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Soil and foliar fertilization of mungbean (*Vigna radlata* (L) *wilczek*) under Egyptian conditions

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ABSTRACT
Two sets of field experiments were performed in two successive summer seasons to study the effect of soil and foliar fertilization of mungbean. The first set included the effect of late foliar applied N or K under different levels of phosphatic fertilization on mungbean yield and chemical constituents. Mungbean (*Vigna radiata* (*L*) *Wilczek*) var. Kawmy-l was fertilized with 0,19,38,57 and 76 Kg P_20_5 ha^{-1} at sowing. Foliar applied N was sprayed as 1 % urea solution and K was applied as potassium sulphate 36% K_20 solution; both N and K sprays were carried out at early pod formation stage. The second set of experiments aimed to study the effect of micronutrient application when combined with urea. The foliar applied treatments were urea (1%); and four key micronutrients; i.e. Fe (0.5%); Zn (0.1%); Mn (0.2%) and $CuSO_4$ (0.05%). Micronutrient treatments were sprayed either alone or combined with urea at early pod formation. The obtained results showed that P fertilization significantly increased mungbean pod weight per plant, 100-seed weight, yield per plant and per hectare compared with the untreated control. Mungbean seed yield per hectare showed more response to foliar applied N than that with K. The best seed yield per hectare was reported from the combined effect of 76 Kg P_20_5 ha^{-1} and foliar spraying with N. Protein percentage in mungbean seeds was not affected by either soil or foliar applications and ranged between 20.6 to 22.9%. However, protein yield kg ha^{-1} significantly increased when the plants were fertilized with 76 Kg P_20_5 ha^{1} and foliar sprayed with N. In addition, soil application of P and foliar spray treatments showed significant effects on carbohydrate percentage and carbohydrate yield $ha^{-1}$of mungbean seeds. Micronutrient application showed beneficial effects on yield and yield components from the association of urea with Zn on pod-number and with all micronutrients on pod-weight per plant. The highest seed yield per plant was recorded when the plants were foliar sprayed with Fe and Mn alone or Urea+Zn. Meanwhile, the highest seed yield per hectare was achieved by foliar spraying with Fe or Zn alone as well as by the combined application with urea Fe, Mn or Zn. Micronutrient concentrations in mungbean seeds were elevated more than in the control treatment due to foliar spray treatments but it did not reach the level of significance for Fe, Zn and Cu. It could be concluded from this study that mungbean productivity responds to combined soil application of P at 57 Kg P_20_5 ha^{-1} and late foliar applied N at early pod formation stage. Foliar spray of urea combined with Fe or Zn may increase seed yield and improve the quality of seeds.

Introduction

Mungbean (*Vigna radiata* (L) Wilczek) is a summer pulse crop greatly widespread in different regions of the world, Lawn and Ahn (1985). It is a new introduced crop in Egypt, (Ashour *et al* 1991 and 1993) for its acceptable nutritive value of seeds (protein; 25-28%, carbohydrates; 62-65%, oil; 1-1.5%, fiber; 3.54.5% and ash 4.5-5.5%; on dry weight basis) Ashour *et al* (1994). Moreover, it has numerous utilities and used primarily as a food crop because it is a major source of protein in cereal based diets for its high lysine content. Mungbean flour is used for making bread mixtures and it is an important source of starch production.

Mungbean is a short duration crop (70-90 days) and mostly with a fully determinate nature. Determinate plants are characterized with low yield potential because it has smaller PAl (photosynthetic area index) than the indeterminate plants. Such lower yield potentiality occurs because after the 1st flower formation, the plants begin to produce a number of compensatory side branches before the 1st flowering node, and that means new sinks formed. Consequently, inter and intra plant competition cause inadequate supplies of assimilates for the new reproductive sinks formed (Heath *et al*. 1992). These symptoms appear sharply at later growth stages especially at early pod formation stage. Several reports show that mungbean yield can be raised via fertilization especially phosphatic fertilization (Kothari and Saraf 1990, Sakar and Banik, 1991 and Tank *et al* 1992). Also one of the feasible and economic methods of mungbean fertilization is late foliar fertilization with N Ghildiyal (1992) or K; Sadasivam *et al* (1990).

Ghildiyal (1992), sprayed mungbean plants with 1% urea at weekly intervals and found that the rate of photosynthesis in the urea, treated plants remained constant 20 days after flowering, while it was declined in the untreated plants. Moreover, the same investigators found that foliar urea application during pod-

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filling (after 63 days from sowing) of mungbean enhanced ammonia assimilation and the accumulation of amino acids. Furthermore, foliar applied N to mungbean was found to increase seed yields (Abdo, 2001). In addition, several investigators showed the positive response of mungbean yield and chemical composition to micronutrients, i.e Zn and Fe, and Cu (Zaghloul, *et al* 2002)

In Egypt, very few reports handled mungbean because it is a new crop. So, the aim of this study is to investigate the effect of foliar applied N or K under different soil P levels as well as micronutrient foliar application when applied alone or combined with urea on mungbean growth, yield and seed chemical constituents.

Materials & Methods

Two sets of field experiments were performed during two successive summer seasons of 2010 and 2011 in clay soil on a private farm Kalubia governorate. The physical and chemical analysis of the soil was (pH7.65;EC 0.24dsm-1 ;OM 0.73 ;N 1400ppm ;P132ppm ;K 826ppm ;Fe 3694 ppm; Mn 56.8ppm; Zn 17.8; Cu 3.78). The first set of experiments aimed to study the response of mungbean yield to different phosphatic fertilization levels alone or combined with late foliar supplemental applications of nitrogen or potassium.

The experiment included 15 treatments which were five levels of phosphatic fertilization 0, 19, 38, 57 and 76 kg P_20_5 ha^{-1} alone or combined with foliar applied solutions of urea (1%) or potassium sulphate (36% K_20). The experimental design was Complete Randomized Block Design (CRBD) with four replications.

The experimental soil was ploughed twice, ridged and divided into experimental unites 21 m^2. Fertilizer was applied as calcium super phosphate 15.5% P_20_5. Mungbean variety Kawmy -1 * seeds were sown on June 6th and 14th in the 1st and the 2nd seasons respectively according to the results of Ashour, *et al* (1993). The seeds were inoculated with the specific rhizobium strian**, then mungbean seeds immediately sown in hills at both sides of the ridge at 15 cm space. A starter dose of N at the rate of 36 kg N ha^{-1} was applied at sowing in the form of ammonium nitrate (33.5% N). Two weeks later the plants were thinned at 2 plants/hill, thus the theoretical number of plants was 432,000 plants per hectare as recommended (Ashour, *et al* 1994). Weeds were controlled manually after 18 and 32 days.

For the second set of experiments, a uniform basal dressing of phosphatic fertilizer as calcium superphosphate 15.5% P_2 O_5 at the rate of 360 ha^{-1} was applied during seed-bed preparation.

Mungbean plants flowered after 41 and 39 days from sowing (50% of the plants) in the 1st and 2nd seasons, respectively. At early pod formation stage (45-47 days from sowing, 2-3 pods/raceme, 2-3cm length) the assigned plots were foliar sprayed either with Nitrogen as urea solution (1 %) at 11 kg ha^{-1}, or with Potassium solution (36% K_20) at 3.6 l kg ha^{-1} in the first set of experiments while in the second set the assigned plots were sprayed with the following treatments;

1- Control (water spray)
2- 1% Urea
3- 0.5% Fe - EDTA (7%)
4- 0.1% Zn - EDTA (14%)
5- 0.2% Mn - EDTA (13%)
6- Cu (0.05% Cu SO_4)
7- Urea 1% + Fe
8- Urea 1% + Zn
9- Urea 1% + Mn
10- Urea 1% + $CuSO_4$

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*Released by Field Crops Research Department, Agricultural Division, National Research Centre and registered in April 1997.
**Prepared by the Microbiology Unit, NRC.

The untreated plots were sprayed with tap water. Teepol 1% was applied as a surfactant to foliar spray treatments. All foliar spray treatments were applied early in the morning. Mungbean harvest took place after 93 and 89 days from sowing in both seasons, respectively .Ten plants were taken from each plot to determine plant height, number of branches, above-ground biomass weight, pod number and weight per plant, number of seeds/pod, 100-seeds weight and seed yield per plant Two central ridges were harvested from each plot; pods were separated and shelled to obtain seed yield per hectare. Total nitrogen content was determined by the standard procedures described by Chapman and Parker (1981). Then N-content was multiplied by 6.25 to calculate protein percentage. Total carbohydrate was determined according to (A.O.A.C, 1984). Micronutrient determinations were carried out by wet ashing digestion and were measured using atomic absorption apparatus according to Chapman and Prtt (1961)

The obtained data were subjected to the proper statistical analysis according to Gomez and Gomez (1984). Since the trends were similar in both seasons, the homogenty test was carried out according to Partlet's test and the combined analysis of the data was applied according to Gomez and Gomez (1984). Treatment means were compared using LSD test at 5% level.

Results

Data in Table (1) show that neither soil applied P level nor foliar applied N or K have significant effect on pod number per plant. However, such tendency was not true for pod weight per plant, since increasing P level gave significant increases in mungbean pod weight. Such increase was successive and parallel to the increase in P level. Also, foliar application with either N or K resulted in significant increase in pod weight/plant compared with the untreated control. The highest response due to the interaction between soil and foliar application occurred when P was applied at 76 Kg P_20_5 ha^{-1} with foliar sprayed N, while for foliar K application; the greatest increase occurred up to 57 Kg P_20_5 ha^{-1} only. Number of seeds per pod was not affected by either soil or foliar applied nutrients. Moreover, P application levels induced significant increases in 100-seed weight compared with the untreated control.

P application to mungbean plants induced significant increases in seed yield per plant over the untreated control. Such increases were successive and significant as P level increased up to 57 Kg P_20_5 ha^{-1}. Meanwhile, foliar applied N or K gave significant increases in seed yield per plant. Foliar application with N exhibited more slight increase than K, though the difference between them was insignificant. Concerning the interaction between soil and foliar application, the greatest response occurred by foliar applied N especially under 57 or 76 Kg P_20_5 ha^{-1}

Significant increases in seed yield per hectare were reported by soil applied P levels, foliar application of both N and K and the interaction between soil and foliar application (Table-1). Soil applied P levels resulted in successive yield increases as compared with the untreated control. Foliar spray with N gave greater seed yield per hectare than that of K, meanwhile, the difference between them was insignificant. Concerning the interaction between P level and foliar spray with N, the data

show that the plants fertilized with 57 Kg $P_2 0_5$ ha^{-1} and sprayed with 1% urea solution gave the best seed yield per hectare. In addition, the greatest response of mungbean yield to foliar applied K was reported under 76 Kg $P_2 0_5$ ha^{-1}.

Data in Table (2) did not show significant differences among the treatments effect on protein percentage in mungbean seeds. Foliar applied N resulted in slight increase in protein content more than the untreated control or those plants which sprayed with K. However, the best treatment which improved protein percentage in seeds was 57 Kg $P_2 0_5$ ha^{-1} combined with foliar spray with urea at 1%.Data in the same table also show significant effects due to increasing P level and foliar spray treatments on total carbohydrate percentage in mungbean seeds. The greatest carbohydrate content was detected when the plants were fertilized with 38 Kg $P_2 0_5$ ha^{-1}, compared with the untreated control. Moreover, under this level foliar spray either with N or K gave the highest carbohydrate percentage in mungbean seeds than the other treatments.

Data illustrated in Fig (1) show that soil applied P levels resulted in successive yield increases as compared with the untreated control. Foliar spray with N gave greater yield of protein per hectare more than with K. Concerning the interaction between P level and foliar spray with N, Figure show that the plants which fertilized with 57 Kg $P_2 0_5$ ha^{-1} and foliar sprayed with urea at 1% solution gave the best protein yield per hectare. In addition, the greatest response of mungbean protein yield to foliar applied K was reported under 76 Kg $P_2 0_5$ ha^{-1}. Similar tendency was reported for carbohydrate yield per hectare (Fig.2). Soil applied P levels resulted in successive carbohydrate yield increases as compared with the untreated control. Foliar spray with N gave greater yield of carbohydrate per hectare than that with K. Concerning the interaction between P level and foliar spray with nitrogen, Figure2 show that the plants which fertilized with 57 Kg $P_2 0_5$ ha^{-1} and foliar sprayed with urea at 1% solution gave the best carbohydrate yield per hectare. In addition, the greatest response of mungbean protein yield to foliar applied K was reported under 76 Kg $P_2 0_5$ ha^{-1}.

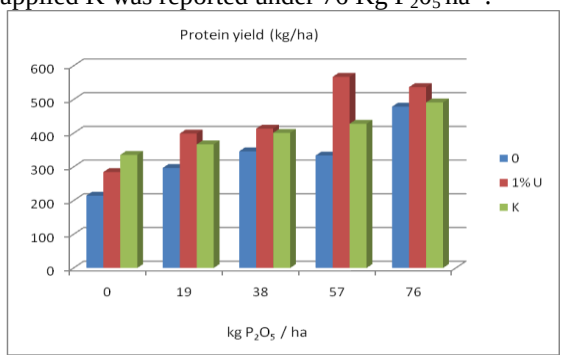

Fig (1): Effect of interaction between phosphorus levels and foliar spray treatments on Protein yield (kg/ha).

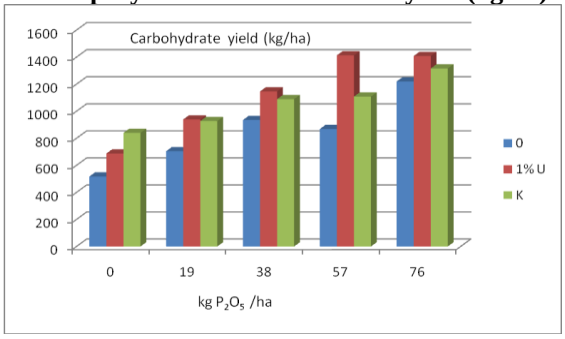

Fig (2): Effect of interaction between phosphorus levels and foliar spray treatments on Carbohydrate yield (kg/ha).

Micronutrient:

Data given in Table-3 show that the effect of foliar spray treatments was significant on mungbean yield and yield components. Foliar spray with Mn alone or with Zn combined with urea produced the highest number of pods per plant, while the other treatments were similar in these criteria. Also, application of Zn alone or urea combined with Fe, Mn, Zn or Cu produced heavier pod-weight per plant without significant differences. Meanwhile, the effect of these elements was not significant when each element was applied alone. All foliar spray treatments were similar without significant differences and exceeded the control treatment in number of seeds per pod. The highest 100 seeds weight was obtained when mungbean plants were sprayed with Cu. However, the data show severe reduction in 100-seeds weight when Cu was combined with urea.

From the same Table, it can be realized that foliar spray with Fe, Mn and Zn alone or combined with urea gave higher seed yield per plant compared with the control treatment. Evidently, the data show that when foliar spray was carried out with Fe and Mn alone or with urea + Zn, higher seed yield per plant was obtained. The results of seed yield per hectare show significant differences among foliar spray treatments. The highest seed yield per hectare was attained by foliar spray of mungbean plants with Fe or Zn alone without significant differences. Moreover, the data also show obvious increments in seed yield per hectare resulted from the combined application of Fe, Mn or Zn with urea.

Table (4) shows that the highest protein percentage in mungbean was detected when the plants were sprayed with urea + Zn followed by urea + Mn. However, the lowest protein percentage was found as a result of foliar spray Cu alone. On contrast, urea + Cu resulted in, significant increase in protein percentage.

Data in Table 5 show that except for foliar spray treatment with Zn alone, no significant differences among treatments on total carbohydrates percentage in mungbean seeds were detected. The highest total carbohydrate content in mungbean seeds resulted from the combined applications of urea + Fe.. The greatest total protein and carbohydrate yield per hectare was recorded when the plants were sprayed with Fe (Fig 3)

Data in Table-5 reveal insignificant differences in Fe, Zn and Cu concentrations of mungbean seeds due to the foliar spray treatments; however, such magnitude was not true for Mn concentration. Foliar spray of urea alone gave the lowest Fe concentration in mungbean seeds. However, a synergistic effect was recorded between the urea + Fe as well as urea + Cu which lead to the increase of Fe concentration in mungbean seeds. The same table also shows that, foliar spray treatments in general increased Zn concentration in mungbean seeds as compared with the control treatment. The highest concentration of Zn was recorded due to urea + Zn treatment.

Mn concentration in mungbean seeds showed significant differences as a result of foliar spray treatments, the highest Mn concentration was found in mungbean seeds when the plants were sprayed with Fe or Mn either alone or combined with urea, while the lowest concentration was induced by foliar spray with Cu. Furthermore, when Cu was associated with urea in the spray solution, Mn concentration tended to increase. Foliar spray of Cu increased Cu concentration in mungbean seeds. The highest Cu concentration in the seeds was recorded due to foliar spray of urea + Fe.

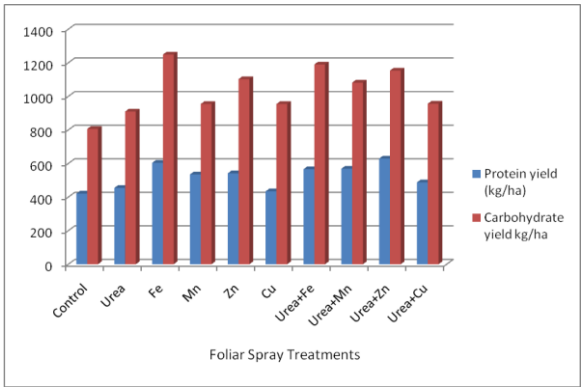

Fig (3): Effect of foliar spray treatments on Protein and Carbohydrate yields / ha.

Discussion

It can be noticed from the data in Table -1 that late foliar applied N (as 1% urea) or K as (K_20 36%) enhanced most of the studied characters. Mungbean plants which received late foliar-N were taller, possessed greater no. and weight of pods; seeds per plant which reflected on the yield per hectare compared to the untreated plants.

The obtained results showed beneficial effects of the interaction between PxN and PxK. Moreover, PxN interaction surpassed the PxK in its effect on rnungbean seed yield per plant and per hectare compared with the untreated control. These responses of mungbean to both late foliar applied N or K could be attributed to the nutritional status of mungbean during the stage of early pod formation which was relevant for mungbean to benefit from the late foliar applied nutrients especially N. Also, the nature of mungbean growth shared in such response since mungbean is a determinate type which is characterized by the developing of new sinks formed on the compensatory side branches after the first flower formation like other determinate legumes (Heath et al, 1992). Meanwhile, the increased inter-plant competition due to the new sinks formed lead to inadequate supply of assimilates to each reproductive sinks, thus the plants become ready to absorb and benefit from foliar applied nutrients. In this respect, the earlier hypothesis of Sinclair and de Wit (1975) about the self destruction phenomena in legumes due to the sharp decline of leaf N content at pod filling stage emphasized the importance of N supply to several legumes at early pod formation. Thus, mungbean appeared better response to N more than K which reflected on yield components. Apart from the genetic constitution, the physiological factors such as inefficient partitioning of assimilates, poor pod setting, excessive flower abscission and lack of nutrients during the critical stages of crop growth were found to be some of the yield barriers of mungbean (Alberta and Bower, 1983; Promila Kumari and Varma, 1983). Nutrients play a pivotal role in increasing the seed yield in pulses. Foliar application of major nutrients like nitrogen and potassium was found to be as good as soil application (Subramanian and Palaniappan, 1981). According to Mitra *et al*., (1988), nitrogen is the major limiting factor for yield in mungbean. Several reports (Hamid, 1991; Kalita *et al*., 1994) suggested that supplementing urea at the reproductive stage significantly enhanced the seed yield by delaying leaf senescence in mungbean.

.Similar results were reported on soybean by Ghildiyal (1992) who sprayed mungbean at weekly intervals from the beginning of the flowering and found that the rate of photosynthesis declined after flowering in control plants but remained constant until 20 days after flowering in urea treated plants which resulted in greater DW, no. of pods and seed yield per plant. Also, similar attitude was reported by. Ramanand and Venkataramana (2006) who stated that crop nutrient uptake, yield and its attributes (number of pods per plant and number of seeds per pod) of green gram augmented significantly due to foliar nutrition. The foliar application of (DAP + NAA + Penshibao) was significantly superior to other treatments in increasing the values of N, P and K uptakes, yield attributes and yield. The highest grain yield of 1529 kg/ha was recorded with this treatment. Spraying mungbean with different forms of K improved mungbean yield as reported by Sadasivam *et al*., (1992).

None of the studied treatments could affect protein percentage in mungbean seeds (Table-2). Carbohydrate percentage in mungbean seeds were greater with phosphatic fertilization especially under 38 kg P_2 O_5 ha^{-1}Such increase may be attributed to the regulatory role of P to the sucrose in legumes, (Marschner 1986).

Foliar application of major nutrients like nitrogen and potassium was found to be as good as soil application (Subramanian and Palaniappan, 1981). According to Mitra *et al*. (1988), nitrogen is the major limiting factor for yield in mungbean. Several reports (Hamid, 1991; Kalita et al., 1994) came to similar conclusion

Concerning the micronutrient application the results show that mungbean has good response to foliar spray with urea and micronutrients either alone or in combination especially urea + Fe or Zn. Such response to foliar applied urea and micronutrients could be attributed to the stimulatory effect of these elements on plant growth which in turn led to better yield. The stimulatory effect of foliar application of nitrogen on growth and yield of mungbean could be attributed to the high demand of N at pod-filling stage where only 50% of the total seed N is found in the vegetative tissues (Sinclair and di Wit, 1975). Therefore it seems that the external foliar applied N or micronutrients is a good supplement for N requirements to mungbean at this growth stage. Some reports pointed out to the positive response of mungbean yield to foliar spray with either urea Ramanand and Venkataramana (2006) or micronutrients Masood and Mishra (2000). Such results emphasize the beneficial effect resulted from combining urea with Mn, Zn or Cu in increasing protein percentage in mungbean seeds. The obtained results are in agreement with those obtained by Abdo (2001) and Ghildiyal (1992) who found a slight increase in mungbean seed protein content resulted from 1% urea spray. Also Zaghloul *et al* (2002) obtained increases in protein content in mungbean seeds by Zn application

From the obtained results it seems that the association of urea with some micronutrients may increase the concentration of these elements in mungbean seeds especially Fe and Cu. This effect may be due to the accelerating of micronutrients uptake in the presence of nitrogen source. This result is in harmony with those obtained by Singh and Saxena (1998) who emphasized the importance of micronutrients to mungbean.

In general, it could be concluded from these experimental trials that phosphatic fertilization of mungbean with 57 Kg P_20_5 ha^{-1} is favorable and recommended. Also, foliar application of nitrogen and potassium improves mungbean yield attributes, but N is more preferable than that of K. In addition, foliar application with urea in association with micronutrients

especially Fe and Zn may increase the productivity of mungbean also usefully improve the quality of seeds.

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Table-1Effect of soil and foliar applied macronutrients on mungbean yield and yield components

Foliar spray treatment (F)	Soil applied phosphate (S) kg P_2O_5 ha^{-1}					
	0	19	38	57	76	Mean
	No. of pods $plant^{-1}$					
Water	27.6	26.0	25.6	25.6	21.6	24.1
Urea 1%	26.5	33.6	27.3	24.3	21.3	26.5
Potassium	29.0	22.6	26.0	18.3	27.0	24.6
Mean	27.7	25.4	26.3	22.7	23.3	
LSD 0.05	S=NS		F=NS		S x F=NS	
	Pod weight g plant -1					
Water	4.45	6.08	5.04	5.11	3.32	5.80
Urea 1%	4.05	7.16	7.48	10.30	11.40	8.08
Potassium	5.0	6.34	7.77	7.91	6.32	6.66
Mean	4.5	6.52	6.74	7.78	3.66	
LSD 0.05	S=1.8		F=1.6		S x F =N.S	
	No. of seeds pod-1					
Water	11.0	10.3	11.3	10.0	10.3	10.6
Urea 1%	8.6	11.3	9.0	10.6	10.3	10.0
Potassium	8.0	9.0	11.0	8.6	9.0	9.1
Mean	9.2	10.2	10.4	9.7	9.9	
LSD 0.05	S= N.S		F= N.S		S x F =N.S	
	100-seed weight (g)					
Water	3.4	4.2	3.8	4.3	4.2	3.99
Urea 1%	3.4	4.4	4.3	3.9	4.6	4.15
Potassium	3.3	4.4	4.2	3.9	4.4	4.06
Mean	3.38	4.33	4.12	4.08	4.43	
LSD 0.05	S= 0.62		F= N.S		S x F =N.S	
	Seed yield g plant -1					
Water	2.67	3.63	3.02	3.07	4.49	3.38
Urea 1%	2.43	4.30	4.49	6.20	6.82	4.85
Potassium	3.01	3.80	4.66	4.75	3.79	4.00
Mean	2.70	3.91	4.05	4.67	5.03	
LSD 0.05	S= 0.56		F=0..59		S x F =1.1	
	Seed yield kg ha-1					
Water	1007.76	1343.76	1681.44	1644.48	2301.6	1595.76
Urea 1%	1270.08	1741.68	2007.36	2532.24	2496.48	2009.52
Potassium	1575.6	1682.88	1918.08	1982.16	2350.08	1902.0
Mean	1284.24	1589.28	1869.36	2053.2	2382.72	
LSD 0.05	S=179.76		F=141.12		S x F =271.68	

Table 2: Effect of soil and foliar applied macronutrients on mungbean seed chemical components

Foliar spray treatment	Soil applied phosphate kg P_2O_5 ha^{-1}					
	0	19	38	57	76	Mean
	Protein %					
Water	21.3	22.1	20.6	20.3	20.8	20.96
Urea 1%	22.4	22.9	21.9	22.4	21.5	22.30
Potassium	21.3	21.8	20.9	21.6	20.9	21.30
Mean	21.67	22.26	21.13	21.43	21.20	
LSD 0.05	S=N.S		F=N.S		S x F =N.S	
	Carbohydrate %					
Water	51.3	52.4	55.6	52.8	53	53.22
Urea 1%	54.1	53.9	57.1	55.8	56.4	56
Potassium	53.3	55.1	56.8	55.9	56	55.4
Mean	52.9	53.8	56.8	54.8	54.9	
LSD 0.05	S=2.1		F=2.7		S x F =N.S	

Table 3: Effect of foliar spray treatments with urea and micro nutrients on yield and yield components of mungbean

Treatments	No. of Pods/plant	Pod weight (g/plant)	No. of seeds/pod	Seed yield (g/plant)	100- seed weight (g)	Seed yield (kg/h)
Control	15.00	11.90	8.70	4.10	2.80	1676.60
Urea	15.60	16.80	11.20	4.80	3.70	1730.60
Fe	15.00	17.50	12.00	7.30	3.90	2377.20
Mn	20.60	16.60	11.00	6.50	3.40	1833.80
Zn	17.80	19.00	12.20	5.40	3.70	2254.60
Cu	15.70	17.50	11.20	4.20	4.00	1825.00
Urea + Fe	14.70	21.20	11.50	7.10	3.40	2200.80
Urea + Mn	14.70	22.30	11.70	5.70	3.70	2098.60
Urea + Zn	22.00	22.50	11.50	6.70	3.40	2223.60
Urea + Cu	16.10	20.70	11.50	5.20	2.60	1828.40
LSD 0.05	4.40	3.80	0.60	0.30	0.20	103.00

Table 4: Effect of foliar spray treatments on the content of carbohydrates and micronutrients in mungbean seeds

Foliar spray treatment	Protein (%)	Carbohydrates (%)	Protein yield (kg/ha)	Carbohydrates Yield (kg/ha)	Micronutrient (ug/100g)			
					Fe	Zn	Mn	Cu
Control	25.1	48.1	420.8	806.3	2617.5	238.5	99.5	58.0
Urea	26.3	52.5	454.3	909.3	1929.0	448.5	109.5	84.5
Fe	25.4	52.5	603.8	1249.0	3537.0	487.0	144.0	73.0
Mn	29.2	52.0	534.7	954.3	3389.0	471.5	131.0	71.5
Zn	23.7	48.3	541.5	1102.5	4048.0	449.0	142.0	78.0
Cu	23.8	52.3	434.2	954.3	1858.5	409.5	87.0	64.0
Urea+Fe	25.7	54.1	565.6	1189.8	4671.9	449.5	143.4	86.5
Urea+Mn	27.1	51.5	568.7	1081.6	2652.0	372.0	105.6	51.5
Urea+Zn	28.3	51.9	629.3	1153.6	2088.5	494.5	116.5	67.0
Urea+Cu	26.7	52.3	487.6	956.1	3848.5	440.8	101.6	67.0
LSD 0.05	1.0	N.S	60.3	234.7	NS	NS	22	NS