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SOIL MOISTURE STRESS AND MICRONUTRIENTS FOLIAR APPLICATION EFFECTS ON GROWTH AND YIELD OF MUNG BEAN PLANTS

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ABSTRACT

Two field experiments were carried out at the Agricultural Experimental Station of National Research Centre at Shalakan, Kalubia Governorate during 2001 and 2002 seasons to study the single and combined effects of soil moisture stress (Skipping one irrigation either at vegetative growth, flowering or pod formation stage i.e. 30, 45 and 60 days from sowing, respectively) and foliar application of micronutrients compound amino (0, 0.5, 1 and 1.5 L/fed.) on growth, yield and its related characters as well as the seed chemical composition of mung bean (cv. Kawmy-1). The results revealed that skipping one irrigation at any of the three studied stages significantly reduced growth criteria, seed yield and its components as compared with the control plants. However, the negative response of mung bean plants to skipping one irrigation was more pronounced at pod formation stage than other two stages. Moreover, the exposure to water stress significantly increased the protein content in mung bean seeds, whereas an inverse relationship was noticed as for the percentage of total carbohydrate in the produced seeds, carbohydrate and protein yields per feddan.

The data indicated further that spraying mung bean plants with amino up to 1 L/fed. resulted in significant increases in growth parameters studied, seed yield and its related characters as compared to the untreated ones. Similar tendency could be noticed regarding the percentages of total carbohydrate and crude protein in the produced seeds, and consequently increased each of carbohydrate and protein yield per feddan. The results suggested that irrigation every 15 days and application of amino with 1 L/fed. could be recommended for maximum yield of mung bean plants under similar conditions.
Keywords: Growth, Micronutrients, Mung bean, Yield, Water stress

INTRODUCTION

Mung bean green gram (*Vigna radiata* L. Wilczek) is an early mature high yielding pulse crop. It is annual legumenious crop, relatively drought tolerant and can be eaten. Mung bean seeds surpass lentil and faba bean in Ca, Fe and vitamin A contents and contain nearly the same percentage of protein (about 23 to 24%).

Introducing of high yielding food crops of short growing season in the crop pattern is considered to be an effective mean for narrowing the food gab in Egypt. Because of limited water resources particularly in the newly reclaimed land in the northern part of Egypt, mung bean crop have to grow on a diminishing supply of soil water and are often subjected to water stress during the post-flowering period causing significant yield reduction. Despite having a reputation for drought avoidance (Haqqani and Pandey, 1994), mung bean yield has been shown to be responsive to irrigation (DeCosta and

Shanmugathasan, 1999b), as they indicated that the treatments which received irrigation during two or more stages had significantly higher yields than those received irrigation during only one stage.
Kandil (2000) results have shown that water stress, at any studied reproductive stage revealed harmful effects on growth criteria, seed yield and its components.

On the other hand, regerding to micronutrient treatments Singh and Badhoria (1984) reported significant positive effect of Zinc treatment on dry matter, seed and straw yield of mung bean as well as on the percentage of protein in the seeds. Krishna (1995) stated that Zn up to 15 kg/ha significantly increased seed yield and protein % in mung bean seeds. Abd El-Lateef *et al* (1998) indicated that foliar spray with Zn, Mn and their combination increased the seed yield and protein content of mung bean seeds. Abdo (2001) and Rizk & Abdo (2001) indicated that foliar application with Zn, Mn, B and their combination increased significantly growth parameters, yield and its components.

The aim of this research is to study the effect of water stress and micronutrients foliar application on growth, yield and its related characters as well as the chemical composition of mung bean seeds.

MATERIAL AND METHODS

Two field experiments were carried out during the two successive seasons of 2001 and 2002 at the experimental farm of the National Research Center in Shalakan Kalubia Governorate, Egypt. The soil texture of the experimental site was clay loam in both seasons. The investigation included sixteen treatments which were the combination of four irrigation treatments and four concentrations of micronutrients compound amino i.e., Fe (2%), Mn (2%), Zn (2%), Mg (2%), produced by El-Nasr company for fertilizers and pesticides at concentrations of 0, 0.5, 1 and 1.5 L/fed.. A split plot design with three replications was employed. The main plots were devoted to water stress treatments while the sub-plots were assigned for amino foliar spray treatments. The soil was ploughed twice ranged and divided into plots. Each plot (10.5 m^2) consisted of 5 rows of 3.5 m in length and 0.6 m apart. To avoid the effect of lateral movement of irrigation water, the plots were isolated by borders of 1.5 m in width from all sides. Irrigation treatments were imposed to allow the plants either unstressed (control treatment), or stressed by skipping one irrigation at vegetative growth, flowering and pod formation stages i.e. 30, 45 and 60 days from sowing, respectively.

Foliar spraying with either tap water as control or 0.5, 1 and 1.5 L/fed. from amino was applied twice at 45 and 60 days after sowing.

On July 12th and 10th in 2001 and 2002 seasons , mung bean seeds (*Vigna radiata* L. Wilczek) cv. Kawmy-1 were sown in hills 15 cm a part at the two sides of the row. Seeds peviously inculated with the spesific strain of *Rhizobium leguminosarum* L., . Thinning to two plants per hill was done before the first irrigation (15 days after sowing). The normal agricultural practices for growing mung bean were followed as recommended in the region. Calcium superphosphate (15.5% P_2O_5) and Potassium sulphate (48% K_2O) at the rate of 150 and 50 kg/fed., respectively were applied before sowing. Stimulative dose of nitrogen (urea 46% N) at the rate of 15 kg N/fed. was added just after thinning and before the first irrigation.

Representative plant sample was collected from three replicates for each treatment after 75 days from sowing where plant height, number of branches, leaves and pods as well as the leaves, stem, pods, root and total dry weight per plant were determined. At harvest time, nine guarded plants were chosen at random from each plot for determing the yield attributes like number of pods per plant, weight of pods and seeds/plant, 1000-seed weight.

Seed, straw and biological yields/fed. were estimated using the guarded plants of two central rows from each experimental plot. Moreover, total nitrogen was determined in dry seeds using Kjeldah's apparatus according to A.O.A.C. (1990) method. Crude protein percentage was calculated by multiplying the nitrogen percentage by the factor 6.25. Total carbohydrate content in mung bean seeds was determined using the method adopted by Dubois *et al* (1956), then crude protein and carbohydrate yields per feddan were calculated.

The obtained data were subjected to the statistical analysis of variance described by Snedecor and Cochran (1980) and the combined analysis of results of the two seasons were applied according to the method adopted by Steel and Torrie (1960).

RESULTS AND DISCUSSION

1. Effect on growth parameters

Table (1) clearly indicates that decreasing soil moisture content by skipping one irrigation at any of the studied reproductive stages (i.e. vegetative growth, flowering and pod formation) led to significant reduction in plant height, number of branches, leaves and podes per plant, weight of leaves, stem, pods and root per plant as well as total dry weight per plant than those of adequate water supply (control plants). Similar results were obtained by Phogat *et al* (1984); Miah *et al* (1996); DeCosta & Shanmugathasan (1999a); Kandil (2000) and Kassab (2000). In this regard, Phogat *et al* (1984) reported that the decrease in growth of mung bean plants by water stress (low amounts of water) may be attributed to the decrease in net photosynthesis (Pn), dark respiration (Rd) and absorption coefficient of photosynthetic activity rate (PAR) which decrease the translocation of metabolic products from source (leaf) to sink organs (seed). The present results reveal that mung bean plants appeared to be more sensitive to soil moisture stress during pod formation stage, where the total dry matter production per plant was more significantly reduced than control . In addition, the results of DeCosta & Shanmugathasan

(1999a) indicated that mung bean plants which did not receive irrigation during the pod formation stage had a lower total dry weight than the other treatments studied.

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The data revealed further that plant height, number of branches, leaves and pods per plant, weight of leaves, stem, pods and root per plant as well as total dry weight per plant tended to increase significantly by increasing the concentration of amino up to 1 L/fed. as compared to the untreated plants. Similar results were obtained by Singh & Badhoria (1984); Singh & Singh (1995); Abd El-Lateef *et al* (1998); Sarkar *et al* (1998) and Abdo (2001).

The interaction effect between water stress and amino fertilization treatments was not significant except number of pods per plant, weight of stem and pods per plant and total dry weight per plant. Spraying 1 L/fed. of amino under normal irrigation gave the highest number of pods per plant, weight of stem and pods per plant and total dry weight per plant as compared with the other treatments (Table 1).

2. Effect on yield and its related characters

Data presented in Table (2) show that exposing mung bean plants to water stress at each of vegetative growth, flowering or pod formation stages resulted in significant reductions in number of pods per plant, weight of pods and seeds per plant, 100-seed weight as well as seed, straw and biological yields per feddan as compared with control treatment (irrigation every 15 days). However, the response of mung bean plants to water stress was more pronounced at pod formation stage than the two other stages. These results are in agreement with those obtained by Prasad & Yadav (1990); Sarkar (1992) and Kandil (2000). In this connection, DeCosta and Shanmugathasan (1999b) illustrated that the number of pods per plant was the yield component that had the strongest control on the variation of mung bean yields under different water regimes. Therefore, the most certain way of achieving high mung bean yields under any water regime would be to focus breeding and crop management efforts towards achieving a high number of pods per plant.

The obtained results reveal also that foliar application of micronutrients significantly affected the yield and its related characters. Increasing the concentration of amino up to 1 L/fed. caused a significant increase in the

Aforementioned parameters. Similar results were obtained by Singh & Singh (1995); Abd El-Lateef *et al* (1998); Sarkar *et al* (1998) and Rizk and Abdo (2001).

The interaction effect between water deficit and amino fertilization treatments, was not significant except weight of seed per plant. Spraying 1 L/fed. of amino under normal irrigation gave the highest weight of seeds per plant as compared with the other treatments (Table 2).

3. Effect on seed chemical composition

Data presented in Table (3) clearly show that subjecting mung bean plants to water stress at any investigated stage significantly reduced total carbohydrate content in the produced seeds as compared to the control. The same trend was noticed regarding carbohydrate and protein yields per feddan.

Table (3): Effect of water stress, micronutrients foliar application and their interaction on seed chemical composition of mung bean. (combined analysis of 2001 and 2002 seasons).

Water stress treatments	Micronutrients treatments (L/fed.)	Total carbohydrate (%)	Carbohydrate yield/fed. (kg)	Crude protein (%)	Protein yield/fed. (kg)
Unstressed (control)	0	57.16	439.54	18.69	143.72
	0.5	57.92	450.47	19.74	153.45
	1.0	58.82	521.51	20.70	183.54
	1.5	58.31	435.37	20.21	151.42
	Mean	58.01	461.72	19.84	158.03
Stressed at vegetative growth stage	0	55.82	393.12	21.10	148.58
	0.5	56.22	405.56	21.33	153.87
	1.0	57.18	447.90	22.68	177.67
	1.5	56.75	398.35	21.71	152.37
	Mean	56.49	411.23	21.70	158.12
Stressed at flowering stage	0	54.32	327.55	22.65	136.59
	0.5	55.13	330.67	23.12	141.37
	1.0	56.19	397.84	24.12	170.75
	1.5	55.65	345.37	23.36	144.96
	Mean	55.32	350.38	23.31	148.42
Stressed at pod formation stage	0	53.11	248.02	23.11	107.92
	0.5	53.37	275.20	23.48	121.04
	1.0	54.24	318.57	24.64	144.70
	1.5	53.61	259.65	24.27	117.50
	Mean	53.58	275.36	23.87	122.79
Mean values for micronutrients treatments	0	55.10	352.06	21.39	134.20
	0.5	55.66	365.50	21.92	142.43
	1.0	56.61	421.45	23.04	169.16
	1.5	56.03	359.68	22.39	141.56
L.S.D at 5% level for:	S	0.10	13.09	0.26	3.91
	M	0.12	11.37	0.14	4.39
	S x M	0.24	NS	0.28	NS

S = water stress treatments **M = micronutrients treatments**
S x M = interaction

Reversely, crude protein percentage significantly increased by the exposure to such unfavourable conditions. These observations could correspond with certain results reported by Hamed (1998) and Kassab (2000). The reduction in carbohydrates accumulated due to water shortage may be attributed to a decrease in photosynthetic efficiency and/or an increase in respiration rates and hence, leading to an inhibition in translocation of assimilates into seeds.

The obtained data reveal that spraying mung bean plants with micronutrients resulted in a significant increase in the percentages of total carbohydrate and crude protein in the produced seeds and consequently increased each of carbohydrate and protein yields per feddan as compared with the untreated ones. Such increment was in line with the increase in the micronutrient concentration up to 1 L/fed. The obtained results are in great agreement with those obtained by Singh & Badhoria (1984); Krishna (1995); Abd El-Lateef *et al* (1998) and Rizk & Abdo (2001).

The interaction between water stress and micronutrients treatments was significant except for carbohydrate and protein yields per feddan. Spraying 1 L/fed. of amino under normal irrigation gave the highest total carbohydrate (58.82%) as compared with the other treatments (Table 3).

It could be concluded that irrigation every 15 days and application of amino with 1 L/fed. gave the highest productivity of mung bean plants.

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تأثير الاجهاد الرطوبى للتربة والرش بالعناصر الصغرى على نمو ومحصول نباتات فول المانج

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قسم العلاقات المائية والرى الحقلى- المركز القومى للبحوث- الدقى- الجيزة- مصر

أقيمت تجربتان حقليتان بمزرعة المركز القومى للبحوث بشلقان (محافظة القليوبية) خلال عامى ٢٠٠١، ٢٠٠٢ بهدف دراسة تأثير معاملات الرى (الرى كل ١٥يوم، منع ريه واحدة عند كل من مرحلة النمو الخضرى، الإزهار، وتكوين القرون وذلك بعد ٣٠، ٤٥، ٦٠ يوم من الزراعة علي التوالى) والرش بالعناصر الصغرى باستخدام المركب التجارى أمينو (حديد ٢% - زنك ٢% -٠ منجنيز ٢% - ماغنسيوم ٢%) بمعدل صفر، ٠,٥، ١، ١,٥ لتر/ فدان وذلك علي النمو، المحصول ومكوناته وكذلك التركيب الكيميائى لبذور فول المانج صنف قومى-١.

أوضحت النتائج الآتى:

١- أن تعريض النباتات للاجهاد المائى نتيجة منع الرى في أى من المراحل الثلاث المشار إليها أدى إلي نقص معنوى في صفات النمو ومحصول البذور ومكوناته بالمقارنة بالنباتات المروية عادياً. والاستجابة السالبة لنباتات فول المانج كانت أكثر وضوحاً عندما تتعرض للحرمان من الرى في مرحلة تكوين القرون. بالإضافة إلي ذلك فإن التعرض للإجهاد المائى أدى إلي زيادة معنوية في محتوى البروتين الخام للبذور، بينما هناك إتجاه عكسى بخصوص النسبة المئوية للكربوهيدرات الكلية في البذور وكذلك محصول الكربوهيدرات والبروتين للفدان.

٢- أن رش نباتات فول المانج بالعناصر الصغرى بمعدل ١ لتر/ فدان أحدث زيادات معنوية في قياسات النمو المدروسة، ومحصول البذور ومكوناته مقارنة بالنباتات غير المعاملة، لوحظ إتجاه مماثل بالنسبة لمحتوى الكربوهيدرات الكلية والبروتين الخام في البذور مما أدى إلي زيادة كل من محصول الكربوهيدرات والبروتين للفدان.

٣- يمكن التوصية برش نباتات فول المانج بالعناصر الصغرى باستخدام المركب التجارى أمينو بمعدل ١ لتر/ فدان مع استمرار الرى كل ١٥ يوم وذلك لتحقيق أعلى محصول من نباتات فول المانج.

Table (1): Effect of water stress, micronutrients foliar application and their interaction on growth parameters of mung bean plants after 75 days from sowing .(combined analysis of 2001 and 2002 seasons).

Water stress treatments	Micronutrient treatments (L/fed.)	Plant height (cm)	No.of branches/ plant	No. of Leaves/ plant	No. of pods/ plant	Wt. of leaves/plant	Wt. of stem/plant	Wt. of pods/ plant	Wt. of root/ plant	Total dry Wt. Plant
						(g)				
Unstressed (control)	0	97.00	4.11	16.00	20.44	14.00	16.33	12.44	3.44	46.22
	0.5	98.22	4.44	16.44	23.11	14.11	18.44	14.78	3.78	51.11
	1.0	101.00	4.89	17.89	25.44	15.44	19.55	17.44	4.22	56.66
	1.5	96.22	4.22	15.55	20.44	13.11	16.44	12.78	3.33	54.66
	mean	98.11	4.41	16.47	22.36	14.17	17.69	14.36	3.69	49.91
Stressed at vegetative growth stage	0	82.00	2.55	12.89	16.44	12.33	14.44	10.00	2.11	38.89
	0.5	84.11	2.89	13.55	16.67	12.44	14.44	10.78	2.44	40.11
	1.0	88.00	3.89	14.78	21.00	13.78	16.44	14.33	3.11	47.66
	1.5	82.11	2.55	12.89	16.78	11.67	14.55	10.67	2.55	39.44
	mean	84.06	2.97	13.53	17.72	12.56	14.97	11.44	2.55	41.52
Stressed at flowering stage	0	74.67	2.22	10.33	14.44	9.44	10.55	8.22	2.11	30.33
	0.5	76.00	2.11	12.00	16.44	10.67	12.11	9.78	2.55	35.11
	1.0	81.00	3.00	12.67	18.78	12.11	14.44	11.89	2.78	41.22
	1.5	77.44	2.00	10.44	15.00	9.78	11.33	8.78	2.78	32.66
	mean	77.28	2.33	11.36	16.17	10.50	12.11	9.66	2.55	34.83
Stressed at pod formation stage	0	71.67	2.89	9.44	10.44	8.11	9.11	6.44	2.11	25.77
	0.5	75.00	2.55	10.44	13.78	9.33	10.11	8.44	2.33	30.22
	1.0	78.00	3.11	12.11	15.33	10.78	12.78	10.11	2.55	36.22
	1.5	74.11	2.55	9.22	12.44	8.78	10.33	7.11	2.11	28.33
	mean	74.69	2.78	10.30	13.00	9.25	10.58	8.03	2.28	30.13
Mean values for micronutrient treatments	0	81.33	2.94	12.17	15.44	10.97	12.61	9.28	2.44	35.30
	0.5	83.33	3.00	13.11	17.50	11.64	13.78	10.94	2.78	39.13
	1.0	87.00	3.72	14.36	20.14	13.03	15.80	13.44	3.16	45.44
	1.5	82.47	2.83	12.03	16.17	10.83	13.17	9.83	2.69	36.52
L.S.D at 5% level for:	S	1.42	0.17	0.65	0.97	0.77	0.26	0.64	0.35	1.51
	M	0.94	0.39	0.34	0.49	0.38	0.39	0.42	0.30	0.84
	SxM	N.S	N.S	N.S	0.98	N.S	0.78	0.85	N.S	1.68

S = water stress treatments M = Micronutrients treatments S x M = interaction

Table (2): Effect of water stress, micronutrients foliar application and their interaction on yield and its related characters of mung bean .(combined analysis of 2001 and 2002 seasons).

Water stress treatments	Micronutrients treatments (L/fed.)	No.of pods/plant	Wt.of pods/plant (g)	Wt .of seeds/plant (g)	Seed index (1000-seed weight) (g)	Seed yield/fed. (kg)	Straw yield/fed. (kg)	Biological yield/fed. (kg)
Unstressed (control)	0	30.00	20.00	11.44	61.11	769.00	2489.00	3258.00
	0.5	32.67	22.44	11.89	64.11	777.67	2648.00	3425.67
	1.0	35.67	24.89	14.44	68.00	886.67	2757.67	3644.33
	1.5	29.44	20.44	11.55	62.00	749.00	2753.33	3502.33
	mean	31.94	21.94	12.33	63.81	795.58	2662.00	3457.58
Stressed at vegetative growth stage	0	25.44	15.89	10.55	56.44	704.33	2258.00	2962.33
	0.5	28.11	18.44	11.11	59.67	721.33	2360.00	3081.33
	1.0	31.78	20.44	12.89	63.67	783.33	2541.00	3324.33
	1.5	25.00	15.67	10.44	57.00	702.00	2414.33	3116.33
	mean	27.58	17.61	11.25	59.19	727.75	2393.33	3121.08
Stressed at flowering stage	0	22.44	12.22	8.44	51.44	603.00	2027.00	2603.00
	0.5	25.00	15.22	10.11	55.11	611.33	2184.33	2795.67
	1.0	29.00	19.00	11.22	59.11	708.00	2388.00	3096.00
	1.5	23.33	14.00	9.11	52.22	620.67	2148.67	2769.33
	mean	24.94	15.11	9.72	54.47	635.75	2187.00	2822.75
Stressed at pod formation stage	0	20.44	11.00	7.11	49.89	467.00	1752.67	2219.67
	0.5	23.11	12.44	8.89	51.67	515.67	1980.00	2495.67
	1.0	24.33	14.55	10.11	54.11	587.33	2071.00	2658.33
	1.5	21.22	11.78	8.11	50.33	484.33	1915.33	2399.67
	mean	22.28	12.44	8.55	51.50	513.58	1929.75	2443.33
Mean values for micronutrients treatments	0	24.58	14.78	9.39	54.72	635.83	2131.67	2767.50
	0.5	27.22	17.14	10.50	57.64	656.50	2293.08	2949.58
	1.0	30.19	19.72	12.16	61.22	741.33	2439.42	3180.75
	1.5	24.75	15.47	9.80	55.39	639.00	2307.92	2946.92.
L.S.D at 5% level for:	S	0.83	0.56	0.38	0.62	22.61	69.15	68.73
	M	0.84	0.73	0.32	0.72	20.87	52.17	61.73
	S X M	NS	NS	0.65	NS	NS	NS	N.S

S = water stress treatments M = <icronutrients treatments S x M = interaction

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