile 2.

S.O.V	df	HI	Grain yield	Biological yield	Plant height
R	1	7.293^{*}	3901.500^{ns}	1908.167^{*}	3.527^{ns}
water stress (a)	2	21.672^{**}	525276.083^{**}	105638.083^{**}	189.688^{**}
Phosphate fertile 2 (b)	3	44.732^{**}	215152.546^{**}	87644.546^{**}	157.611^{**}
a*b	6	6.964**	4766.157^{ns}	2247.824^{**}	7.230^{ns}
Error	23	1.215	2758.804	267.123	8.285
CV (%)	-	3.509	2.255	2.222	3.66

*, **, ns: significant at $p<0.05$ and $p<0.01$ and non-significant, respectively.

B. Grain yield

Analysis of variance showed that the effect of water stress on grain yield was significant (Table 1). The maximum of grain yield of treatments control was obtained (Table 2). The minimum of grain yield of treatments reproductive growth was obtained (Table 2). Analysis of variance showed that the effect of Phosphate fertile 2 on grain yield was significant (Table 1). The maximum of grain yield of treatments 150(kg/ha) was obtained (Table 2). The minimum of grain yield of treatments no Phosphate fertile 2 was obtained (Table 2).

Table 2: Comparison of different traits affected by water stress and Phosphate fertile 2.

Treatment	HI	Grain yield (kg/ha)	Biological yield (kg/ha)	Plant height (cm)
Water stress				
Control	32.49a	833.17a	2560.00a	82.57a
Vegetative growth	31.85a	727.00b	2275.83b	78.74b
Reproductive growth	29.91b	646.08c	2151.92c	74.62c
Phosphate fertile 2				
0	28.67c	621.11d	2161.56d	73.98b
50 (kg/ha)	31.16b	704.67c	2225.67c	76.54b
100(kg/ha)	31.74b	759.56b	2390.67b	80.73a
150(kg/ha)	34.10a	856.33a	2513.11a	83.33a

Any two means not sharing a common letter differ significantly from each other at 5% probability

C. Biological yield

Analysis of variance showed that the effect of water stress on biological yield was significant (Table 1). The maximum of biological yield of treatments control was obtained (Table 2). The minimum of biological yield of treatments reproductive growth was obtained (Table 2). Analysis of variance showed that the effect of Phosphate fertile 2 on biological yield was significant (Table 1). The maximum of biological yield of treatments 150(kg/ha) was obtained (Table 2). The minimum of biological yield of treatments no Phosphate fertile 2 was obtained (Table 2).

D. Plant height

Analysis of variance showed that the effect of water stress on Plant height was significant (Table 1). The maximum of Plant height of treatments control was obtained (Table 2). The minimum of Plant height of treatments reproductive growth was obtained (Table 2). Analysis of variance showed that the effect of Phosphate fertile 2 on Plant height was significant (Table 1). The maximum of Plant height of treatments 150(kg/ha) was obtained (Table 2). The minimum of Plant height of treatments no Phosphate fertile 2 was obtained (Table 2).

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