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Effect of water stress and salicylic acid on some quantitative characteristics of mung bean

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Abstract

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. Among the favorable characters of growing Mung bean, fast growth, nitrogen fixation capability and prevention of soil erosion are in top. Salicylic acid (SA) is a plant origin phenolic compound that has shown its role as a growth enhancer. The experiment was conducted at the Research Station tropical fruits and natural resources in bahukalat (In Iran). The field experiment was laid out in randomized complete block design with split plot design with three replications. Analysis of variance showed that the effect of water stress and salicylic acid on quantitative characteristics was significant.

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Introduction

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). Plant performance under conditions of water shortage has been extensively studied. Water stress affects various physiological processes associated with growth, developed and economic yield of a crop (Hsiao and Acevedo, 1974; Begg and Turner, 1976). Water deficit disturbs normal turgor pressure, and the loss of cell turgidity may stop cell enlargement that causes reduced plant growth. Water deficit may change the pattern of growth. Often root shoot ratio increases, leaf area index decreases and the thickness of cell walls and amount of cutinization and lignifications increase by water stress. The pre-monsoon period, however, has erratic rainfall leading to water deficit stress in some years and water logging in others. Water logging affects the emergence, establishment, growth and productivity legume crops (Timsina *et al.* 1993, 1994). 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). 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 maturi-ty. Adequate rainfall is required from flowering to late pod fill in order to ensure good yield. Production of mung beans is 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 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; Tim-sina and Connor 2007). 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 condi-tions. 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, pro-duction area rose to 33,200ha, production in-creased to 26,400t, but yield declined to 795kg/ha. The improved varieties have encouraged more farmers to plant Mung bean (Weinberger 2003). Drought problems for mungbeans are worsening with the rapid expansion of water stressed areas of the world including 3 billion people by 2030 (Postel, 2000). Crop yield of mungbean is more dependent on an adequate supply of water than on any other single environmental factor (Kramer and Boyer 1997). In winter cultivation when temperature is low, relative humidity is low and evapotranspiration is greater, then 3-4 times irrigation may need to obtain higher yields of mungbean to overcome drought effect (Lal *et al.*, 2000). The response of grain legume to moisture stress is often related to so-called 'moisture sensitive period' –certain developmental phases in which the plant is or appears by its observed response to be more sensitive to moisture conditions than during other phases. Maqsood *et al.* (2000) observed that mungbean suffer due to water stress when grown in an upland rice soil and that irrigation at vegetative and flowering plus pod development stages improve seed yield. Most prominent aspect of growth and development of mungbean is that the plant is sensitive to drought stresses, as a consequence of which growth and developments go significantly below potential. Mungbean 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). Thomas *et al.* (2004) investigate some genotypes of mung bean and stated that water stress accelerate flowering and podding time in many cases. Leaf chlorophyll content is one of the most important indices showing the environmental stress on plants which reduces under stress conditions (Zarco-Tejada, 2000). Wang (2008) stated that by increasing water stress, soybean seed protein was decrease. Liu *et al.* (2004) reported that sever water stress, in the first stage of pod development in soybean, decreased pods growth and led to considerable decrease in number of pod. Sangakkara *et al.* (2001) mentioned the positive effect of potassium consumption on reducing the harmful effects of water stress. Salicylic acid (SA) is a plant origin phenolic compound that has shown its role as a growth enhancer (Arberg, 1981). It commonly occurs naturally in white willow (*Salix alba*) and was extracted from the herb meadowsweet (*Filipendula ulmaria*), formerly named as Spiraea ulmaria by the German scientists in 1839. It is called a useful "natural product" because it can be isolated from nature (Mohrig *et al.*, 1998). Salicylic acid was used historically as an analgesic (pain reliever) but now a days it is becoming popular among plant physiologists as it also act as an important growth regulator especially under salinity stress. However, the information regarding nitrogen mechanism under the action of salicylic acid in enhancing salt tolerance and plant growth especially mungbean is not enough for making any concrete recommendation to the end-users. Several studies have demonstrated that exogenous SA application enhances plant growth and development. Fariduddin *et al.* (2003) showed that mustard plants sprayed with low concentrations of SA produced larger amounts of dry matter and had higher photosynthetic rate in comparison with control plants. SA application to corn and soybean promoted leaf area and dry weight of plants (Khan *et al.* 2003). In another study Hussein *et al.* (2007) revealed that growth traits of wheat plants were improved as a result of SA spraying on the plants. In addition, Hayat *et al.* (2005) reported that soaking of wheat grains in low concentrations of SA significantly promoted growth of wheat seedlings. SA is a plant phenol and is used for rising plant resistance to undesirable effects of biotic and abiotic stresses and participates in regulation of plant physiological stages. SA has significant effect on different aspects of plant life like plant growth and development, photosynthesis, evaporation, ion transmission and absorption; also causes to special changes in leaf anatomy and chloroplast structure (Sakhabutdinova *et al.*, 2003). Motivation and aims of the study were evaluation of water stress and salicylic acid on some quantitative characteristics of mung bean.

Material and methods

Location of experiment

The experiment was conducted at the Research Station tropical fruits and natural resources in bahukalat (In Iran) which is situated between 25° North latitude and 61° East longitude and at an altitude of 85m above mean Sea Level.

Composite soil sampling

The soil of the experimental site belonging loam. Composite soil sampling was made in the experimental area before the imposition of treatments and was analyzed for physical and chemical characteristics.

Field experiment

The field experiment was laid out in randomized complete block design with split plot design with three replications.

Treatments

Treatments included irrigation as a major factor in three levels included (Full irrigation, Irrigation cut at flowering time, Irrigation cut at pod time) and salicylic acid concentrations in four levels included (0, 900, 1800, 2700 Micromolar) before planting the priming was done.

Data collect

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

Plant height

Analysis of variance showed that the effect of water stress on plant height was significant (Table 1). The maximum of plant height (46.48 cm) of treatments Full irrigation was obtained (Table 2). Water stress by reducing cell proliferation (reduced cell size and decreased cell division) in the vegetative stage of plant growth, plant height is reduced (Shakirova *et al.*, 2003). Because of the reduced height, reduced pressure, reducing inflammation and subsequent cell division and enlargement in terms of water stress (Cabusly *et al.*, 2002). Analysis of variance showed that the effect of Salicylic acid on plant height was significant (Table 1). The maximum of plant height (46.48 cm) of treatments 2700 Mm salicylic acid was obtained (Table 2). The precise mechanism of action is not yet clear but it is probable that salicylic acid as auxin is involved in the regulation of cell division and elongation.

Table 1. Anova analysis of the mungbean affected by water stress and salicylic acid.

S.O.V	df	Plant height	Stem diameter	Pod length	Number of pods per plant	Number of seeds per pod
R	2	221.91**	4.98**	4.98ns	192.56**	5.32**
Irrigation cut	2	228.10**	1.95**	0.41**	193.81**	4.89**
Error	4	1.72	0.04	0.02	1.42	0.05
Salicylic acid	3	94.85**	4.19**	4.83*	92.05**	1.95**
Irrigation cut* Salicylic acid	6	11.16ns	0.68ns	1.08ns	8.86ns	0.19ns
Total error	18	8.34	0.53	48.52	6.42	0.17
C.V	-	6.96	8.82	14.55	10.25	5.03

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

Stem diameter

Analysis of variance showed that the effect of water stress on stem diameter was significant (Table 1). The maximum of stem diameter (8.75) of treatments Full irrigation was obtained (Table 2). Analysis of variance showed that the effect of Salicylic acid on stem diameter was significant (Table 1). The maximum of stem diameter (8.98) of treatments 2700 Mm salicylic acid was obtained (Table 2). Salicylic acid increases the amount of lignin in the cell wall structure, which can be a factor in the increase in stem diameter of plants subjected to drought stress.

Table 2. Comparison of different traits affected by water stress and salicylic acid.

Treatment	Plant height	Stem diameter	Pod length	Number of pods per plant	Number of seeds per pod
Water stress					
Full irrigation	46.48a	8.75a	8.37a	22.53b	9.11a
Irrigation cut at 50% flowering	38.78b	7.98b	8.50a	22.28b	8.03b
Irrigation cut at 50% pod	39.08b	8.17b	8.13b	29.36a	7.99b
Salicylic acid					
0	37.94c	7.45c	7.53b	21.20c	7.83c
900	39.87bc	8.07bc	8.27ab	23.32bc	8.19bc
1800	42.57ab	8.70ab	8.22ab	25.76b	8.57ab
2700	45.39a	8.98a	9.31a	28.62a	8.91a

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

Pod length

Analysis of variance showed that the effect of water stress on pod length was significant (Table 1). The maximum of pod length (8.37) of treatments Full irrigation was obtained (Table 2). Analysis of variance showed that the effect of Salicylic acid on pod length was significant (Table 1). The maximum of pod length (9.31) of treatments 2700 Mm salicylic acid was obtained (Table 2).

Number of pods per plant

Analysis of variance showed that the effect of water stress on number of pods per plant was significant (Table 1). The maximum of number of pods per plant (22.53) of treatments Full irrigation was obtained (Table 2). Analysis of variance showed that the effect of Salicylic acid on number of pods per plant was significant (Table 1). The maximum of number of pods per plant (28.62) of treatments 2700 Mm salicylic acid was obtained (Table 2).

Number of seeds per pod

Analysis of variance showed that the effect of water stress on number of seeds per pod was significant (Table 1). The maximum of number of seeds per pod (9.11) of treatments Full irrigation was obtained (Table 2). If corn is drought stress at flowering, number of grains per ear was significantly reduced, which confirms the results of the research (Composer, 2004). Analysis of variance showed that the effect of Salicylic acid on number of seeds per pod was significant (Table 1). The maximum of number of seeds per pod (8.91) of treatments 2700 Mm salicylic acid was obtained (Table 2).

References

Abro IP Bronson KF, Duxbury JM, Gupta RK. 1997 Long-term soil fertility experiments with rice-wheat rotation in South Asia. In Long-term soil fertility experiments with rice-wheat rota-tion in South Asia, Rice-Wheat Consortium Paper Series 1, ed. I. P. Abrol, K. F. Bronson J M Duxbury and R K Gupta. New Delhi: Rice-Wheat Consortium for the Indo-Gangetic Plains. **17,** 79-88.
http://dx.doi.org/10.1002/(SICI)1521-186X

Arberg B. 1981. Plant growth regulators XLI. Monosubstituted benzoic acid. Swed. J. Agric. Res., **11,** 93-105.
http://dx.doi.org/10.1017/S0960258599000057

Athar H, Ashraf M. 2005.Photosynthesis under drought stress. : Hand Book Photosynthesis, 2nd (ed.) by M. Pessarakli. C. R. C. Press, New York, USA **12,** 795-810.
http://dx.doi.org/10.2135/cropsci2002.1996

Begg JE, Turner NC. 1976. Crop water deficits. Adv. Agron. Academic press **28,** 191-217.
http://dx.doi.org/10.2135/cropsci2003.2135

Fariduddin Q, Hayat S, Ahmad A. 2003. Salicylic acid influences net photosynthetic rate, carboxylation efficiency, nitrate reductase activity and seed yield in Brassica juncea. Photosynthetica **41,** 281–284.
http://dx.doi.org/10.2135/cropsci2002.1996

Hayat Q, Hayat S, Irfan M, Ahmad A. 2010. Effect of exogenous salicylic acid under changing environment: A review. Environ. Exp. Bot. **68,** 14–25.
http://dx.doi.org/10.2135/cropsci2003.2135

Hsiao TC, Acevedo F. 1974. Plant response to water deficits, water use efficiency and drought resistance. Agric. Meteorol **14,** 69-84.
http://dx.doi.org/10.1016/S0074-7696(08)62489-4

Hussein MM, Balbaa LK, Gaballah MS. 2007. Salicylic acid and salinity effects on growth of maize plants. Res. J. Agric. Biol. Sci. **3,** 321–328.
http://dx.doi.org/10.1016/j.eja.2005.08.001

Khan W, Prithviraj B, Smith DL. 2003. Photosynthetic responses of corn and soybean to foliar application of salicylates. J. Plant Physiol. **160,** 485–492.
http://dx.doi.org/10.4141/cjps94-012

Kramer PJ, Boyer JS. 1997. Water relations of Plants and Soils, Academic Press, San Diago Arrese I Gonzalez EM Mariano D Landera R Larraiza E Gil-Quintana E. 2009 Physiological response of legume nodules to drought, Plant stress, Global Science Book, **5,** 24-31.
http://dx.doi.org/10.1006/anbo.1999.1076

Kramer PJ, Boyer JS. 1997. Water relations of Plants and Soils, Academic Press, San Diago Arrese I Gonzalez EM Mariano D Landera R Larraiza E Gil-Quintana E 2009 Physiological response of legume nodules to drought, Plant stress, Global Science book **5,** 24-31.

Lal M, Gupta PC, Pandey RK. 2000. Response of lentil to different irrigation schedules (Lens culinaris Medick). LENS Newsl. **15(1),** 20-23. http://dx.doi.org/10.2478/v10247-012-0052-4

Liu F, Jensen CR, Andersen MN. 2004. Drought stress effect on carbohydrate concentration in soybean leaves and pods during early reproductive development: its implication in altering pod set. Field Crops Research **86**, 1-13. http://dx.doi.org/10.1016/S0308-521X(01)00023-3

Maqsood M, Rahman S, Islam A. 2000. Effect of soil moisture stress on growth and yield of summer mung bean. Asian J. Plant Sci. **33(8),** 250-258. http://dx.doi.org/10.1093/aob/77.6.591

Pandey RK, Herrera WAT, Villegas AW, Penletion JW. 1984. Drought response of grain legumes under irrigation gradient. III. Plant growth, **76,** 557-560. http://dx.doi.org/10.2135/cropsci1992.0011183X003200030033x

Postel SL. 2000. Entering an era of water scarcity: The challenges ahead. Ecological Applications, **10**: 941-948. http://dx.doi.org/10.1071/P9930639

Sadasivan R, Natrajaratnam N, Dabu R, Muralidharan V, Rangasmay SRS. 1988. Response of Mungbean cultivars to soil moisture stress at different growth phases. Mungbean Proceeding of the Second International Symposium. AVRCD. 260-262 p. http://dx.doi.org/10.1017/S0960258500004141

Sakhabutdinova AR, Fatkhutdinova DR, Bezrukova MV, Shakirova FM. 2003. "Salicylic acid prevents the damaging action of stress factors on wheat plants". Bulg. J. Plant Physiol., special issue, 314– 319. http://dx.doi.org/10.1016/j.eja.2005.10.006

Sankar B, Abdul Jaleel C, Manivannan P, Kishorekumar A, Somasundaram R, Panneerselvam R. 2007. Effect of paclobutrazol on water stress amelioration through antioxidants and free radical scavenging enzymes in Arachis hypogaea L. Biointerfaces, **60,** 229-235. http://dx.doi.org/10.1017/S0960258500003032

Singh J, Patal A, 1996. Water statues, gaseous exchange, proline accumulation and yield of mung bean in response to water stress. Annual of Biology Ludhiana. **12,** 77-81. http://dx.doi.org/10.1017/S0960258500004141

Soltani A and Faraji A. 2007. Soil Water and Plant Relationship. Published by: Mashhad University. pp 246. (In Persian). http://dx.doi.org/10.2478/v10247-012-0042-6

Thomas M, Robertson J, Fukai S, Peoples MB. 2004. The effect of timing and severity of water deficit on growth development, yield accumulation and nitrogen fixation of mung bean. Field Crops Res. **86 (1),** 67-80. http://dx.doi.org/10.1016/j.indcrop.2006.07.004

Timsina J, Connor DJ. 2001. Productivity and management of rice-wheat cropping systems: Issues and challenges. Field Crops Research **69,** 93-132. http://dx.doi.org/10.1016/S0308-521X(01)00023-3

Timsina J, Garrity DP, Pandey RK .1993. Water table gradient effects on the performance of diverse cowpea cultivars. Agron. J. **85,** 359-367. http://dx.doi.org/10.2135/cropsci1997.0011183X003700010038x

Timsina J, Garrity DP, Pandey RK. 1994. The interaction of cowpea maturity with degree of

waterlogging in the post-rice environment. Field Crops Res. **39,** 39-48.
http://dx.doi.org/10.1002/j.20500416.2008.tb00300.x

Wang Ch F, Zhiu H, Feng LJ. 2008. Effect of water and fertilizer level on agronomic characteristics and quality of high protein soybean. Soybean Sci., China **47,** 23-35.
http://dx.doi.org/10.2135/cropsci2002.1996

Weinberger K. 2003. Impact analysis of Mungbean research in South and Southeast Asia. Final report of GTZ Project. The World Vegetable Center (AVRDC), Shanhua, Taiwan.
http://dx.doi.org/10.1002/(SICI)1521-186X

Zarco-Tejada PJ, Miller JR, Mohammad GH, Noland TL, Sampson PH. 2000. Chlorophyll fluorescence effects on vegetation apparent reflectance. Remote Sensing of Environment **74,** 596-608.
http://dx.doi.org/10.1016/S0308-521X(01)00023-3