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Effect of Different Levels of NPK Fertilizers with the Foliar Application of Iron, Zinc and Boron on Vegetative Growth and Yield of Cowpea

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ABSTRACT

Two experimental trials were carried out in the two successive seasons of 2014and 2015 to investigate the effect of five NPK fertilizers levels and foliar spraying with some micronutrients on cowpea plant. The experiment consisted of five treatments of fertilizers levels (50%, 75%, 100%, 125%, and 150% RDF) of NPK and three rates of mixtures of (6%Fe, 5% Zn and 1% B)beside a control. A split plot in a randomized complete blocks design with three replicates was used. Results can be summarized as follows: increasing applied fertilizer NPK at rate from (50% to 150 % RDF) lead to significantly increase in plant height, plant fresh and dry weight, leaf area/plant chlorophyll b content as well as seed yield and its components, i.e., seed yield/plant, seed yield/fed, number of pods/plant, number of seeds/pod, pod length and weight of 100-seeds weight and some chemical content of plant and seeds of cowpea. But the higher values were recorded after application with use applied fertilizers at rate 100%RDF in the two seasons. On the other hand spraying cowpea plant with(6% Fe, 5% Zn and 1% B)mixture significantly increased all the previous traits in all experiment investigated compared with control (without foliar).The foliar mixture(6% Fe, 5% Zn and 1% B) gave a superior value in both seasons. Since; it produced the highest values of plant height, number of leaves/plant, number of branches/plant, leaf area/plant, seed yield and its components and percentage of crud protein of seeds content. According to the mentioned results, the recommendation is application of NPK at rate 100%RDF with foliar mixture of micronutrients at rate 3g/l three times so as to give the highest cowpea seed yield and its quality.

Keywords: cowpea, NPK fertilizers, Iron, Zink, Boron, growth, yield

INTRODUCTION

Cowpea (*Vigna unguiculata* L.) is a member of family *Fabaceae* and considered as one of the most vegetable legumes, which had been cultivated in Egypt since long time. It is mainly cultivated for local consumption since; the pods were harvested either at green pods stage for fresh market or mature stage for dry seeds. The seeds represent a chief source of protein and carbohydrate. Cowpea seeds are a nutrition component in the human diet as well as a nutritious livestock feed. The protein in seeds of cowpea is rich in lysine and tryptophan amino acids compared to cereal grains.

However, mineral fertilizers play an important role in plant growth and productivity. Nitrogen is essential for synthesis of (chlorophyll, enzymes and protein). Phosphorus is essential for (root growth, phospho-proteins, phospholipids and ATP, ADP formation). Potassium plays an important role in (the promotion of enzyme activity and enhancing the translocation of assimilates and protein synthesis)(Helmy,2013,(Mishra *et al*.(2010), Dawa *e tal*.,(2013)on pea). Abayomi *et al*.,(2008), Azarpour *et al*.,(2011), Nkaa *et al*., (2014) on cowpea

However, Microelements is one of the most important factors involved in improving plant growth, yield and quality of cowpea.). In this respect(El Mansi *et al*., (2005), El-Tantawy *et al*.(2009) on pea El-Haggan (2014) on soybean. Salehien and Rahman (2012) on french bean Ati and Ali.,(2011) on faba bean Srivastava *et al*., (1996) and Eisa and Ali (2014) on cowpea indicated that spraying with mixture of Fe, Zn, Mn, Mo and B a significantly increased(vegetative growth and Average number of seeds/pod, number of pods/plant, weight of seeds/pod, seed yield/plant , seed yield/fed. and relative seeds yield/fed).

Some research carried out some trials to study the interaction between NPK and microelements in this regard Hams and Puttaiiah. (2012) and Salehin and Rahman, (2012) fertilized French bean with application of RDF(N P K)+ Zinc (Zinc sulphate) at 18 Kg ha^{-1}+ boron (boric acid) at 4 Kg ha-1.They brought about significantly the highest residual impact on growth(plant height, number leaves of per plant, branches per plant. El Sayed *et al*.,(2012) and Moghaze *et al*.,(2014) showed a significant effect as a result of the interaction between microelements (Fe, Zn and Mn) at different fertilizer sources (FYM, mineral fertilizer and control) on (fresh pod length and fresh pod weight and number of seeds/pod, seed index (1000-dry seed weight) and chemical constituents such as NPK, carbohydrates (%) and protein (%) of green seeds of pea plant) .So, this study was designed to evaluate the effect of NPK fertilizer at different percentage of DRF in combination with foliar spray with micronutrients and their interaction on vegetative growth and yield of cowpea.

MATERIALS AND METHODS

Two field experiments were carried out at the Experimental Station Farm, kafr sad, Damietta, Egypt, in the two summer seasons of 2014 and 2015,to study the effect of mineral fertilizers and foliar application with some microelements as well as their interaction on vegetative growth, yield and its components and chemical composition of cowpea (*Vigna unguiculata* L.). Kafr El-Sheik-1 CV.

The experimental design and treatments:

A split plot design with three replications was used. The main plots were assigned for five treatments of NPKRDF(recommended doses of fertilizers as follows:

1- 50 % NPK (15.3 kg Nitrogen + 11.25 kg P_2O_5 + 18kg K_2O/fed).
2- 75 %NPK (3.0 kg Nitrogen + 16.72 kg P_2O_5 + 27kg K_2O/fed).
3- 100 % NPK (30.75 kg Nitrogen+ 22.5 kg P_2O_5 + 36kg K_2O/fed).
4- 125 %NPK (38.43 kg Nitrogen + 28.12 kg P_2O_5 + 45kg K_2O/fed).
5- 150 %NPK (46.12 kg Nitrogen + 33.75 kg P_2O_5 + 54kg K_2O/fed).

Calcium super phosphate (15.0 % P_2O_5) as a source of phosphorus fertilizer was applied during preparation of soil. Potassium Fertilizer in the form of potassium sulfate (48.0 % K_2O) and nitrogen fertilizer in the form of ammonium sulfate (20.5 % N) were applied in two equal doses, the first one was added before the first irrigation and the second one was before the following irrigation. The sub-plots were devoted to three rates of foliar spraying with micronutrients mixture (6%Fe, 5%Zn and 1.5%B)

1- Without (control treatment).
2- foliar spraying with micronutrients mixture (6%Fe, 5%Zn and 1.0%B at rate of 1.5 g/l.
3- Foliar spraying with micronutrients mixture (6%Fe, 5%Zn and 1%B) at rat 3g/l.

The sources of Fe, Zn, and B were Iron sulfate, zinc sulfate and boric acid, respectively. Plants were sprayed three times at 20, 35 and 50 days after sowing (DFS) .

Each experimental basic unit (sub – plot) included three ridges, each of 60 cm width and 6 m long, resulted an area of 10.8 m^2.

Practices of agricultural:

The experimental field was prepared were for each experiment through two ploughing, leveling, compaction, ridging and then divided into the experimental units

Cowpea seeds were immediately sown in the soil of clay loamy texture with EC(1.11), pH 7.8, SP(58%),OM(1.5%) and Total $CaCO_3$(3.3%)

On24th and 26thAprilin the first and second seasons, respectively. Seeds were sown at 20 cm apart on 2 sides of each ridge and then thinned after completely emergency to leave one plant/hill during the two growing seasons; other normal cultural practices for cowpea were followed according to the recommendation of Egyptian Ministry of Agriculture.

Studied Characters:

1. Vegetative growth characters:

Plant growth parameters

After 55 days from the sowing, a random sample of 10 plants were taken from each plot to determine the following parameters:

a-The height of plant

b- Number of branches for plant

c- Number of leaves for plant

d- Leaf area was calculated according to Koller (1972). using following formula:

$$\text{Plant leaf area cm}^2 = \frac{\text{Dry weight of leaves}}{\text{Dry weight of 10 disks}} \times \text{Leaf area of disks in cm}^2$$

Dry weight

The different organs of plant, i.e. branches and leaves of chosen plant were cleaned from dust and oven dried at 70^{O}C till constant weight

Photosynthetic pigments.

Total chlorophyll (a + b) and Chlorophyll a, b as well as carotenoids content were determined in samples taken randomly from the fourth true upper leaf at 60 days after sowing according to method described by Wettestein (1957)

Components of yield .

Dry pods of each plot were harvested and the following parameters were calculated:

Average number of pods per plant ,average weight of pod (gm),average length of pod (cm),average number of seeds per pod ,Individual plant yield (gm),average dry weight of 100 seeds (gm) and Total yield per feddan (Kg)

2. Chemical composition in the leaves and seeds:

For determination NPK and Fe, Zn and B contents, 0.2g crude dried powder from each sample was wet digested with a mixture of concentrated sulphoric acid and perchloric acid to determine the flowing:

Total nitrogen was determination According to A.O.A.C. (1984),

Total phosphorus was determined spectrophotomitrically using the method described by Jackson (1967).

Total K were estimated Flame photometrically according to Peterburgski; 1968.

Total Fe, Zn and B were estimated using atomic absorption spectrophotometer) according to the methods of Chapman and Pratt (1971)

Total ash contents

Two g of sample were added into previously weighed porcelain crucible, place in muffle furnace at 600^{O}C for 2 hours according to(AOAC, 2000).

Crude Fat (Ether Extract)

Ten g of each powdered sample were extracted using a continuous extraction apparatus (Soxhlet) with a solvent of petroleum ether (b.p.60-80^{O}C) for sixteen hours. According to (AOAC,2000).

Crude Protein

Each sample was calculated by multiplying the total nitrogen by the factor 6.25.sAccording to (AOAC,2000)

Total carbohydrates content: was determined calorimetrically according to methods described by Michel *et al. (*1956).

All obtained data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the strip-split plot design as published by Gomez and Gomez (1984)by using "CoStat" computer software package. Least significant of difference (LSD) method was used to test the differences between treatment means at 5 % level of probability as described by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

1. Vegetative growth traits

A. Effect of NPK fertilizers levels

Data presented in table (2) show that, all studied vegetative characters, i.e., plant height, number of leaves, number of branches per plant, fresh weight per plant , dry weight per plant and leaf area plant were significantly increased with increasing amount of applied fertilizers levels from 50% of the recommended doses to 150 % of the recommended doses in both seasons. The results also indicated that the highest values of plant height were recorded when plants received fertilizer level (150% RDF).

On the other hand, the lowest values were noticed when plants received NPK (50% RDF) in both seasons.

Likewise, number of leaves, number of branches per plant, fresh weight per plant , dry weight per plant and leaf area plant had the least values when plants received fertilizer level (50% RDF) in both seasons. The obtained results are in agreement with those mentioned by Abayomi *et al*., 2008)who found increment in vegetative growth with increasing of NPK fertilizer application referring to In role in synthetic and activate many enzymes in plant.Such enzymes act as catalyst for making materials such as starch and protein. Potassium also plays a role in photosynthesis, osmotic adjustment, cell growth, stomatal regulation, water system of plant, downloading hydrocarbons. These results are in agreement with Russd (1973), Choudhary and Yadav (2011),Nkaa *et al*.,(2014) and Atakora *et al*. (2014)on cowpea.

Table 2. Effect of NPK fertilizer levels, foliar spray with micronutrients mixture (Fe, Zn and B) and their interaction on (plant height, number of leaves/plant, number of branches/plant, fresh weigh, dry weight and leaf area/plant) of cowpea plants at 2014 and 2015 seasons.

Treatments		Plant height		Number of leaves		Number of branches		Fresh weight		Dry weight		Leaf area Plant (cm)2	
		S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Factor A (N P K) Fertilizers													
50 %		45.11	46.94	18.33	19.77	5.33	6.00	96.3	101.1	13.33	13.38	1234	1231
75 %		48.11	49.00	21.44	23.33	5.77	7.11	116.8	125.7	14.4	15.03	1466	1510
100 %		51.33	52.77	24.88	26.44	6.77	7.77	158.7	166.3	15.9	17.20	1870	1881
125 %		51.77	54.66	27.00	28.11	6.22	8.22	166.6	173.4	17.17	17.50	1990	2016
150 %		52.11	55.77	28.66	30.11	6.44	8.55	185.2	184.5	18.82	18.91	2436	2460
LSD at 5 %		1.43	1.37	0.428	0.42	0.891	0.53	7.259	6.103	0.877	0.299	70.34	39.92
Factor B													
control		48.66	50.86	23.3	24.66	6.53	7.20	135.6	145.9	14.46	15.81	1694	1737
1.5g/l		50.06	51.88	24.00	25.33	6.06	7.46	145.7	149.0	16.42	16.46	1796	1803
3g/l		50.80	52.76	25.05	26.66	5.73	7.93	152.8	155.7	16.92	16.94	1903	1919
LSD at 5 %		0.99	0.61	0.61	0.66	0.69	0.47	6.285	2.58	0.135	0.324	54.42	32.54
A X B													
50 %	control	44.00	45.66	17.33	18.66	4.66	5.66	90.3	98.33	12.76	12.56	1210	1194
	1.5g/l	46.33	47.00	18.33	19.00	5.33	5.66	95.0	101.9	13.20	13.76	1214	1221
	3g/l	47.31	48.16	19.33	21.66	6.00	6.66	103.6	103.6	14.00	13.80	1278	1278
75 %	control	47.00	48.00	20.66	22.33	5.33	7.00	109.3	122.0	12.76	14.10	1354	1440
	1.5g/l	48.33	49.33	21.00	23.33	5.66	7.00	113.4	123.3	14.90	15.30	1457	1477
	3g/l	49.00	49.66	22.66	24.33	6.33	7.33	127.7	132.6	15.53	15.80	1586	1612
100 %	control	50.00	51.33	23.66	25.66	6.33	7.33	154.3	161.1	15.63	16.32	1790	1775
	1.5g/l	51.00	52.33	25.00	26.33	6.66	7.66	158.3	162.3	16.96	17.31	1873	1880
	3g/l	53.00	54.66	26.00	27.33	7.33	8.33	163.4	175.3	17.66	18.00	1946	1988
125 %	control	51.00	53.66	26.00	27.33	6.00	7.66	157.6	169.0	16.10	16.60	1917	1969
	1.5g/l	52.33	55.00	27.33	28.00	6.33	8.33	170.1	174.0	17.53	18.20	1989	1989
	3g/l	52.00	55.33	27.66	29.00	6.33	8.66	172.1	177.3	17.90	17.61	2064	2092
150 %	control	51.33	55.66	28.00	29.33	6.33	8.33	166.3	178.7	17.48	18.23	2220	2279
	1.5g/l	52.33	55.66	23.33	30.00	6.33	8.66	192.0	184.3	19.16	18.64	2447	2626
	3g/l	52.66	56.00	29.66	31.00	6.66	8.66	197.2	190.7	19.86	18.80	2642	2474
LSD at 5 %		N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	1.22	0.72	122.7	72.77

Factor A: NPK, Factor B: Fe, Zn and B.

B. Effect of foliar application of (Fe,Zn and B)

Data given in Table (2) show that foliar application caused a significant increase in the vegetative growth parameters of cowpea in both seasons and the higher values were recorded when the plants sprayed at 3g/l micronutrients mixture (Zn, B and Fe) in the second season. In this direction, Atia and Brdisi,(2005) reported that the microelements as Fe and Mo play a vital role in synthesis of chlorophyll and chloroplast formation. Also Iron, molybdenum and boron play a vital role of enzymes activity as nitrogenase, catalase and peroxidase. These results agree with those obtained by Singh (2004), Tariq and Matt. (2007),Hamas and Puttaiiah.(2012) and Rahman *et al*.,(2014) who reported on Common Bean that micronutrients (B+ Mo + Zn) application significantly increased the plant height, number of branches plant.

C. Effect of NPK fertilizers levels and foliar application of (Fe, Zn and B) interaction

Data in the table (2) generally indicated that the interaction had no significant influence on plant height, number of branches and fresh weight in both seasons. However the effect was significant on dry weight and leaf area in both seasons. Higher dry matter accumulation / plant and leaf area / plant was obtained under150% RDF + 2% at micronutrients mixture (Fe ,Zn and B) followed in descending order by 50% without foliar of micronutrients mixture in two seasons. These results agree with those obtained by El Mansi *et al*., (2005) who found that spraying pea plants with Fe, Mo and B at 100, 50 and 25 ppm, respectively, significantly increased vegetative growth (plant height (n) of leaves, leaf area) and dry weight, compared with the control. These results are in harmony with those found by Hamsa and Puttaiiah(2012), Salehien and Rahman. (2012) and Moghaze *et al* ., (2014)

2. Yield and its components

A. Effect of NPK fertilizers levels

Data in Table (3)show that all parameters number of pods/plant, average pod weight (g) / plant, pod length (cm) and pod diameter (cm) were significantly increased with applied fertilizers levels in both seasons. The increment in number of pods/ plant, average pod weight was obtained when plants received fertilizer level (100%

RDF). On the other hand, the lowest values were noticed when plants received NPK level (50% RDF) in both seasons. Moreover, the higher pod length and pod diameter were produced when plants received fertilizers level (150% RDF). On the other hand, the lowest values were noticed when plants received fertility level (50% RDF) in both seasons. In this concern Achakzal and Bangulzai. (2006)on pea found a significant increase in yield and yield attributes (number of fresh pod plant-1, fresh pods length (cm) and 1000 seed weight (g)) with progressive increase in applied N fertilizer. These results are in harmony with those found by Abdul Kabir (2006), Mansouri and Shokoohfar.(2015) and. (El-Tanahy *et al*.,2012) on cowpea

Table (4) show that, all studied seed characters. i. e, number of seeds /pod, 100seeds weight (g), seed yield (g)/plant and seed yield (kg)/fed) were significantly increased with increasing amount of applied fertilizers levels in both seasons. The results indicated that the highest values of number of seeds /pod and 100 seeds weight (g) were recorded when plants received NPK level 100% RDF and 125% RDF While; the lowest values were obtained in case of plants received NPK fertilizers at 50% RDF in both seasons. Likewise, seed yield (g)/plant and seed yield (kg)/fed are significantly increased with increasing amount of applied fertilizers levels in both seasons. A clear increase in seed yield (g)/plant at rate (23.5and 24.46(g)/plant) and seed yield (kg)/fed at rate (1044 and 1087(kg)/fed) in two season respectively was obtained in case of plants received fertilizers 100%RDF .While; there was no significant effect due to125%RDF and 150%RDF on seed yield (g)/plant and seed yield (kg)/fed) in both season. These results are in agreement with those obtained by Abayomi *et al*., (2008) who reported that the application of 30-15-15 kg NPK ha-1 gave a yield of 1.29 tons ha-1. These results are in harmony with those found by Hasan *et al*. (2010),Ayodele and Oso. (2014).

Table 3. Effect of NPK fertilizer levels, foliar spray with micronutrients mixture (Fe, Zn and B) and their interaction on (number of pods/plant, average pod weight, pod length and pod diameter) of cowpea plants at 2014 and 2015 seasons.

Treatments		Number of pods / plant		Average pod weight (g)		Pod length (cm)		Pod diameter (cm)	
		S1	S2	S1	S2	S1	S2	S1	S2
Factor A									
50 %		16.33	16.88	29.55	31.55	17.11	17.22	0.176	0.187
75 %		23.88	25.44	41.22	41.44	17.61	19.11	0.218	0.22
100 %		34.00	36.55	50.11	51.66	18.77	20.66	0.304	0.303
125 %		27.44	32.77	42.55	43.77	17.88	20.55	0.326	0.320
150 %		29.00	32.00	43.22	44.22	18.55	21.88	0.352	0.332
LSD at 5 %		2.259	1.63	2.25	2.61	0.949	1.218	0.025	0.11
Factor B									
control		24.6	27.26	39.53	40.8	17.64	19.53	0.260	0.286
1.5g/l		26.13	28.86	41.80	42.86	18.00	19.80	0.274	0.271
3g/l		27.46	30.06	42.66	43.93	18.43	20.33	0.287	0.278
LSD at 5 %		1.08	0.918	1.86	1.46	0.356	0.647	0.012	0.008
A X B									
50 %	control	15.00	15.33	26.66	30	16.33	16.66	0.156	0.173
	1.5g/l	16.66	17.00	30	31.33	17.33	17.33	0.180	0.193
	3g/l	17.33	18.8	32	33.33	17.66	17.66	0.193	0.196
75 %	control	23.66	24.00	39.33	40.33	17.5	19.00	0.193	0.210
	1.5g/l	22.33	25.00	41.66	41.66	17.33	18.66	0.233	0.220
	3g/l	25.66	27.33	42.66	42.33	18.00	19.66	0.236	0.230
100 %	control	30.66	34.33	49	50	18.33	20.33	0.290	0.290
	1.5g/l	35	36.33	49.66	51.33	18.66	20.66	0.296	0.303
	3g/l	36.33	39.00	51.66	53.66	19.33	21.00	0.326	0.316
125 %	control	26	31.66	40.66	41.00	17.33	20.00	0.320	0.326
	1.5g/l	27.66	33.66	43.66	44.66	18.00	20.66	0.336	0.316
	3g/l	28.66	33.00	43.33	43.66	18.33	21.00	0.323	0.316
150 %	control	28.66	31.00	42.00	42.66	18.16	21.33	0.343	0.323
	1.5g/l	29	32.33	44.00	45.33	18.66	22.00	0.343	0.330
	3g/l	29.33	32.66	43.66	44.66	18.86	22.23	0.370	0.343
LSD at 5 %		N.S	N.S	N.S	N.S	N.S	N.S	0.027	0.018

Factor A: NPK, Factor B: Fe, Zn and B.

B. Effect of foliar application of (F, Zn and B)

Table (3) shows that foliar application of Fe, Zn, B caused a significant increase in (number of pods/ plant, average pod weight (g) / plant, pod length and pod diameter (cm)) of cowpea in both seasons and the superior values were recorded when the plant sprayed with 2% micronutrients mixture (Fe, Zn, B) compared with control .These results agree with those obtained by Srivastava *et al*.(1996) who mentioned that micronutrients have considerable significant effects, as limiting factors, on the productivity of legumes; spraying cowpea plants with Zn + Mn + Fe at 100 ppm of each increased dry matter, yield/plant and number of pods/plant. In addition, El Sayed *et al*.(2012) indicated that pea plants sprayed with a mixture of microelements (Fe, Zn and Mn, 100 ppm) significantly increased yield components expressed as pod length, pod weight, number of green seeds/pod, weight of 100-green seed , seed index(1000-dry seed weight).These results are in harmony with those found by Eisa and Ali .(2014)on cowpea and also, El-Haggan.(2014) on soybean.

Data presented in table (4) show that foliar application of (Fe, Zn and B)gave more (number of seeds/pod, 100seeds weight (g), seed yield (g)/plant and seed yield (kg)/fed) of cowpea plants during 2014 and

2015.Moreovere, foliar application caused a clear increments on (number of seeds /pod, 100seeds weight (g), seed yield (g)/plant and seed yield (kg)/fed) in two seasons. The higher values were recorded when the plant sprayed at 3g/l micronutrients mixture (Zn, B and Fe) in the second season. The increase in total yield owed directly to the increase in vegetative growth (Tables 2 and 3).These increases might be ascribed to the favorable role of micronutrients in pigments formation, photosynthesis activation and carbohydrates assimilation diverted to seed. This results are in conformity with those obtained by Srivastava *et al*., (1996) who reported that micronutrients have considerable significant effects, as limiting factors, on the productivity of legumes.

C. Effect of NPK fertilizers levels and foliar application of (F, Zn and B) interaction

Data also in Table (3) indicate that interaction treatments had non-significant effect on number of pods / plant, average pod weight / plant, pod length in both seasons. But, pod diameter was significantly increased by this interaction. This result is in agreement with that of Oseni. (2009) who reported that cowpea yield was decreased with increasing zinc application. Moreover, cowpea yields were slightly lower when phosphorus applied in combination with zinc than without zinc. This effect could be attributed to the fact that phosphorus application reduces the zinc requirements for optimum plant growth. On the other, hand El Sayed *et al*.,(2012) on pea showed that there were significant effects as a result of the interaction between microelements (Fe, Zn and Mn, 100 ppm) and (FYM and mineral fertilizer) on fresh pod length and fresh pod weight and No. of seeds.

Data in Table (4) cleared that the interaction treatments had no significant effect on number of seeds /pod and 100seeds weight (g) in the two seasons. But, seed yield plant and seed yield kg/fed were significantly increased by this interaction in both seasons. Seed yield of cowpea was affected by three major yield components, i.e. number of pods plant^{-1}, number of seeds pod^{-1} and average seed weight. Effect of NPK fertilizers and micronutrients on yield and its components might be attributed to their positive role on enhancing photosynthesis, biosynthesis of proteins and carbohydrate assimilation (Epstien, 1972). The obtained results are in harmony with those of Malla *et al*., (2007) Moghaze *et al*., (2014) El Sayed *et al*., (2012)on pea.

Table 4. Effect of NPK fertilizer levels, foliar spray with micronutrients mixture (Fe, Zn and B) and their interaction on (number of seeds/pod, 100 seeds weight (g), seed yield (g)/plant and seed yield (kg)/fed.) of cowpea plants at 2014 and 2015 seasons.

Treatments		Number of seeds/pod		100 seeds weight (g)		Seed yield(g)/ plant		Seed Yield(kg)/ fed	
		S1	S1	S1	S2	S1	S2	S1	S2
Factor A									
50 %		9.22	9.44	17.11	17.14	12.93	13.62	574.8	605.4
75 %		10.88	10.88	17.75	17.96	18.75	19.45	825.6	859.1
100 %		11.44	11.33	18.72	18.97	23.5	24.46	1044	1087
125 %		11.44	11.44	19.45	19.38	21.51	22.1	956.5	987.6
150 %		11.11	11.44	19.74	19.75	22.17	22.02	985	973.3
LSD at 5 %		1.011	0.324	0.334	0.314	0.503	0.351	19.18	17.38
Factor B									
control		10.26	10.46	18.33	18.50	18.86	19.29	838.2	857.1
1.5g/l		10.93	11.06	18.52	18.52	19.78	20.34	878.6	900.6
3g/l		11.26	11.2	18.81	18.91	20.68	21.36	919.1	949.8
LSD at 5 %		0.806	0.662	0.326	0.198	0.318	0.247	12.89	13.14
A X B									
50 %	control	8.33	8.33	11.60	16.96	11.60	12.80	515.6	568.8
	1.5g/l	9.333	9.66	13.07	16.83	13.07	13.50	580.8	599.9
	3g/l	10.00	10.33	14.13	17.63	14.13	14.56	628.1	647.3
75 %	control	10.66	10.33	17.37	17.66	17.56	17.23	780.7	765.9
	1.5g/l	11.00	11.33	17.83	17.93	18.43	19.56	891.2	852.8
	3g/l	11.66	11.00	18.08	18.30	20.26	21.56	900.7	958.5
100 %	control	11.00	10.66	18.46	18.90	22.30	23.53	991.1	1045.0
	1.5g/l	11.33	11.33	18.55	18.83	23.46	24.63	1043	1095
	3g/l	12.00	12.00	19.16	19.20	24.73	25.23	1099	1121
125 %	control	10.33	11.66	19.23	19.20	21.03	21.46	934.8	954.3
	1.5g/l	11.00	11.33	19.59	19.36	21.5	22.10	956.9	982.2
	3g/l	11.33	11.33	19.59	19.60	22.00	22.73	977.7	1026
150 %	control	11.00	11.33	19.87	19.80	21.80	21.43	968.9	951.1
	1.5g/l	12.00	11.66	19.63	19.63	22.43	21.90	994.2	973.3
	3g/l	11.33	11.33	19.75	19.83	22.30	22.73	989.5	995.5
LSD at 5 %		N.S	N.S	N.S	N.S	0.713	0.552	31.75	29.38

Factor A: NPK, Factor B: Fe, Zn and B.

3. Chemical constituents in the leaves

A. Effect of NPK fertilizers levels

Data in table (5) Show that all tested parameters chlor.a, chlor.., chlor.a+b., nitrogen and phosphorus content were significantly increased with applied fertilizers levels in both seasons. The results indicated that the highest values of (chlor.a, chlor.b, chlor.a+b) were recorded when plants received NPK level (100% RDF. While; the lowest values were obtained in case of plants received fertilizers level (50% RDF) in both seasons. On the other hand; N% and P% content were of the highest values when plants received fertilizers level (150% RDF. While; the lowest values were obtained in case of plants received fertilizers level (50% RDF) in both years.

The obtained results are in harmony with those of El Sayed *et al*.,(2012) on pea indicated also that N, P and K contents in the green seeds are significantly increased by the application of both FYM and mineral fertilizer compared with control plants. Moghaze *et al*., (2014) on pea, El-Tanahy *et al*.,2015 on cowpea plants came out to similar conclusion

Data in Table (6) show the effect of NPK fertilizers levels on Potassium%, Zinc ppm, Fe ppm and Born ppm content of cowpea plants. The data reveal that, increasing rate of NPK fertilizer levels led to significantly increased P, Zn, Fe and B content of cowpea plant during two seasons. The highest accumulation of K % was obtained when plants received fertilizers level 150% RDF. But, the highest accumulation of Zn, Fe and B ppm was obtained when plants received fertilizers level 100%NPK.On the other hand the lowest values of K%, Fe and B ppm content were obtained in case of plants received fertilizers level 50%NPK in both seasons. While, the lowest accumulation of Zn was obtained in case of plant received fertilizers level 150%NPK.

B. Effect of foliar application of (Fe, Zn and B)

Data presented in table (5) illustrated that, foliar application caused a clear increments after all tested treatments application and the higher values were recorded when the plant sprayed at 3g/l micronutrients mixture (Fe, Zn and B) compared with control. In this direction Marchner, (1995) reported that Zn improves its concentration within leaves of the treated plants. In turn, it might protect plasma membrane and its linked transporter enzymes against the harmful effects of higher temperature/oxidative stresses thereby improves its transportation functions for other elements and solutes. Also, zinc is a component of many enzymes which are important for metabolism of carbohydrate, protein and phosphate. This results are in harmony with those of El-Sayed *et al.*(2012) on pea and Eisa and Ali (2014)on cowpea plant

Data show in Table (6) clear that, foliar application with (B .Fe and Zn) significantly increased (Potassium%, Zinc ppm, Fe ppm and B ppm) content of cowpea plant with spraying at two rates under study. Higher (Potassium%, Zinc ppm , Fe and B content) was obtained in cowpea plant received 3g/lmicronutrients mixture (Zn, B and Fe) compared with control .This results agree with those obtained by El Mansi *et al*., (2005),Moghaze *et al* ., (2014) and Eisa and Ali .(2014)on cowpea

Table 5. Effect of NPK fertilizer levels, foliar spray with micronutrients mixture (Fe, Zn and B) and their interaction on (chl. a, chl. b, chl. a + chl. b, N% , P%) content of cowpea plants at 2014 and 2015 seasons

Treatments		Chl. a mg/g F.W		Chl. b mg/g F.W		Chl. a +b mg/g F.W		N%		P%	
		S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Factor A											
50 %		0.549	0.571	0.449	0.459	0.998	1.031	2.21	2.376	0.245	0.207
75 %		0.557	0.579	0.456	0.467	1.014	1.047	2.493	2.655	0.269	0.247
100 %		0.582	0.607	0.481	0.491	1.063	1.098	2.774	2.978	0.288	0.270
125 %		0.572	0.596	0.529	0.483	1.043	1.079	2.861	3.230	0.254	0.293
150 %		0.565	0.579	0.464	0.467	1.029	1.065	2.973	3.428	0.217	0.316
LSD at 5 %		0.004	0.004	0.09	0.006	0.006	0.008	0.06	0.076	0.002	0.017
Factor B											
control		0.525	0.544	0.459	0.434	0.950	0.970	2.576	2.780	0.251	0.250
1.5g/l		0.564	0.589	0.466	0.475	1.03	1.06	2.67	2.920	0.263	0.264
3g/l		0.605	0.633	0.503	0.516	1.108	1.149	2.74	3.090	0.245	0.286
LSD at 5 %		0.004	0.002	0.061	0.002	0.005	0.003	0.036	0.033	0.33	0.011
A X B											
50 %	control	0.509	0.527	0.406	0.418	0.916	0.945	2.123	2.278	0.236	0.194
	1.5g/l	0.545	0.570	0.449	0.485	0.994	1.030	2.233	2.370	0.246	0.208
	3g/l	0.591	0.617	0.491	0.501	1.083	1.118	2.273	2.486	0.228	0.218
75 %	control	0.519	0.536	0.417	0.427	0.937	0.964	2.406	2.566	0.269	0.273
	1.5g/l	0.555	0.579	0.459	0.468	1.014	1.047	2.510	2.656	0.278	0.236
	3g/l	0.598	0.623	0.493	0.508	1.092	1.131	2.560	2.743	0.259	0.278
100 %	control	0.543	0.563	0.441	0.449	0.985	1.012	2.676	2.813	0.287	0.257
	1.5g/l	0.583	0.607	0.483	0.492	1.065	1.099	2.773	2.966	0.296	0.273
	3g/l	0.620	0.652	0.519	0.531	1.139	1.184	2.873	3.156	0.281	0.282
125 %	control	0.532	0.551	0.606	0.442	0.949	0.994	2.790	2.966	0.249	0.266
	1.5g/l	0.572	0.599	0.475	0.481	1.032	1.080	2.870	3.213	0.287	0.291
	3g/l	0.613	0.638	0.507	0.525	1.107	1.163	2.916	3.516	0.248	0.320
150 %	control	0.524	0.543	0.425	0.434	0.949	0.977	2.874	3.416	0.214	0.304
	1.5g/l	0.567	0.592	0.465	0.477	1.032	1.069	2.960	3.550	0.229	0.312
	3g/l	0.604	0.633	0.507	0.516	1.107	1.150	3.074	3.550	0.209	0.332
LSD at 5 %		N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

Factor A: NPK, Factor B: Fe, Zn and B.

C. Effect of NPK fertilizers levels and foliar application of (Fe, Zn and B) interaction

Data in the same Table (5)The results show that the interaction treatments (chlor.a., chlor.b. and chlor.a+b., had no significant effect on chlor.a., chlor.b. and chlor.a+b. nitrogen content and phosphorus contentin both seasons. The obtained results are in harmony with those of El Sayed *et al*.,(2012)and Moghaze *et al*., (2014)on pea.

The obtained results are in harmony with those El Sayed *et al*.,(2012),and Abdel-Salam and Salem.(2012) and Nyoki and Ndakidemi, 2014 ElTanahy *et al*.,2015on cowpea plants.. (Benvindo *et al*., 2014)cleared that zinc absorption capacity is reduced by high phosphorus utilization and zinc in plant and soil has an antagonism state with phosphorus (negative interaction), this negative

interaction or antagonistic effect of phosphorus and zinc might be due to one or more reasons.

Data in Table (6) indicate that, this interaction had significant effect on Potassium%, Zn ppm, Fe ppm and B ppm content in both seasons. The results illustrated that the increment of potassium content was obtained when plants received fertilizers level 150% RDF and sprayed at 3g/lmicronutrients mixture (Zn, B and Fe) compared with control. While, the lowest accumulation of K was obtained in case of plant received fertilizers level 50% RDF without microelements. Data cleared that Zn ppm, Fe ppm and B ppm content were also affected with this interaction. the higher content of all tested characters were obtained when plants received fertilizers level 100% RDF with spraying at 3g/lmicronutrients mixture (Zn, B and Fe) compared with control. But, the lowest accumulation of element was obtained in case of plant received fertilizers level 50% RDF without microelements. This results are in harmony with those of Nasri *et al*.(2011), Nyoki and Ndakidemi.(2014) and Moghaze *et al* . (2014).

Table 6. Effect of NPK fertilizer levels, foliar spray with micronutrients mixture (Fe, Zn and B) and their interaction on (K% , Zn ppm, Fe ppm and B ppm) of cowpea plants at 2014 and 2015 seasons.

Treatments		K%		Zn ppm		Fe ppm		B ppm	
		S1	S2	S1	S2	S1	S2	S1	S2
Factor A									
50 %		1.85	1.75	30.56	25.7	47.54	37.41	26.38	22.44
75 %		2.12	2.06	44.53	28.33	58.83	42.17	33.14	26.96
100 %		2.23	2.38	55.94	28.76	67.82	43.70	40.42	28.10
125 %		2.02	2.63	36.38	26.71	54.64	40.81	29.85	25.33
150 %		1.66	2.83	27.63	24.38	47.54	39.02	24.51	24.07
LSD at 5 %		0.07	0.06	0.344	1.17	4.73	0.730	0.665	0.518
Factor B									
control		1.89	2.19	22.04	20.02	35.32	31.72	18.33	17.61
1.5g/l		1.99	2.33	42.92	25.32	56.8	39.65	30.78	24.69
3g/l		2.05	2.46	52.07	34.95	74.82	50.5	43.48	33.84
LSD at 5 %		0.032	0.031	0.564	0.764	3.34	0.378	0.574	0.393
A X B									
50 %	control	1.78	1.66	17.26	19.3	27.66	29.13	13.86	15.26
	1.5g/l	1.84	1.73	32.6	24.53	49.83	36.60	26.76	21.30
	3g/l	1.93	1.85	41.83	33.32	65.13	46.50	38.53	30.76
75 %	control	2.02	1.96	26.36	20.93	42.56	32.96	21.44	18.73
	1 .5g/l	2.15	2.04	47.06	25.73	58.10	41.16	33.46	26.50
	3g/l	2.18	2.17	60.16	38.33	75.83	52.40	44.56	35.66
100 %	control	2.15	2.24	30.7	21.66	48.60	34.06	25.26	19.63
	1.5g/l	2.23	2.45	65.22	27.93	70.96	42.50	40.6	27.73
	3g/l	2.32	2.46	71.90	36.76	83.90	54.53	55.42	36.93
125 %	control	1.94	2.39	20.76	20.03	39.53	31.80	17.66	17.76
	1 .5g/l	2.03	2.62	39.80	24.6	50.90	39.83	29.61	24.7
	3g/l	2.09	2.87	48.60	35.23	79.50	50.80	42.30	33.53
150 %	control	1.56	2.70	15.10	18.23	24.26	30.63	13.46	16.66
	1.5g/l	1.69	2.81	29.93	23.80	54.46	38.16	23.46	23.23
	3g/l	1.74	2.97	37.80	31.13	69.73	48.26	36.60	32.33
LSD at 5 %		N.S	0.070	1.261	1.70	7.48	0.847	1.283	0.880

Factor A: NPK, Factor B: Fe, Zn and B.

4. Chemical constituents in the

A. Effect of NPK fertilizers levels

Data in table (7) the data show that, increasing rate of NPK fertilizer levels led to significantly increase in all parameters ,i.e moistures%, crude protein%, Fat%, ash% and carbohydrates %of cowpea seeds. The results also indicated that, the highest values of moistures% content of cowpea seeds was recorded when plants received fertilizer level 150% RDF. While, the lowest values were obtained in case of plants received fertilizers level (50% RDF) in both seasons.

On the other hand, the results illustrated that, the highest increment of crud protein, Fat and ash content in seeds of cowpea plants were obtained in case of plants received fertilizer level 100% RDF of recommended doses. But, the lowest values were obtained in case of plants received fertilizer level 150% RDF in both seasons. The highest increment of carbohydrates content in seeds was obtained in case of plants received fertilizer level at 50%RDF and 150%RDF of recommended doses, respectively. But; the lowest values were obtained in case of plants received fertilizers level 100% RDF in both seasons. Improving application NPK on crud protein and carbohydrates content of cowpea seeds might be due to its role in synthetic and activate many enzymes in plant. Such enzymes act as catalyst for making starch and protein. This is in coincidence with the findings of Achakzal and Bangulzai. (2006) and El-Sayed *et al*.,(2012)on pea Choudhary and Yadav (2011),El Tanahy *et al*. (2012),and Shekara *et al*. (2012)on cowpea

B. Effect of foliar application of (Fe, Zn and B)

Data presented in table (7) illustrated that, foliar application caused a significant increase in moistures%, crude protein%, Fat%, ash% and carbohydrates% of cowpea plants during both seasons. The higher values were recorded when the plants sprayed at 3g/l micronutrients mixture (Zn, B and Fe) compared with control. The positive effect of micronutrients on chemical composition of cowpea seeds may be important biological functions such as synthesis of chlorophyll, electron transport system, oxidation-reduction reactions, protein synthesis and degradation. The obtained results are in harmony with those of El Mansi *et al*., (2005). , El Sayed *et al*.,(2012),Eisa and Ali (2014)on cowpea and El-Haggan (2014)on soyabean

Table 7. Effect of NPK fertilizer levels, foliar spray with micronutrients mixture (Fe, Zn and B) and their interaction on (moisture, crude protein, fat, ash and carbohydrates %) contents of cowpea seeds at 2014 and 2015 seasons.

Treatments		Moistures%		Crud protein%		FAT%		Ash %		Carbohydrates %	
		S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Factor A											
50 %		8.26	9.88	17.17	17.77	3.12	3.58	6.15	6.67	65.48	63.97
75 %		9.26	10.50	19.99	20.22	4.29	4.06	7.25	7.56	59.69	59.40
100 %		10.01	11.16	20.86	21.18	4.56	4.67	7.43	7.94	57.63	56.86
125 %		11.35	11.66	18.73	19.11	3.75	4.14	6.82	7.15	59.84	58.87
150 %		12.40	12.16	15.68	16.51	3.14	3.15	5.99	6.25	63.26	63.97
LSD at 5 %		0.088	0.068	0.245	0.190	0.025	0.140	0.026	0.053	0.249	0.393
Factor B											
control		9.97	10.74	17.99	18.49	3.87	4.05	6.67	6.92	61.13	60.46
1.5g/l		10.23	11.07	18.50	18.91	3.78	3.86	6.78	7.11	61.13	60.55
3g/l		10.72	11.41	18.97	19.47	3.67	3.86	6.91	7.31	61.17	60.14
LSD at 5 %		0.032	0.050	0.132	0.240	0.033	0.052	0.035	0.041	0.146	0.325
A X B											
50 %	control	8.23	10.02	17.74	18.24	2.98	3.53	6.58	6.82	65.16	63.54
	1.5g/l	8.23	9.89	18.11	17.60	3.12	3.68	6.44	6.66	65.59	64.07
	3g/l	8.23	10.02	17.74	18.24	2.98	3.53	6.58	6.82	65.16	63.54
75 %	control	8.96	10.30	19.97	19.40	4.41	4.07	7.14	7.27	59.80	60.04
	1.5g/l	9.14	10.53	19.97	20.45	4.29	3.76	7.23	7.55	59.85	59.59
	3g/l	9.68	10.68	20.54	20.79	4.17	4.37	7.37	7.85	59.44	58.57
100 %	control	9.03	10.86	20.39	21.19	4.64	4.74	7.27	7.71	57.53	56.76
	1.5g/l	10.29	11.20	20.76	21.58	4.57	4.72	7.43	7.99	57.94	56.96
	3g/l	10.71	11.42	21.45	21.08	4.48	4.55	7.61	8.12	57.91	56.85
125 %	control	10.84	11.02	18.08	19.33	3.81	4.40	6.71	6.95	60.02	58.52
	1.5g/l	11.36	11.64	19.02	19.41	3.80	4.10	6.83	7.12	59.46	59.11
	3g/l	11.85	12.33	19.07	20.08	3.63	3.91	6.91	7.38	60.03	58.99
150 %	control	11.74	11.86	15.36	16.54	3.21	4.49	5.91	6.13	63.14	62.68
	1.5g/l	12.40	12.08	15.65	17.02	3.14	3.04	5.91	6.24	63.23	63.00
	3g/l	12.86	12.55	16.04	17.46	3.08	2.94	6.16	6.39	63.33	62.74
LSD at 5 %		0.073	0.113	0.290	N.S	N.S	0.11	N.S	0.093	0.328	0.726

Factor A: NPK, Factor B: Fe, Zn and B.

C. Effect of NPK fertilizers levels and foliar application of (Fe, Zn and B) interaction

The results show in table (7) that, the interaction between NPK and microelements had significant effect on moistures, crude protein, Fat%, ash and carbohydrates content of cowpea seeds in both seasons. Except with crude protein content in the second season. Likewise, fat and ash content were not effected in the first season. The moistures content was increased with increasing fertilizers levels from 50% at 150% from recommended doses with foliar application of micronutrients mixture (Fe, Zn and B) at rate3g/l. The highest mean values of the studied characters were recorded in case of plants received fertilizer level 100% of recommended doses with sprayed at 3g/l micronutrients mixture (Fe, Zn and B). But, the lowest values recorded when plants received fertilizer level 150% of recommended doses without micronutrients. The highest increment of carbohydrate content of cowpea seeds was obtained in case of plants received fertilizers level at 50% of recommended doses without foliar application. This results are in harmony with those of Nasri *et al*.,(2011) on common bean and Moghaze *et al* . (2014)and Nyoki and Ndakidemi. (2014) on cowpea, who showed that N,K with spray of a significantly affected nitrate in pod, carbohydrate percentage, carbohydrate yield, protein percentage, protein yield and chlorophyll of leaf.

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تـأثير مسـتويات مختلفـة مـن التسـميد المعـدني مـع الـرش الـورقي بمخلـوط العناصـر الصـغرى مـن الحديـد والزنـك والبورون على نمو ومحصول البذور في اللوبيا

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أجريت هذه الدراسة على محصول اللوبيا (صنف كفر الشيخ ١) خلال الموسمين المتعاقبين ٢٠١٤ و٢٠١٥ . في مزرعة خاصة بكفر سعد – دمياط بهدف دراسة تأثير مستويات مختلفة من التسميد المعدني بالنيتروجين والفسفور والبوتاسيوم بمعدلات (٥٠% و٧٥% و١٠٠% و١٢٥% و١٥٠%) من التسميد الموصى به مع الرش الورقي بمخلوط من العناصر الصغرى من الزنك ٥% والحديد ٦% والبورون ١% بثلاثة معدلات (بدون رش(كنترول) وبمعدل ١.٥جم/لتر وبمعدل ٣ جم/لتر . وكان التصميم المستخدم هو نظام القطع المنشقة في ثلاثة مكرارات حيث وزعت مستويات التسميد المعدني الموصى به على القطع الرئيسية بينما وزعت معدلات الرش الورقي داخل القطع المنشقة وتتلخص أهم النتائج المتحصل عليها على الاتى بصفة عامة أوضحت النتائج انه بزيادة معدلات التسميد المعدني من ٥٠% حتى ١٥٠% من الموصى به أدت إلى زيادات معنوية فى طول النبات وعدد الأفرع والوزن الطازج والجاف ومحتوى الأوراق من الكلوروفيل وكذلك المحصول ومكوناته ومحصول النبات الواحد ومحصول الفدان وعدد القرون على النبات وعدد البذور في القرن وطول وعرض ووزن القرن ووزن ١٠٠ بذرة وبعض المحتويات الكيماوية للأوراق والبذور ومحتواها من البروتين. حيث كانت أفضل النتائج عند التسميد بمعدل ١٠٠% من الموصى به خلال موسمي النمو أوضحت النتائج أيضا أن الرش الورقي بمخلوط العناصر الصغرى بمعدلات (١.٥جم/لتر و٣جم/لتر) من الحديد٦% والزنك٥% والبورون ١% أدت إلى زيادة معنوية في النمو الخضري ومحصول البذور ومكوناته بالإضافة إلى زيادة محتوى الأوراق من الكلوروفيل ومحتوى البذور من البروتين خلال موسمي النمو وكانت أفضل النتائج المتحصل عليها الرش بمخلوط العناصر الصغرى بمعدل ٣جم/لتر مقارنة مع الكنترول (بدون رش) وبناء على النتائج من التفاعل بين المستويات المختلفة من التسميد المعدني الموصى به مع الرش بمخلوط العناصر الصغرى (زنك ،بورون، حديد) وجد أن أفضل النتائج كانت عند التسميد بالسماد المعدني بمعدل ١٠٠% مع الرش بمخلوط العناصر الصغرى بمعدل ٣جم/لتر والتي أعطت أعلى نمو خضري ومحصول البذور ومكوناته بالإضافة إلى زيادة معنوية في محتوى الأوراق من الكلوروفيل والبذور من البروتين . توصى نتائج هذه الدراسة بتسميد اللوبيا بالمعدل الموصى به من السماد المعدني مع الرش بالعناصر الصغرى بمعدل ٣جم/لتر للحصول على أقصى قدر من النمو والمحصول والجودة تحت الظروف البيئية لمنطقة كفر سعد دمياط - مصر