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RESPONSE OF FABA BEAN (*Vicia faba* L.) PLANTS TO FOLIAR SPRAY WITH SOME NUTRIENTS
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ABSTRACT

Spraying faba bean plants with Zn (50 and 100 ppm), K and Mg (100 and 200 ppm) for each at 35, 50 and 65 days after sowing during 1998/99 and 1999/2000 seasons, significantly enhanced plant height, No. of branches, No. of leaves / plant, stem and leaf dry weights / plant and total leaf area / plant. Moreover, chlorophyll a& b and carotenoids as well as total carbohydrates and crude protein contents were also increased. The highest endogenous IAA levels were obtained with Zn followed by K treatments at start of blooming, full blooming and at the time of maximum shedding. The applied treatments significantly increased No. of flowers and No. of setted pods / plant, whereas reduced the percentages of flowers and pod shedding, therefore significantly increased No. of survived (mature) pods / plant. Moreover, K and Mg were more effective for increasing pod and seed yields / plant as well as the seed index compared with the control plants especially at 200 ppm. Furthermore, seed contents of N, P, K, crude protein, reducing and total sugars were also increased with different applied nutrients. It could be recommended that treating faba bean plants with Zn, K and Mg as foliar application, practically being of great effectiveness for reducing abscission of flowers and pods which consequently reverse upon obvious increase in the final seed yield.

INTRODUCTION

The phenomena of shedding in faba bean plant especially for its buds, flowers and immature pods usually took place in serious values leading to a great reduction in seed yield of this economic plant. Therefore, plant physiologists and breeders are studying intensively the problem of shedding, in order to find out a solution for reducing the high percentage of buds, flowers and immature pods, that fail to develop into fully mature pods in this plant. In this respect, it is well known that, as a rule there is a great discrepancy between the mineral nutrient concentration in both soil and plants (Marschner, 1995). Also, during plant life cycle, each leaf undergoes a shift in which its function as a sink changes to that of a source for both mineral nutrients, this shift is correlated with a change in the prevailing long distance transport in the phloem and xylem (Turgeon, 1989). In addition, soil may contain high concentrations of mineral elements not needed for growth (Robinson Boers *et al.*, 1990).

Moreover, mineral nutrients not only have major effects upon flower formation, seed development and yield responses (Gerendas and Sattelmacher, 1990) but also required for chloroplast formation and sink limitations (Tersahima and Evans, 1988). Furthermore, foliar spary of mineral nutrients represents the more quick and efficient methods in many cases for supply of these elements (Marschner, 1995 and Bastawisy and Sorial, 1998).

Therefore, in the present study it was thought advisable to use foliar spray of zinc, potassium and magnesium on faba bean plants to reduce or diminish the flower and immature pod shedding phenomena as well as increase the final seed yield of this economic plant especially in Egypt.

MATERIALS AND METHODS

Two field experiments were conducted at the Experimental Farm of the Faculty of Agriculture at Moshtohor, Zagazig University, Benha Branch during two successive growing seasons of 1998/99 and 1999/2000 to investigate the effects of spraying either of zinc, potassium or magnesium on some growth characters, chemical components, flowering, shedding, yield and its components, of faba bean (*Vicia faba* L.) cultivar Giza3. Seeds of faba bean were secured from the Agricultural Research Center, Ministry of Agriculture, Giza, Egypt.

Each experiment included seven treatments i.e., the control (distilled water), 50 and 100 ppm Zn (zinc sulphate), 100 and 200, K (potassium citrate) and 100 and 200 ppm Mg (magnesium sulphate). The experimental design was complete randomized blocks with four replicates. The treatments were randomly chosen for the plots in each replicate. The plot area was 10.5m^2 (3.5 x 3m) with 5 rows. Faba bean seeds were sown in hills spaced 15 cm on ridges at the 9th of November in the two seasons. At 20 days after sowing, hills were thinned to leave one seedling/ hill. Calcium superphosphate (15.50% P_2O_5) was added before sowing in the two seasons at the rate of 100 and 50 Kg / fed., respectively. Also, nitrogen urea (46%) fertilizer at rate of 20 Kg/fed. was applied before the first irrigation. The other cultural practices for growing faba bean plants were performed as recommended by Ministry of Agriculture.

All treatments were applied triple as foliar spray on plants at 35, 50 and 65 days after sowing, using hand operated compressed air sprayer at the rate of 10 liter / plot with 1ml / l of Tween-20 as a wetting agent.

Sampling and collecting data:

I - Vegetative growth characters:

Five plants were randomly chosen from central row of each plot at 65 and 95 days from sowing (after 15 and 45 days from the second spraying, respectively) in both seasons to estimate plant height (cm), number of branches / plant, stem dry weight (g) / plant, number of leaves / plant, leaf dry weight (g) /

plant and total leaf area (cm^2) / plant using the disc method as described by Deriaux *et al.,* (1973) this method could be summarized as: a representative sample of leaves at different growing stages were taken then discs of certain area were picked out from each leaf, weighted, average weight of disc was recorded and the relationship between the dry weight of the disc and its area was detected. Then by detecting the total dry weight of leaves/ plant, the total leaf area/ plant could be easily calculated.

II- Chemical constituents and endogenous auxins in the leaves:

Samples of faba bean leaves were taken at 80 days after sowing in both season to determine some chemical constituents i.e., photosynthetic pigments (Nornal, 1982), total carbohydrates (Dubois *et al.,* 1956) and total nitrogen (Horneck and Miller, 1998), Crude protein was calculated according to the following equation:

Crude protein = total nitrogen x 6.25 (A.O.A.C., 1990).

To determine the endogenous auxin at the different stages of plant growth i.e., start of blooming, full blooming and pod setting (the time of maximum shedding), 20 g from the 5^{th} apical leaf was collected from each treatment at 60, 80 and 100 days after sowing in the second season for IAA extraction with 80% cold methanol . The acidic ethyl acetate fraction was concentrated to dryness, then used for the determination of IAA by Gas Liquid Chromatography (GLC) according to the method described by Shindy and Smith (1975).

III- Flowering and yield data :

Five plants were randomly chosen in each plot and were marked in the field from the start of flowering to harvesting time and the following characters were recorded:

a- No. of opened flowers / plant : Counting was started at 60 days of plant age with 3 days intervals until 100 days.

b- No. of setted pods / plant: Counting was started at 75 days of plant age with 3 days intervals until 125 days.

c- No. of survived (mature) pods / plant: It was recorded at harvest time.

$$d - \text{\% of flower shedding} = \frac{\text{Total No. of flowers/plant - No. of setted pods/plant}}{\text{Total No. of setted pods/plant}}$$

$$e - \text{\% of pod shedding} = \frac{\text{Total No. of setted pods/plant - No. of survived pods/plant}}{\text{Total No. of setted pods/plant}}$$

In addition, pod yield (g) / plant, seed weight (g) / pod, seed yield (g) / plant and seed index [100-seed weight (g)] were recorded at harvesting time.

IV- Chemical constituents in the seeds:-

After harvesting, seeds were also analyzed for total nitrogen (Horneck and Miller, 1998), phosphorus (Sandell, 1950), potassium (Horneck and Hanson

,1998) and reducing and total sugars (Dubois *et al.*, 1956). Crude protein was also calculated.

V - Statistical analysis :

All data were subjected to statistical analysis according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

I- Growth parameters:

1- Stem growth :

Table (1) shows that either zinc (Zn) in the form of zinc sulphate or potassium (K) in the form of potassium citrate and magnesium (Mg) in the form of magnesium sulphate significantly increased the height of sprayed faba bean plants compared with the control. The increases were more obvious with Zn and K treated plants than with Mg ones. That was true at 65 and 90 days after sowing in both seasons. Also, increases were parallel to the applied concentration of each element. Since, the highest concentration of Zn, K and Mg during 1998 / 99 season gave 56.60 & 106.50, 55.20 & 105.70 and 54.50 & 95.50 cm of plant height at 65 and 95 days after sowing, respectively. Meanwhile, the control values were 42.20 & 85.20 at 65 and 95 days after sowing, respectively. Results of the second season were parallel to those of the first one.

The stimulating effect of Zn on plant height may be attributed to its effect on IAA synthesis (Cakmak *et al.*, 1989). They suggested that 50% reduction in IAA synthesis in Zn deficient plants might be the result of inhibited synthesis or enhanced degradation of IAA. Similar conclusion was previously reported by Karakis *et al.*, 1990; Hossain *et al.*, (1998) and Nakhlla, (1998). In addition, it was reported that Zn enhances gibberellin biosynthesis (Alphonse, 1996 and Sekimoto *et al.*, 1997).

In addition, in most inst-ances, cell extension is a consequence of the accumulation of K^+ in the cell, which is required for both stabilizing the pH of cytoplasm and increasing the osmotic potential in the vaculoes (Marschner, 1995; Ren *et al.*, 1997 and Rashad, 1998). Also, Bastawisy and Sorial (1998) reported that K increased auxin level in faba bean leaves.

Regarding the number of branches / plant, data in the same table indicate that except that insignificant increase in number of branches / plant existed with 100 ppm Zn treatment at 65 days of plant age during the first season, the all other treatments at the two stages of growth and in the two seasons significantly increased this number compared with the control. The highest values of this number, especially at 95 days after sowing existed with K and Mg at their high concentration (200 ppm). Meanwhile, the lowest increases were obtained with Zn treatments.

As for stem dry weight, it was significantly increased with different applied treatments at the two stages of growth in both seasons (Table, 1). This result indicates that more dry matter being allocated for the formation of new branches. These branches could carry an additional yield similar results were reported by. Mahady (1990), Sakr *et al.*, (1996), Bastawisy and Sorial (1998) and Sallam and Sohsah (1998).

2- Leaf growth :

Data in Table (1) clearly show that different applied nutrient elements in their two assigned concentrations significantly increased number of leaves and total leaf area / plant as well as their dry weight at 65 and 95 days of plant age during the two seasons. Increment each of leaf number and total leaf area in treated plants may be attributed to the new formed branches. That was clearly reversed upon leaf dry weight. That means that photosynthetic area and its activity were increased. This was directly reflected on the final yield of seeds. These results are in agreement with those obtained by Mahady (1990), Bastawisy and Sorial (1998) and Sallam and Sohsah (1998).

II- Photosynthetic pigments and some bioconstituents:

Data in Table (2) clearly indicate that the leaf content of chlorophylls (a & b) and carotenoids was obviously increased with different applied elements at their two assigned concentrations during the two growing seasons. The highest increment was obtained with Mg treatments followed by K ones. Zn showed the lowest increment in this respect. These results are in harmony with those obtained by Sallam and Sohsah (1998) who reported that the enhancement in chlorophylls a & b content of leaves sprayed with different Mg levels may be ascribed to the effect of such elements on increasing the biosynthesis of these pigments and / or decreasing their degradation. Also, it may be partially attributed to the synergistic effect of Mg upon chlorophylls formation. Since the major function of Mg in plants is the central atom of the tetrapyrrole ring of chlorophyll (Devlin and Witham, 1983 and Marschner, 1995).

Table (2) shows also that total carbohydrates % was increased with different applied elements. The maximum value was recorded with K at 200 ppm in the first season and with Mg at 200 ppm in the second one. This positive effect of Zn, K and Mg might be due to their stimulative effect on chlorophyll biosynthesis.

The crude protein % behaved similar to that of total carbohydrates (Table, 2). These results are of economic values because they included increases of chlorophylls, carbohydrates and protein % in leaves, which may reflect on reduction of flower shedding percentage and increasing pod setting percentage. Similar results were obtained by Mahady (1990) Xia and Xiong (1991); Bastawisy and sorial (1998) Sallam and Sohsah (1998).

III- Endogenous auxins :

As shown in Table (3) the endogenous auxins (IAA) level in leaves of faba bean at 60, 80 and 100 days after sowing was highly affected with Zn, K and Mg treatments. Zn and K showed its highest level, whereas Mg was less pronounced in this respect. Moreover, endogenous auxins level was arised with advancing of plant age up to 80 days (i.e., at full blooming stage) then decreased. The treatments of Zn, K and Mg diminished the reduction of endogenous auxins in leaves of treated plants compared with the control especially at 100 days of plant age (i.e., at the time of maximum shedding).

Table (2): Effects of zinc (Zn), potassium (K) and magnesium (Mg) on photosynthetic pigments and some bioconstituents in leaves of faba bean (*Vicia faba* L. cv. Giza 3) at 80 days after sowing during 1998/99 and 1999/2000 seasons.

Treatments	ppm	Chl. a mg/g d.w.	Chl. B mg/g d.w.	Chl. (a+b) Mg/g d.w.	Carot. Mg/g d.w.	Total carbohydrates%	Crude protein %
		Season 1998 / 1999					
Control	0.0	5.36	1.75	7.11	5.86	34.60	17.60
Zn	50	5.93	2.54	8.47	6.16	36.70	19.00
	100	6.64	2.89	9.53	6.55	38.90	19.60
K	100	6.35	2.78	9.13	6.41	39.90	19.30
	200	6.65	3.14	9.79	7.09	45.30	22.60
Mg	100	6.94	3.08	10.02	6.73	41.20	22.20
	200	7.08	3.36	10.44	7.92	43.80	21.80
		Season 1999 / 2000					
Control	0.0	5.85	2.20	8.05	6.04	35.10	18.10
Zn	50	6.22	2.73	8.95	6.51	37.50	19.30
	100	7.08	3.22	10.30	6.78	40.10	20.20
K	100	6.16	2.65	8.71	6.36	39.60	18.90
	200	6.28	2.89	9.17	6.91	40.60	21.90
Mg	100	6.56	2.76	9.32	6.54	40.20	21.50
	200	7.54	3.62	11.16	7.16	45.50	22.40

Chl. = Chlorophyll Carot. = Carotenoids

In this respect, the present study answered that arises question relative to nutrient stress in plants that is: Do changes in nutrient levels affect plant growth directly or indirectly through alteration in hormones production? Since, the treated plants were dominantly exhibited highest auxin level. Other studies have been also got similar conclusion (Cakmak *et al.*, 1989; Karakis *et al.*, 1990; Jones 1990; Davis and Zhang 1991; Marschner 1995; Ren *et al.*, 1997; Hossain *et al.*, 1998 and Nakhlla 1998). They concluded that Zn is required for the synthesis of IAA. Moreover, K has been reported to enhance auxin biosynthesis. The stimulative effect of K on IAA synthesis might be ascribed to its role in activating the enzymes involved in the biosynthesis of IAA (Salisbury and Ross, 1992) and also, its inhibitory effect on ethylene production (Beyer, 1976).

The above mentioned results economically being of a great interest. Since, plant hormones apparently interact to control abscission. Auxin generally inhibits abscission (Devlin and Witham, 1983; Marschner, 1995 and Hopkins, 1995). Thereby, increment of endogenous auxins in treated leaves with Zn, K and

Mg directly reversed upon increases of pod number/ plant. Hence, final yield of seeds (Table, 4) was also significantly increased with the treatments of the three applied elements.

IV- Reproductive growth and yield components:

1- flowering, shedding and pod setting:

As shown in Table (4) different applied treatments (Zn, K and Mg at their two applied concentrations) significantly increased the total number of formed flowers / plant compared with the control. The only exception was that insignificant increase existed with Mg at 100 ppm during 1998/99 season and with Zn at 50 ppm in the second season. Also, it was found that K at the two applied concentrations gave the highest increases in number of flowers / plant in the two seasons, meanwhile Zn treatments showed the lowest increases in this number.

Table (3): Effects of zinc (Zn), potassium (K) and magnesium (Mg) on endogenous auxin (Indole-3-acetic acid) in leaves of faba bean (*Vicia faba* L. cv. Giza 3) at 60, 80 and 100 days after sowing during 1999/2000 season.

		Days after sowing					
		60 (start of blooming)		80 (full blooming)		100 (time of maximum shedding)	
Treatments	ppm	IAA µg/g f.w.	% to control	IAA µg/gf.w.	% to control	IAA µg /gf.w.	% to control
Control	0.0	92	100.00	114	100.00	73	100.00
Zn	50	115	125.00	134	117.54	111	152.05
	100	122	132.61	140	122.81	115	157.53
K	100	118	128.26	132	115.79	102	139.73
	200	121	131.52	136	119.30	111	152.05
Mg	100	102	110.87	125	109.65	93	127.40
	200	114	123.91	129	113.16	105	143.84

Data in Table (4) clearly show that percentage of flower shedding was significantly reduced with all applied treatments. In addition, the different applied nutrients nearly diminished flower abscission with the same degree during the two growing seasons of this study.

Number of setted pods / plant was significantly increased with different applied nutrients at their two assigned concentrations during the two growing seasons compared with the control (Table, 4). Also, the enhancement of pod development and the formed fruits reached its maximum with K treatments, while its lowest existed with Mg treatments.

With respect to the percentage of pod shedding, the enhancement of pod setting was directly reversed upon a reduction in the percentage of their shedding (Table, 4). Thereby, reduction of this percentage was obtained with different applied treatments and reached level of significance with Zn and Mg at 100 ppm

Table (4): Effects of zinc (Zn), potassium (K) and magnesium (Mg) on flowering, shedding, yield and its components of faba bean (*Vicia faba* L. cv. Giza 3) plants during 1998/99 and 1999/2000 seasons.

Tretments (ppm) / Characters		No. of flowers /plant	% of flower shedding/ plant	No. of stetted pods/ plant	% of pod shedding / plant	No. of mature pods / plant	Weight of pod (g)	Pod yield (g) / plant	Weight of seeds / pod	Seed yield (g) / plant	Seed index (g)
		Season 1998 / 1999									
Control	0.00	72.50	73.24	19.40	34.02	12.80	2.57	32.90	2.07	26.50	69.00
Zn	50	73.20	67.08	24.10	31.54	16.50	2.68	44.22	2.19	36.14	72.00
	100	80.50	65.71	27.60	30.43	19.20	2.73	52.42	2.28	43.78	76.00
K	100	84.50	64.26	30.20	32.78	20.30	2.78	56.43	2.34	47.50	78.00
	200	89.00	64.38	31.70	31.23	21.80	2.73	59.51	2.32	50.57	77.33
Mg	100	77.50	69.68	23.50	30.63	16.30	2.69	43.58	2.11	34.18	70.33
	200	84.50	66.62	26.20	31.56	19.30	2.74	52.88	2.23	40.81	74.33
L.S.D	0.05	5.30	3.12	2.30	3.10	1.23	0.09	2.10	0.11	2.09	1.15
		Season 1999 / 2000									
Control	0.00	76.00	70.00	22.80	38.60	14.00	2.42	33.88	1.94	27.16	64.67
Zn	50	79.90	66.45	26.80	35.07	17.40	2.58	44.89	2.15	37.41	71.67
	100	85.70	65.22	29.80	33.56	19.80	2.58	51.08	2.17	42.97	72.33
K	100	90.80	64.80	30.90	31.23	21.20	2.69	57.03	2.22	47.06	74.00
	200	94.00	64.57	33.30	30.63	23.10	2.59	59.57	2.16	49.90	72.00
Mg	100	82.00	66.95	27.10	32.47	18.30	2.51	45.66	2.04	34.18	68.00
	200	90.30	67.00	29.80	29.53	21.00	2.61	54.81	2.16	41.69	72.00
L.S.D	0.05	4.60	2.80	2.50	3.50	1.52	0.13	2.30	0.16	1.70	1.66

during 1998/99 as well as with the two applied concentrations of each nutrient in 1999/2000 season.

As for the number of mature (survived) pods/plant, of interest was to note that the increases of formed flowers and setted pods as well as the reduction in shedding percentages of flowers and pods obtained with all applied nutrient led to an increase in the number of pods / plant. Since, a significant in increase in the number of mature pods was existed with different applied treatments in the two seasons of this study. Also, it could be noticed that K treatments gave the highest increase in the number of mature pods, while Zn treatments showed the lowest increase in this number.

Again, it could be concluded that, reduction in shedding percentages of flowers and pods as well as enhancement of pod setting and development which obtained with Zn, K and Mg treatments may be due to an increase in concentrations of total carbohydrates and protein in the leaves (source) as well as the endogenous auxins, especially at full blooming and setting stages.

2- Yield components:

Table (4) shows that pod weight was significantly increased with different applied nutrient elements during the two growing seasons. The only exception was the insignificant increase existed with Mg at 100 ppm during the second season.

Data in Table (4) clearly show that in the two seasons, pod yield (g) / plant was significantly increased with different applied nutrients in the two growing seasons . Also, it could be noticed that K treatments showed the highest increases in this yield. Meanwhile, Mg and Zn treatments similarly increased this parameter.

Concerning, weight of seeds per pod and per plant, data in Table (4) show that the all applied treatments in the two seasons, significantly increased these parameters. Also, it could be clearly noticed that K treatments were more effective in this respect.

Regarding the seed index (100-seed weight), it was significantly increased with the two applied concentrations of Zn, K and Mg in the two seasons Also, K treatments were proceeded in this respect.

V- Seed contents of NPK, crude protein and sugars:

As shown in Table (5) different applied nutrients i.e., Zn, K and Mg obviously increased NPK, crude protein and total sugar contents in seeds of treated faba bean plants. Increases were also proportional to the applied concentrations. Since, the highest concentration of each nutrient was more effective when compared with the lowest one regarding different estimated NPK and other constituents. In addition, Mg at 200 ppm was the most effective either when compared with its lowest concentration or with the two concentrations of

Table (5): Effects of zinc (Zn), potassium (K) and magnesium (Mg) on some bioconstituents in seeds of faba bean (*Vicia faba* L. cv. Giza 3) during 1998/99 and 1999/2000 seasons.

Tretments (ppm) \ Characters		Season 1998 / 99						
		%			mg/g d.w.			
		N	P	K	Crude protein	Reducing sugars	Non reducing sugars	Total sugar
Control	0.00	3.80	0.35	5.34	23.75	16.00	36.00	52.00
Zn	50	4.06	0.37	5.41	25.38	16.00	38.00	54.00
	100	4.47	0.39	5.45	27.94	18.00	42.00	60.00
K	100	4.35	0.41	5.93	27.19	18.00	41.00	59.00
	200	4.73	0.46	6.27	29.56	18.50	44.00	62.50
Mg	100	4.64	0.43	5.78	29.00	18.25	42.50	60.75
	200	5.17	0.48	5.93	32.31	19.00	45.50	64.50
		Season 1999 / 2000						
Control	0.00	3.65	0.33	5.20	22.81	17.00	36.50	53.50
Zn	50	3.86	0.36	5.36	24.13	18.00	39.50	57.50
	100	4.20	0.40	5.48	26.25	18.50	44.00	62.50
K	100	4.12	0.38	5.70	25.75	18.00	40.00	58.00
	200	4.40	0.42	5.98	27.50	19.00	45.50	64.50
Mg	100	4.37	0.46	5.65	27.31	18.00	44.50	62.50
	200	4.85	0.51	5.78	30.31	19.00	47.75	66.75

the other two nutrients regarding different estimated constituents. On the other hand, Zn at 50 ppm was less effective in this respect.

The applied nutrient treatments improved seed yield of faba bean plants (Table, 4) due to increasing flower formation and the reduction of flowers and pod shedding as well as increasing their ability to accumulate more bioconstituents and NPK contents (Table, 5). These positive effects of nutrient treatments upon seed yield and its characters could be considered as a reversion of their effects upon the early vigorous growth of faba bean plants (Table, 1). Other studies also reported nearly similar results with applying Zn, K or Mg to faba bean or other plants. Of these studies are Abd-El-Hadi *et al.*, (1985); Mahady (1990); Xia and Xiong (1991); Sakr *et al.*, (1996); Sallam and Sohsah (1998) and Bastawisy and Sorial (1998).

In general, it has been established that yield response curves differ between seed and straw particularly at higher K level in favor of seed yield in contrast with nitrogen when its excess was added (Marschner, 1995).

Also, the obtained positive yield responses are the result of individual processes, such that significant increase in leaf area (Table, 1) and its reversion upon increasing the net photosynthesis per unit of leaf area i.e., effects at the source or that increase in pods and seed weights (Table, 4), i.e., effects at the sink.

In this respect, Chapin *et al.*, (1988) reported that when the nutrient supply is suboptimal, the leaf growth rate, and thus the leaf area index, can be limited by low rates of net photosynthesis or insufficient cell expansion or both these two factors. Also, Marschner and Cakmak, (1989) stated that plant dry weight was increased in the zinc sufficient plants. In addition Cakmak and Marschner, (1992) reported that accumulation of photosynthates under sufficient nutrient supply (including Zn, K and Mg) was significantly increased in many plants. They stated that mineral nutrients deficiency decreases not only current photosynthesis and leaf area index but also leaf area duration (LAD), that is the length of time in which the source leaves supply photosynthates to sink sites. Moreover, Waters *et al.*, (1984) and Boyle *et al.*, (1991) reported that mineral nutrients supply has positive effects upon flower formation and setting through hormones level.

Therefore, the availability of mineral nutrients such as zinc, potassium and magnesium to the growing plants being of great importance to the comming yield.

Hence, because in the present study the applied nutrients i.e., Zn, K and Mg were applied 3 times by the method of foliar spraying, so sufficient improvement of both vegetative and reproductive growth as well as seed yield being expected.

Thereby, the present study strongly admit the use of Zn at 100 ppm and K & Mg at 200 ppm three times at 35, 50 and 65 days of age of faba bean plants for getting the highest seed yield, with good quality.

REFERENCES

A.O.A.C. (1990): Official Methdos of Analysis, 15th ed. Association of Official Analytical Chemists, Washington DC, USA.

Abd El-Hadi, A.H. Asy, K.G.; Khadr, M.S.; Mohamed, Y.H.; Moustafa, A.A. and Taha, M.E. (1985): Effect of foliar fertilization in different crops under egyptian conditions. Special fertilizer. International Symposium on Foliar Fertilization. Marcg, 11-14, 1985. Berlin, Germany.

Alphonse, M. (1996): Effect of low temperature, zinc and gibberellic acid (GA_3) on the growth, flowering, earliness, yield and protein of pea (*Pissum sativum L.*). Alex. J. Agric. Res., 41 (3): 367-377.

Bastawisy, M.H. and Sorial, M.E. (1998): The physiological role of spraying some mineral nutrients on the growth, flowering, abscission, endogenous auxin and yield of faba bean. J. Agric. Res. Zagazig Univ., 25 (2): 271-284.

Beyer, E.M. (1976): A potential inhibitor of ethylene action in plants. Plant Physiol., 58: 268-271.

Boyle, M.G.; Boyer, J.S. and Morgan, P.W. (1991): Iron metabolism in higher plants. The influence of nutrient iron on bean leaf lipoxygenase. J. Plant Nutr. 9, 1585-1600.

Cakmak, I. and Marschner, H. (1992): Magnesium deficiency and high light intensity enhance activities of superoxide dismutase, ascorbate peroxides and glutathione reductase in bean leaves. Plant Physiol. 98, 1222-1227.

Cakmak, I.; Marschner, H. and Bangerth, F. (1989): Effect of zinc nutritional status on growth, protein metabolism and levels of indole-3-acetic acid and other phytohormones in bean (*Phaseolus vulgaris* L.). J. Exp. Botany, 40 (212): 405-412.

Chapin, F.S. III; Bloom, A.J.; Field, C.B. and Waring, R.H. (1988): Growth response of barley and tomato to nitrogen stress and its control by abscisic acid, water relations and photosynthesis. Planta. 173, 352-366.

Davis, W.J. and Zhang, J. (1991): Root signals and the regulation of growth and development of plants in drying soil. Plant Mol. Biol., 42: 55-76.

Deriaux, M.; Kerrest, R. and Montalon, Y. (1973): Etude de la surface foliaire et de L'activite photosynthetique chez kulkves hybrides de mais. Ann. Amelior Plantes. 23: 95-107

Devlin, M. and Witham, H. (1983): Plant Physiology. 4th ed., Willard Grant Press Pub., Boston.

Dubois, M.; Gilles, K.A.; Hamilton, J.; Rebens, P.A. and Smith, F. (1956): Colorimetric method for determination of sugars and related substances. Anal. Chem., 28: 350-356.

Gerendas, J. and Sattelmacher, B. (1990): Influence of nitrogen form and concentration on growth and ionic balance of tomato (*Lycopersicon esculentum*) and potato (*Solanum tuberosum*). In "Plant Nutrition-Physiology and Application" (M.L. van Beusichem, ed.), pp. 33-37. Kluwer Academic, Dordrecht.

Gomez, K.A. and Gomez, A.A. (1984): Statistical Procedures for Agricultural Research: 2nd ed., John Wiley and Sons Pub., pp. 139.

Hopkins, W.G. (1995): Introduction to plant physiology. John Wiley & Sons Inc. ed., pp. 251-261.

Horneck, D.A. and Hanson, D. (1998): Determination of potassium and sodium by Flame Emission Spectrophotometry. In: Handbook of Reference Methods for Plant Analysis. Kalara Y.D. (ed.), 153-155.

Horneck, D.A. and Miller, R.O. (1998): Determination of total nitrogen in plant tissue. In: Handbook of Reference Methods of Plant Analysis. Kalara, Y.D. (ed.), 75-83.

Hossain, A.; Hirata, N. and Nagatomo, Y. (1998): Zinc nutrition and levels of endogenous indole-3-acetic acid in radish shoots. J. Plant Nutrit., 21 (6): 1113-1128.

Jones, A.M. (1990): Do we have the auxin receptor yet? Physiol. Plant., 80: 154-158.

Karakis, K.D.; Sidorshina, T.N. and Ermak, M.M. (1990): Reduction in zinc deficiency symptoms in maize under the influence beta indolyalcetic acid. Fiziol I-Biokh kul'turnykh-Rastenii. 22 (2): 137-142.

Mahady, A.E.M. (1990): Effect of phosphorus fertilizers, some micro-nutrients and plant density on growth and yield of broad beans. Ph.D. Thesis, Fac. Agric. Moshtohor, Zagazig Univ., Egypt.

Marschner, H. (1995): Mineral nutrition of higher plants. 2nd ed., Academic Press Pub., New York (USA).

Marschner, H. and Cakmak, I. (1989): High light intensity enhances chlorosis and necrosis in leaves of zinc, potassium and magnesium dificient bean (*Phaseolus vulgaris*) Plants. J. Plant Physiol. 134, 308-315.

Nakhila, F.G. (1998): Zinc spray on novel orange in newly reclaimed desert areas and its relation to foliar IAA level and fruit drop. Bull. Fac. Agric., Univ. Cairo, 49: 69-88.

Nornal, R. (1982): Formulate for determination of chlorophyllous pigments extracted with N, N-Dimethylformamide. Plant Physiol., 69: 1371-1381.

Rashad, M.H. (1998): Influence of gibberellic acid and potassium interaction on some cabbage cultivars under heat stress. J. Agric. Mansoura Univ., 33 (4): 1525-1540.

Ren, Z.Z.; Ren, G.L.; Qin, G.H. and Huda, S.Y. (1997): Effects of some inhibitors on potassium and IAA induced adventitious root formation of exised cucumber cotyledon. Acta Botanica Sinica. 39 (1): 64-67.

Robinson-Beers, K.; Sharkey, Th.D. and Evart, R.F. (1990): Import of ^{14}C-photosynthate by developing leaves of sugarcane. Bot. Acta. 103, 424-429.

Sakr, M.M.; Abd El-Mottaleb, H.M. and Ali, E.A. (1996): Effect of spraying iron and zinc on botanical, chemical characters, yield and its components of *Vicia faba* L. Ann. Agric. Sci. Moshtohor. 34 (4): 1457-1477.

Salisbury, F.B. and Ross, C.W. (1992): Plant Pysiology. 4th ed., Eadsoworth Pub. Co., Belmont, California.

Sallam, H.A. and Sohsah, S.M. (1998): Foliar application effects of Mg on growth and chemical components of guar plants under salinity stress. Ann. Agric. Sci., Moshtohor. 36 (2): 925-936.

Sandell, R. (1950): Colorimetric determination of traces of metal 2nd ed., Interscience Publishers Inc. New York.

Sekimoto, H.; Hoshi, M.; Nomura, T. and Yokota, T. (1997): Zinc deficiency affects the levels of endogenous gibberellins in Zea mays. Plant and Cell Physiol., 38 (9): 1087-1090.

Shindy, W.W. and Smith, O.E. (1975): Identification of plant hormones from cotton ovules. Plant Physiol., 55: 550-554.

Terashima, I. and Evans, J.R. (1988): Effects of light and nitrogen nutrition on the organization of the photosynthetic apparatus in spinach. Plant Cell Physiol., 29: 143-155.

Turgeon R. (1989): The sink-source transition in leaves. Plant Mol. Biol. 40, 119-138.

Waters, S.P.; Martin, P. and Lee, B.T. (1984): The influence of sucrose and abscissic acid on the determination of grain number in wheat. J. Exp. Bot. 35, 829-840.

Xia, M.Z. and Xiong, F.Q. (1991): Interaction of molybdenum, phosphorus and potassium on yield in *Vicia faba* L. J. Agric. Sci., Mansoura Univ. 117 (1): 85-89.

استجابة نباتات الفول للرش الورقى ببعض العناصر المغذية

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أظهرت الدراسة أن معاملة نباتات الفول بعنصر الزنك بتركـيزى ٥٠ ، ١٠٠ جزء فى المليون وكذلك عنصرى البوتاسيوم والماغنسيوم بتركيزى ١٠٠ ، ٢٠٠ جزء فى المليون لكل منهما كمعاملات رش ورقى عند ٣٥ ، ٥٠ ، ٦٥ يوم بعـد الزراعـة خلال موسمى ١٩٩٨/٩٩ ، ١٩٩٩/٢٠٠٠ قد أعطت زيادة معنوية فـى كثـير مـن صفات النمو الخضرى مثل ارتفاع النبات ، عدد الأفـرع وعـدد الأوراق / نبـات ، الوزن الجاف لكل من السوق والأوراق / نبات وكذلك مساحة الأوراق الكلية / نبـات. أيضا حدثت زيادة واضحة فى محتوى الأوراق من كلوروفيل أ ، ب والكـاروتينويدات وكذلك الكربوهيدرات الكلية والبروتين الخام فى النباتات المعاملة . هذا وقد تم تسـجيل أعلى مستويات للأوكسينات الداخلية فى اوراق النباتات المعاملة بالزنك يليها النباتـات

المعاملة بالبوتاسيوم خلال مراحل النمو الثلاثة (مرحلة بداية التزهير ، مرحلة تمام الإزهار ، مرحلة التساقط القصوى). وبالإضافة إلى ذلك ، فقد سببت جميع المعاملات المستخدمة زيادة معنوية في عدد الأزهار وعدد الثمار العاقدة / نبات ونقص معنوى في النسبة المئوية لتساقط الأزهار والثمار ونتيجة لذلك حدثت زيادة معنوية فى عدد الثمار المتبقية (الناضجة) / نبات . هذا وقد وجد أن معاملات البوتاسيوم والماغنسيوم خصوصا بتركيز ٢٠٠ جزء فى المليون لكل منهما كانت هى الأكثر فاعلية في زيادة محصول القرون والبذور / نبات وكذلك زيادة وزن الـ ١٠٠ بذرة (دليل البذور). وعلاوة على ذلك فقد زاد محتوى البذور من النتروجين والفوسفور والبوتاسيوم وكذلك البروتين الخام والسكريات المختزلة والكلية مع مختلف معاملات العناصر المستخدمة.

وبناء على ذلك ، فإنه يمكن التوصية بأن معاملة نباتات الفول بعناصر الزنك والبوتاسيوم والماغنسيوم كمعاملات رش ورقي يعتبر من الناحية العملية ذو فاعلية كبيرة فى تقليل تساقط الأزهار والثمار ونتيجة لذلك قد يؤدى إلى زيادة واضحة فى محصول البذور النهائي .