Bull. Fac. Agric. Cairo Univ.,52
(2001): 467-478.

THE RESPONSE OF TWO MUNGBEAN CULTIVARS TO ZINC, MANGANESE AND BORON II. YIELD AND CHEMICAL COMPOSITION OF SEEDS

(Received: 9.12.2000)

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ABSTRACT

Two field experiments were carried out at Giza Experimental Station, ARC, during 1998 and 1999 seasons to investigate the response of mungbean (*Vigna radiata* (L.) Wilczek) to treatments with some micronutrients. Two cultivars of mungbean (V-2010 and VC-1000) were used in this investigation. Zn (0.2 or 0.4 g/l), Mn (1.5 or 2.0 g/l), B (3.0 or 5.0 g/l) and a mixture of Zn, Mn and B (0.2, 1.5 and 3.0 g/l), in addition to distilled water as control were sprayed once at 35 days after sowing (DAS). The obtained results could be summarized in the following:

Generally, cultivar VC-1000 surpassed cultivar V-2010 in yield and its components as well as in the chemical composition of seeds with exception in 100-seed weight and phosphorus percentage in seeds.

All treatments increased significantly yield and its components especially Zn_1 (0.2 g/l) which showed a highly significant increase in all characters under investigation compared to the control.

All adopted treatments increased significantly protein percentage in seeds of the two mungbean cultivars in both seasons. Among all treatments of micronutrients, B gave the highest percentage of crude protein. Seeds of mungbean cv. VC-1000 exceeded those of mungbean cv. V-2010 in crude protein percentage with significant difference in both seasons. In contrast, all sprayed treatments with micronutrients showed no statistical effect on the percentages of total carbohydrates, phosphorus and potassium in seeds of the two investigated mungbean cultivars in both seasons.

Key words: *foliar application, micronutrients, mungbean, yield components.*

1. INTRODUCTION

Mungbean (*Vigna radiata* (L.) Wilczek) is a leguminous species, grown principally for its protein rich edible seeds. Among the factors affecting crop production, fertilizers play the most important role in the production of mungbean. Recently, micronutrients have assumed greater significance due to their deficiency owing to adaptation of intensive cropping and monocropping with the use of high analysis macronutrient fertilizers with very little use of organic manures.

Many investigators demonstrated that yield and its components of mungbean are influenced by Zn, Mn and B application. Howeler *et al.*, (1978) mentioned that the application of 4 kg B/ha was necessary for optimum mungbean yield. Singh and Badhoria (1984) reported significant positive effect of zinc treatment on seed and straw yield of mungbean as well as on protein % in the seeds. Prasad and Ram (1988) and Mary and Dale (1990) stated that foliar application of B (1.12 kg borax/ha) increased the number of pods and seed yield per soybean plant. Singh and Kumari (1990) found that mungbean yield increased from 445 to 535 kg/ha with 30 kg Mn/ha and was not further increased with 60 kg Mn/ha. Krishna (1995) stated that Zn up to 15 kg/ha significantly increased seed yield and protein % in mungbean 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 mungbean seeds. Also, they found that VC-1000 variety had a high number of pods/plant and seed yield compared to V-2010 variety. While, V-2010 gave the highest 100-seed weight. Sarkar *et al.*, (1998) indicated that Mn, Zn and B increased mungbean yield and its components over the control. Hessien (2000) mentioned that VC-1000 variety surpassed V-2010 variety in the number and weight of pods/plant, seed yield/plant and protein percentage, whereas, V-2010 was superior in 1000-seed weight and carbohydrate %.

The present study was carried out to throw some light on the effect of Zn, Mn and B on mungbean yield quality and quantity.

2. MATERIALS AND METHODS

Two field experiments were carried out at Field Crop Research Institute, Agricultural Research Center (ARC), Giza during the two growing seasons of 1998 and 1999. The two mungbean cultivars V-2010 (Giza-1) and VC-1000 were used to study the effect of some micronutrients on yield, yield components and chemical composition of seeds. Eight treatments were applied as foliar spray after 35 days from sowing and the treatments were as follows:

- Control (spray with water)
- Zinc sulphate 0.2 g/l (Zn_1)
- Zinc sulphate 0.4 g/l (Zn_2)
- Manganese (E.D.T.A) 1.5 g/l (Mn_1)
- Manganese (E.D.T.A) 2.0 g/l (Mn_2)
- Boric acid 3.0 g/l (B_1)
- Boric acid 5.0 g/l (B_2)
- Mixture (0.2 Zn, 1.5 Mn and 3.0 B g/l)

The experiment was laid out in a randomized complete block design with four replications. The experimental plot area was 12.6 m^2 consisted of 6 ridges 3 meters in length and 70 cm in width. Seeds were inoculated with the specific *Rhizobium* strain (*Bradyrhizobium japonicum*) and immediately sown in hills on both sides of the ridge at 20 cm apart. Seeds were sown on May 31$^{st.}$ (first season) and May 12$^{th.}$ (second season). All agricultural practices were used as recommended. The mechanical and chemical analysis for the experimental soil were determined and presented in the first paper (Abdo, 2001).

At harvest (after 90 days from sowing date), the following measurements were recorded: the number of pods per plant, mean number of seeds per pod, average weight of 100 seeds (g), seed yield (g)/plant and straw yield (g)/plant. Chemical analysis of mature dried seeds include: crude protein, total carbohydrates, phosphorus and potassium %.

Protein was determined as total nitrogen by micro-Kieldahal method and crude protein was obtained by multiplying nitrogen content by 6.25 (A.O.A.C., 1990).

Total carbohydrates were determined (as glucose) according to Thomas and Dutcher (1924).

The method used for phosphorus determination was that described by Moore and Chapman (1986).

Potassium was determined using Flam-photometric method as described in A.O.A.C. (1990).

The obtained data were statistically analyzed according to Snedecor and Cochran (1982).

3. RESULTS AND DISCUSSION

3.1. Yield and yield components

The mean values of yield characters of two mungbean cultivars as affected by micronutrient treatments in 1998 and 1999 seasons are presented in Table (1).

3.1.1. Number of pods/plant

It is realized from Table (1) that all adopted treatments of micronutrients increased significantly the number of the pods per mungbean plant in both seasons. The maximum increase in the number of pods was obtained by Zn_1 followed by the combined treatment of Zn_1+Mn_1+B_1 in both seasons, being 147.6 and 127.8% over the control in the first season and 169.5 and 121.4% over the control in the second one; respectively. Data also indicated that mungbean cv. VC-1000 surpassed mungbean cv. V-2010 in this respect with significant difference in both seasons.

In this connection, Saleh and Foda (1980) and Nassar *et al.,* (1985) found that micronutrients application increased the number of pods/bean plant. Likewise, Singh and Singh (1995) confirmed these findings using soybean plants. Similarly, Abd-El-Lateef *et al.,* (1998) on mungbean and Sarkar *et al.,* (1998) on greengram, stated that the application of micronutrients increased the number of pods per plant. All, being in agreement with the present findings.

3.1.2. Mean number of seeds per pod

Data presented in Table (1) clearly show that all sprayed treatments of micronutrients increased significantly the mean number of seeds per pod of the two mungbean cultivars under investigation in the first season of 1998. Whereas, the significant increase in the second season (1999) was achieved by Zn_1, Zn_2, Mn_1 and the combined treatment (Zn_1+ Mn_1 + B_1). The other micronutrient treatments (Mn_2, B_1 and B_2) showed insignificant effect on mean number of seeds per pod of the two investigated mungbean cultivars in the second season. The maximum significant increase in the number of seeds per pod was recorded by Zn_1 in both seasons, being 11.6% more than the control in the first season and 10.32% more than the control in the second one.

Data also revealed that mungbean cv. CV-1000 surpassed mungbean cv. V-2010 in this respect with a significant difference between them in the first season only.

These results are in accordance with those obtained by Singh and Singh (1995) and Sarkar *et al.*, (1998).

3.1.3. Average weight of 100 seeds (g)

It is clear from Table (1) that the specific weight of seeds was not affected by micronutrient treatments in the first season. Whereas, all assigned treatments of micronutrients increased significantly the average weight of 100 seeds of the two investigated mungbean cultivars in the second season. The only exception was found when the plants were sprayed with B_2 where the difference proved insignificant. It is obvious that the maximum weight of 100 seeds was achieved by Zn_1 followed by the combined treatment (Zn_1+Mn_1+B_1) then by Zn_2 without significant differences among them. The significant increases over the control were 21.5, 21.14 and 20.76% for Zn_1, combined treatment and Zn_2, respectively. It is worthy to note that mungbean cv. V-2010 exceeded mungbean cv. VC-1000 in this respect with significant differences in both seasons.

The previous reports of Singh and Singh (1995), Abd-El-Lateef *et al*,. (1998) and Sarkar *et al.*, (1998) are in agreement with the present findings.

3.1.4. Yield of seeds (g) per plant

Data on seed yield per plant of the two mungbean cutivars V-2010 and VC-1000 as affected by spraying with the micronutrients in two seasons are given in Table (1). The obtained results revealed that all treatments with Zn, Mn, B or their mixture increased significantly yield of seeds per plant of the two mungbean cultivars in both seasons. It is clear that mungbean cv. VC-1000 surpassed mungbean cv. V-2010 in this respect with significant differences in both seasons. The maximum increase in seed yield was obtained by Zn_1 followed by the combined treatment of Zn_1+Mn_1+B_1 and then by Zn_2 with no significant difference in the first season and with significant difference in the second one. The increases over the control were 152.9, 145.7 and 129.4% in the first season and were 195.5, 139.8 and 126.6% in the second one for Zn_1, Zn_1+Mn_1+B_1 and Zn_2; respectively. It is worthy to note that the increase in seed yield could be mainly attributed to the increase in the number of pods per plant as well as in the number of seeds per pod and partially in weight of 100 seeds.

The present findings are in accordance with those reported by Howeler *et al.*, (1978), Singh and Badhoria (1984), Nassar *et al.*, (1985), Prasad and Ram (1988), Mary and Dale (1990), Singh and Kumari (1990), Krishna (1993), Abd-El-Lateef *et al.*, (1998) and Sarkar *et al.*, (1998).

Table (1): Yield and yield components of two mungbean cultivars as affected by Zn, Mn and B in the two successive seasons of 1998 and 1999.

Treatment	No. of pods per plant	No. of seeds per pod	Weight of 100 seeds (g)	Seed yield (g/plant)	Straw yield (g/plant)
			1998		
Control	19.08	11.20	5.06	8.57	26.15
Zn_1	47.24	12.50	5.67	21.67	52.62
Zn_2	42.76	12.23	5.57	19.66	44.85
Mn_1	40.72	11.99	5.39	16.06	45.27
Mn_2	39.23	11.72	5.37	15.37	42.79
B_1	34.22	11.62	5.34	14.42	40.27
B_2	34.39	11.74	5.23	13.85	38.06
Zn_1+Mn_1+B_1	43.47	12.32	5.51	21.06	46.13
L.S.D. (0.05)	3.14	0.385	N.S.	2.260	3.160
V-2010	36.07	11.80	5.94	14.65	40.58
VC-1000	39.21	12.02	4.84	18.01	43.45
L.S.D. (0.05)	1.57	0.193	0.194	1.140	1.580
			1999		
Control	22.13	11.63	5.25	8.92	29.06
Zn_1	59.63	12.83	6.38	26.36	63.01
Zn_2	46.00	12.43	6.34	20.21	52.87
Mn_1	40.50	12.63	6.10	19.01	49.04
Mn_2	40.00	12.10	5.97	17.07	47.91
B_1	39.88	12.10	5.93	18.60	44.91
B_2	35.38	11.68	5.61	16.06	40.01
Zn_1+Mn_1+B_1	49.00	12.77	6.36	21.39	54.58
L.S.D. (0.05)	13.16	0.694	0.518	2.390	12.380
V-2010	36.88	12.17	6.57	16.96	44.74
VC-1000	46.25	12.36	5.42	19.94	50.61
L.S.D. (0.05)	6.370	N.S.	0.259	1.180	N.S.

3.1.5. Yield of straw (g) per plant

Data presented in Table (1) indicated that all adopted treatments of micronutrients increased significantly straw yield per plant of the two mungbean cultivars under investigation in both studied seasons. It is obvious that cv. VC-1000 exceeded cv. V-2010 in straw yield with a significant difference in both seasons. The maximum increase in straw yield was achieved by Zn_1, being 101.2 and 116.8% more than the control in the first and second season; respectively. On the other hand, the minimum increase in straw yield was recorded by B_2, being 45.5 and 37.7% more than the control in the first and second seasons; respectively.Similar results were also recorded by Krishna (1995).

3.2. Chemical analysis of the seed

Chemical analysis was performed on mature dried seeds of each mungbean cultivar as affected by different treatments of micronutrients. For each treatment, chemical analysis was done to determine the percentages of crude protein, total carbohydrates, phosphorus and potassium. Such quantitative determinations were used to disclose the qualitative changes in mungbean seeds as a result of spraying plants with Zn, Mn and B alone or in combined mixture.

The percentages of these fractions in seeds of treated and untreated plants of the two mungbean cultivars V-2010 and VC-1000 in the two growing seasons of 1998 and 1999 are given in Table (2).

3.2.1. Crude protein

It is realized from Table (2) that all sprayed treatments with micronutrients increased significantly the percentage of crude protein in seeds of the two mungbean cultivars under investigation in both studied seasons. Results presented in Table (2) clearly show that seeds of cv. VC-1000 exceeded those of cv. V-2010 in crude protein percentage with significant difference between the two cultivars in both seasons. The highest percentage of crude protein was recorded in seeds of plants sprayed with B_2 in both seasons. This means that B_2 gave the maximum significant increase in percentage of crude protein, being 17.17 and 14.79% more than crude protein in seeds of control plants in the first and second season; respectively.

In this connection, Singh and Badhoria (1984) as well as Krishna (1995) stated that application of zinc to greengram plants increased the percentage of crude protein in seeds of treated plants. Likewise, Abd-

El-Lateef *et al.,* (1998) found that application of manganese increased the percentage of crude protein in seeds of mungbean. All, being in agreement with the present findings.

3.2.2. Total carbohydrates

Data presented in Table (2) reveal that all adopted treatments of micronutrients showed no statistical effect on percentage of total carbohydrates in seeds of the two investigated mungbean cultivars in both seasons. Moreover, it is clear that the two cultivars were statistically indifferent in this respect.

The previous report of Abd-El-Lateef *et al.*, (1998) stated that zinc showed an insignificant effect on total carbohydrates percentage in mungbean seeds. Whereas, the application of manganese increased the percentage of total carbohydrates in seeds of mungbean plants, being partially in accordance with the present findings.

Table (2): Some chemical constituents of mature dried seeds for two mungbean cultivars as affected by Zn, Mn and B in the two successive seasons of 1998 and 1999

Treatments	Protein (%)	Carbohydrate (%)	Phosphorus (%)	Potassium (%)
		1998		
Control	18.75	45.26	0.407	0.940
Zn_1	20.59	46.69	0.480	0.951
Zn_2	21.11	44.28	0.491	0.936
Mn_1	20.29	45.41	0.447	0.939
Mn_2	20.69	47.30	0.413	0.923
B_1	21.26	48.05	0.426	0.934
B_2	21.97	49.02	0.431	0.936
Zn_1+Mn_1+B_1	21.08	48.44	0.463	0.900
L.S.D. (0.05)	0.456	N.S.	N.S.	N.S.
V-2010	20.18	46.34	0.475	0.909
VC-1000	21.25	47.38	0.414	0.955
L.S.D. (0.05)	0.228	N.S.	N.S.	0.023
		1999		
Control	20.28	44.05	0.430	0.965
Zn_1	22.14	45.46	0.502	0.973
Zn_2	22.99	43.44	0.466	0.945
Mn_1	21.96	44.48	0.456	0.954
Mn_2	22.43	45.64	0.414	0.967
B_1	22.95	47.13	0.429	0.962
B_2	23.28	46.94	0.489	0.949
Zn_1+Mn_1+B_1	22.84	46.85	0.492	0.927
L.S.D. (0.05)	0.813	NS	NS	NS
V-2010	21.68	45.17	0.482	0.939
VC-1000	23.03	45.82	0.438	0.971
L.S.D. (0.05)	0.406	N.S.	N.S.	N.S.

3.2.3. Phosphorus

It is clear from Table (2) that all treatments with micronutrients had no effect on percentage of phosphorus in seeds of the two mungbean cultivars under investigation in both studied seasons of 1998 and 1999. Also, the difference between the two cultivars proved insignificant in the two seasons.

3.2.4. Potassium

Results in Table (2) reveal that all adopted treatments of micronutrients showed no statistical effect on percentage of potassium in seeds of the two mungbean cultivars V-2010 and VC-1000 in the two growing seasons of 1998 and 1999. It is worthy to note that mungbean cv. VC-1000 surpassed mungbean cv.V- 2010 in this respect with a significant difference between the two cultivars only in the first season of 1998.

Information concerning the effect of micronutrients on the percentage of phosphorus and potassium in seeds of mungbean plants are not available.

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إستجابة صنفين من فول المانج إلى كلاً من الزنك والمنجنيز والبورون
٢- المحصول والمحتوى الكيمائى للبذور

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ملخص

أجريت تجربتان بمزرعة مركز البحوث الزراعية بالجيزة خلال موسمى ١٩٩٨ و ١٩٩٩ لدراسة إستجابة صنفين من فول المانج هما V-2010 و VC-1000 لبعض العناصر الصغرى من حيث التأثير على المحصول ومكوناته كما ونوعاً. استخدم الزنك (٠,٢ أو ٠,٤ جم/لتر) والمنحنيز (١,٥ أو ٢ جم/لتر) وعنصر البورون (٣ أو ٥ جم/لتر) وكذلك مخلوط من التركيز الأول لكل من العناصر الثلاث (٠,٢ جم/لتر زنك + ١,٥ جم/لتر منجنيز + ٣ جم/لتر بورون) هذا بالإضافة إلى معاملة المقارنة والتى تم رش نباتاتها بماء الصنبور. تم رش النباتات بالتركيزات السابقة بعد ٣٥ يوما من الزراعة. ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلى:

١. تفوق بصفة عامة الصنف VC-1000 على الصنف V-2010 فى المحصول ومكوناته (فيما عدا وزن المائة بذرة) وكذلك فى المحتوى الكيمائى للبذور من البروتين والكربوهيدرات والبوتاسيوم.
٢. أدت جميع معاملات الرش بالعناصر الصغرى المستخدمة إلى حدوث زيادة معنوية فى جميع صفات المحصول تحت الدراسة (عدد قرون النبات ، متوسط عدد بذور القرن ، متوسط وزن المائة بذرة ومحصول النبات من البذور والقش) وكانت أقصى زيادة معنوية متحصل عليها فى جميع الصفات ناتجة عن الرش بالتركيز الأول من الزنك (٠,٢ جم/لتر).
٣. أظهرت جميع المعاملات المستخدمة زيادة معنوية فى النسبة المئوية للبروتين فى بذور صنفى فول المانج فى كلا موسمى الدراسة. وكانت أعلى نسبة مئوية للبروتين فى البذور متحصل عليها نتيجة الرش بالبورون بتركيز ٥ جم/لتر. وعلى العكس من ذلك، لم تظهر أى من معاملات الرش المستخدمة تأثيراً معنوياً على النسبة المئوية لكل من الكربوهيدرات والفوسفور والبوتاسيوم فى بذور صنفى فول المانج فى كلا الموسمين.

المجلة العلمية لكلية الزراعة - جامعة القاهرة - المجلد (٥٢) العدد الثالث (يوليو ٢٠٠١):٤٦٧-٤٧٨.