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ALLEVIATION OF THE DAMAGE OF FABA BEAN CHOCOLATE SPOT AND RUST DISEASES BY SOME NUTRITIONAL ELEMENTS

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ABSTRACT

Laboratory and filed experiments were conducted in 2005/2006 and 2006/2007 winter seasons to study the effect of some nutritional elements (ferrous, zinc, manganese and calcium) at 2, 4, 6 and 8 g/L on chocolate spot and rust diseases of faba bean. The laboratory results, declared that zinc and manganese at 6 g/L completely inhibited the linear growth and sporulation as well as mycelial dry weight of *Botrytis fabae*. However, ferrous at 2 g/L or calcium at 8 g/l has no effect on neither linear growth nor mycelial dry weight.

The results of field experiment show that calcium at 6 g/L led to maximum reduction of chocolate spot and rust diseases severity followed by manganese at 4 g/L then zinc at 4 g/L. The highest value of plant height occurred under zinc at 4 g/L followed by 6 g/L calcium which increased significantly number of branches/plant. There was positive relationship between number of pods/plant and calcium levels treatment from 2-6 g/L. Calcium at 6 g/L and 4 g/L gave the highest values of 100-seed weight followed by manganese 4 g/L.

Total phenol contents reached their maximum when faba bean sprayed with 2 or 4 g/L calcium followed by ferrous (6 g/L) then manganese (6 g/L). Also, the highest concentrates of chlorophyll a, b and caroteinoids occurred under the application of calcium at 2 g/L.

It is clear from this study that there is no significant differences between the efficacy of calcium at 4 or 6 g/L and Diathine M-45 also between manganese (4 g/L) or calcium (6 g/L) and Plantvax 20% EC effects in reducing faba bean chocolate spot and rust diseases, respectively.

In general, some of nutritional elements are promising trend in controlling of chocolate spot and rust diseases of faba bean, where it decreased the infection, environmental friendly and coast effective compared with the ordinary fungicides.

INTRODUCTION

Faba bean (*Vicia faba*) is a major fabaceous legume crop for Egyptian consumption. Due to its high nutritive value in both energy and protein contents, it is a primary source of protein in the diet of masses. Therefore, increasing the crop production is one of the most important targets of agricultural policy in several countries. This strategic crop is suffering form many destructive diseases. It is attacked by more than 100 pathogens in the Mediterranean region (Hebblethwaite, 1983). Chocolate spot caused mainly by *Botrytis fabae* sard. and to some extent by *B. cinerea* pers.ex.fr (Rahman *et al.*, 2002), and rust (*Uromyces viciae fabae* (pers.) Schroet.) diseases are the most important limiting factors which cause great annual losses and sometimes complete crop failures (Mohamed, 1982; Hebblethwait, 1983 and Hanounik and Bisri, 1991).

Chocolate spot occurs mainly on leaves, but stems and flowers may also be infected under favorable conditions. Under optimum conditions of temperature (18-20 ˚C) and relative humidity (90-100%), the infection becomes aggressive. Also, under prolonged wet conditions, the disease may reach epidemic proportions with heavy crop losses (Harrison, 1988 and Bernier *et al.*, 1993). The infection by rust (*Uromyces viciae-fabae*) first appears as minute, slightly raised, and white to cream colored spots on leaves and to a lesser extent on stems. As spots enlarged, the epidermis ruptures, releasing masses of dark brown spores (urediospores) to form characteristic pustules (uredia). The size of the pustules varies from very small with few spores to very large with abundant sporulation. On highly susceptible cultivars, rust can build up rapidly until most of leaves are covered with pustules. Severely infected leaves rapidly dry up and premature defoliation may occur (Bernier *et al.*, 1993).

Some outhers stated that, some nutritional elements play roles in plant resistance e.g. calcium (Hahlbrock and Scheel, 1989), manganese (Marschner, 1986) and zinc (Ohki, 1978).

The problem of adequately protecting plants against the fungus by using fungicides has been complicated by development of fungicidal resistance and for adverse effect on growth and productivity of the host plant as well as on the accompanying microflora (Khaled *et al.*, 1995). Moreover, because of hazards of pesticides in general, and fungicides in specific, on public health and environmental balance, the aim of this research is to evaluate the effect of some nutritional elements in alleviation of the damage of chocolate spot and rust diseases on faba bean in comparing with the fungicides (Diathine M-45 and Plantvax 20% EC).

MATERIALS AND METHODS

Laboratory experiment:

This experiment aimed to study the effects of some nutritional elements on growth and sporulation of *Botrytis fabae* which causes chocolate spot on Faba bean plants. The different concentration of chemicals used contained, 0 concentration which used as a check and 2, 4,6 and 8 g/L of Ferrous, Zinc, Manganese form of chelate and calcium form of Delta calcium 12% as well as Diathine M-45 (fungicide) at the concentration of 2.5 mg/L (250 gm/100L "recommended dose") were separately mixed with PDA medium before solidification (1:9 v/v) respectively, then poured in a sterile Petri dishes. Four plates for each concentration were inoculated with fungal disc which had been cut from the periphery of 7 days old culture of *B. fabae*. The plates were incubated at 20± 1˚C, linear growth (cm) of the tested pathogenic fungus (*B. fabae*) measured when particular control filled of Petri dishes by fungal mycelial growth.

The influence of Fe, Zn, Mn, Ca and Diathine M-45 on dry weight and sporulation of *B. fabae* were tested on Czapek, s broth medium in conical flask containing 20 ml broth medium amended individually with all tested concentration of each element and 2.5 g/L of the fungicide. A set of similar flasks containing chemical-free medium served as check. Four flasks for each concentration were inoculated with fungal disc (0.5mm diameter) of *B. fabae* taken from 7 days old culture for each flask. After 10 days of incubation at 22 ± 1˚C, flasks were shacked (100 rpm) for 1 hour, then take 1 ml from each flask to determine the number of spores using haemocytometer. The rest of the flask was filtered through pre-weighed Whatman No.1 filter paper, washed with distilled water and dried at 70± 2˚C in a vacuum oven to constant weights.

The reduction of growth and sporulation of *B. fabae* were calculated according to the following equation:

$$\text{Reduction percentage} = \frac{A - B}{A} \times 100 \text{ Where}$$

A= linear growth or dry weight of fungus or sporulation of check.
B= linear growth or dry weight of fungus or sporulation of treatment.

Field experiment:

Two field experiments were carried out at Tag El-Ezz Research Station, Dakahlia Governorate, Egypt during the two winter seasons of 2005/2006 and 2006/2007. The experiments aimed to study the effects of foliar spray treatments of some microelements (Fe, Zn and Mn form of chelate), calcium form of Delta calcium 12% at the concentration of 2, 4 and 6 g/L on some morphological, physiological aspects and reduce the foliar diseases of faba bean. Also, the use of Diathine M-45 at 2.5g/L as a fungicide for chocolate spot disease as well as Plantvax 20% EC at 3.5 ml/L as a fungicide for rust disease. These fungicides were used for comparison with the other treatments.

Seeds of Faba bean (Giza 2 variety) were sown in 8^{th} and 10^{th} November in the first and second seasons respectively. All agriculture practices were carried out according to the recommendation of Ministry of Agriculture, Egypt. At the age of 45 and 60 days in the two seasons, the plants were sprayed till dripping using small pressure pump with one of the concentration of the treatments above.

A complete randomized block design with three replicates was in the two mentioned seasons. The experimental plot contained 5 ridges occupying an area of 10.5 m^2 (3.5x3 m).

a. Disease assessment:

The disease severity of chocolate spot disease was estimated at 60 and 75 days from sowing under natural infection by using the scale of Bernier *et al*., (1993) as follow:

1= No disease symptoms or very small specks (highly resistance).
3= Few small discrete lesions (resistant)
5= Some coalesced lesions with some defoliation (moderately resistant)
7= Large coalesced sporulating lesions, 50% defoliation and some dead plants (susceptible)

9= Extensive lesions on leaves, stems and pods, severe defoliation, heavy sporulation, stem girdling, blackening and death of more than 80% of plants (highly susceptible).

The disease severity of rust was recorded at 90 days from sowing according to the standard scale suggested by Bernier *et al.*, (1993) as follow:

1= No pustules or very small non-sporulating flecks (highly resistant)

3= Few scattered pustules covering less than 1% of leaf area, and few or no pustules on stem (resistant)

5= Pustules common on leaves covering 1-4% of leaf area, little defoliation and some pustules on stem (moderately resistant)

7= Pustules very common on leaves covering 4-8% of leaf area, some defoliation and many pustules on stem (susceptible).

9= Extensive pustules on leaves, petioles and stems covering 8-10% of leaf area, many dead leaves and severe defoliation (highly susceptible).

Percentage of chocolate spot and rust diseases severity were calculated using the formula adopted by (Hanounik, 1986):

$$\text{Disease severity \%} = \frac{\Sigma(\text{NPC x CR})}{(\text{NIP x MSC})} \text{ X } 100$$

Where NPC= No. of plants in each class rate
CR= class rate
NIP= No. of infected plants.
MSC= Maximum severity class rate.

b. Morphological characters and yield components:

For morphological characters of Faba bean, samples were taken at 90 days from planting to estimate plant height and number of branches /plant. At harvest, number of pods/plant and weight of 100 seeds were recorded.

c. Determination of total phenolic compounds:

Total phenolics were determined after 60 days from sowing in fresh shoot using the Folin-Ciocalteau reagent (Singleton and Rossi, 1965). Samples (2g) were homogenized in 80% aqueous ethanol at room temperature and centrifuged at 10000 rpm for 15 min. under cooling and the supernatants were saved. The residues were re-extracted twice with 80% ethanol and supernatants were pooled, put into evaporating dishes and evaporated to dryness at room temperature. Residues were dissolved in 5 mL of distilled water. One-hundred microlitres of this extract were diluted to 3 mL with water and 0.5 mL of Folin-Ciocalteau reagent was added. After 3 min., 2 mL of 20% of sodium carbonate was added and the contents were mixed thoroughly. The color was developed and absorbance measured at 650 nm. in a Spectrophotometer after 60 min. using catechol as a standard. The results were expressed as mg catechol/ 100 g fresh weight material.

d. Determination of photosynthetic pigments

The blade of the 3rd leaf from plant tip (terminal leaflet) was taken to determine photosynthetic pigments (chlorophyll a, b and carotenoids). Photosynthetic pigments were extracted by methanol 90% for 24 h at room temperature after adding traces of sodium carbonate (Robinson and Britz, 2000).Then photosynthetic pigments were determined sepctrophotometrically by the equations of (Mackinney, 1941) at the wave lengths (452.5, 650 and 665nm)

Statistical analysis

Obtained data were subjected to statistical analysis of software CoStat (2005) as the used technique of analysis of variance (Gomez and Gomez, 1984). The means were compared using Least Significant Difference (L.S.D.) at *P=0.05* as outlined by Duncan (1955).

RESULTS

Laboratory experiment:

Data presented in table (1) show great variation in the linear growth and mycelial dry weight as well as sporulation of the pathogen. Zinc and manganese at (6 g/l or higher) completely inhibited the linear growth and sporulation compared with check. Mycelial dry weight follows the same trend and was found to be in correlation with the linear growth. These results come online with this recorded on the fungicide Diathine M-45. It is worthy to mention that all concentrations of zinc and manganese as well as calcium 6 g/l totally inhibited the sporulation of *Botrytis fabae*.

Table (1): Effect of nutritional elements on growth parameter of *Botrytis fabae* .

Treatments	Linear growth cm	Reduction %	Mycelium dry weight mg	Reduction %	Sporoulation X 10^4/ml	Reduction %
Control	9.00 a	0.00	222.25 a	0.00	56.00 a	0.00
Ferrous 2 g/l	9.00 a	0.00	222.75 a	-0.23	23.25 c	58.48
Ferrous 4 g/l	5.03 c	44.11	195.00 c	12.26	16.25 e	70.98
Ferrous 6 g/l	4.01 d	55.44	184.00 d	17.21	8.00 f	85.71
Ferrous 8 g/l	5.93 b	34.11	209.25 b	5.85	19.50 d	65.18
Zinc 2 g/l	4.00 d	55.56	157.00 e	29.36	0.00 g	100.00
Zinc 4 g/l	3.00 f	66.67	138.75 f	37.57	0.00 g	100.00
Zinc 6 g/l	0.00 h	100.00	0.00 i	100.00	0.00 g	100.00
Zinc 8 g/l	0.00 h	100.00	0.00 i	100.00	0.00 g	100.00
Manganese 2 g/l	3.20 f	64.44	135.75 f	38.92	0.00 g	100.00
Manganese 4g/l	1.85 g	79.44	115.00 g	48.26	0.00 g	100.00
Manganese 6 g/l	0.00 h	100.00	0.00 i	100.00	0.00 g	100.00
Manganese 8 g/l	0.00 h	100.00	0.00 i	100.00	0.00 g	100
Calcium 2 g/l	5.23 c	41.89	191.75 c	13.72	27.50 b	50.89
Calcium 4g/l	3.85 d	57.22	116.75 g	47.47	19.00 d	66.07
Calcium 6 g/l	3.45 e	61.67	98.25 h	55.79	0.00 g	100.00
Calcium 8 g/l	9.00 a	0.00	221.75 a	0.23	15.00 e	73.21
Diathine M-45	0.00 h	100.00	0.00 i	100.00	0.00 g	100.00

Values within the same column followed by the same letter(s) are not significantly different *P*=0.05

Field experiment:

a. Disease assessment:

Data on disease severity of chocolate spot disease at two different growth stages of faba bean were recorded in table (2). Except for Diathine M-45, the maximum reduction of disease severity after 60 days was recorded by calcium compared with check. Slight increase in disease severity in all cases was found after 75 days from faba bean sowing, but calcium still had the lowest values of disease severity after Diathine M-45.

Table (2): Nutritional elements against chocolate spot disease in faba bean plant after 60 and 75 days from sowing.

Treatment		2005/2006				2006/2007			
		After 60 days		After 75 days		After 60 days		After 75 days	
		Disease Severity	Reduction %	Disease Severity	Reduction %	Disease Severity	Reduction %	Disease Severity	Reduction %
Control		30.67 a	0.00	46.00 a	0.00	33.33 a	0.00	44.33 a	0.00
Ferrous	2 g/l	19.00 b	38.05	22.33 b	51.46	20.33 b	39.00	23.33 b	47.37
	4 g/l	16.00 c	47.83	19.33 c	57.98	17.33 c	48.01	20.00 cd	54.88
	6 g/l	30.00 a	2.19	45.33 a	1.46	33.33 a	0.00	44.33 a	0.00
Zinc	2 g/l	17.67 bc	42.39	18.33 cd	60.15	19.33 b	42.00	21.33 c	51.88
	4 g/l	15.00 cd	51.09	17.67 cd	61.59	14.67 d	55.99	16.67 e	62.40
	6 g/l	19.00 b	38.05	22.67 b	50.71	20.67 b	37.98	24.00 b	45.86
Manganese	2 g/l	12.00 e	60.87	16.33 d	64.50	12.67 e	61.99	16.67 e	62.40
	4g/l	9.67 f	68.47	13 e	71.74	10.33 f	69.01	14.33 f	67.67
	6 g/l	13.00 de	57.61	16 d	65.22	14.00 de	57.99	18.33 de	58.65
Calcium	2 g/l	8.33 fg	72.84	12 ef	73.91	10.67 f	67.99	13.67 f	69.16
	4g/l	8.00 fg	73.92	10 fg	78.26	10.00 fg	69.99	12.67 f	71.42
	6 g/l	7.33 fg	76.10	9 g	80.43	8.67 g	73.99	10.67 g	75.93
Diathine M-45		6.00 g	80.44	7.33 g	84.07	4.67 h	85.99	7.67 h	82.70

Values within the same column followed by the same letter(s) are not significantly different (*P*=0.05).

Data on disease severity of rust disease at 90 days after sowing of faba bean were recorded in table (3). Except for Plantvax 20% EC, the maximum reduction of disease severity was recorded by calcium (6 g/l) followed by manganese (4 g/l), zinc (4 g/l), calcium (4g/l) and manganese (2 g/l) compared with check. Calcium (6 g/l) still had the lowest values of disease severity after Plantvax 20% EC.

b. Morphological characters and yield components:

Data in table (4) showed that, all nutrients increased significantly faba bean plant height except, the high level of ferrous and manganese (6 g/l) as well as the low level of calcium (2 g/l) which showed no significant effects. The highest value of plant height occurred under the application of zinc at the moderate level (4 g/l) followed by the high level of calcium (6 g/l) then the moderate level of manganese (4 g/l). While, insignificant decrease in plant height was noted with Diathine M-45 also, insignificant increase was noted by using Plantvax 20% EC.

Application of microelements at any dose used and both fungicides (Diathine M-45 and Plantvax 20% EC) had no significant effect in number of branches/plant. In contrast, calcium at 6 g/l increased significantly this parameter. However, number of branches/plant at the concentrate of 4 g/l zinc and also Diathine M-45 was found to be similar to that of the control.

Table (3): Nutritional elements against rust disease in faba bean plant after 90 day from sowing.

Treatment		2005/2006		2006/2007	
		Disease Severity	Reduction %	Disease Severity	Reduction %
Control		39.67 a	0.00	43.67 a	0
Ferrous	2 g/l	21.33 cde	46.23	23.67 b	45.80
	4 g/l	20.33 de	48.75	22.67 bc	48.09
	6 g/l	36.67 b	7.56	44.00 a	-0.01
Zinc	2 g/l	17.00 f	57.15	19.67 d	54.96
	4 g/l	9.67 h	75.62	10.33 f	76.35
	6 g/l	24.00 c	39.50	23.00 bc	47.33
Manganese	2 g/l	15.33 f	61.36	14.00 e	67.94
	4g/l	8.67 hi	78.15	8.67 g	80.15
	6 g/l	22.67 cd	42.85	23.67 b	45.80
Calcium	2 g/l	19.67 e	50.42	21.67 c	50.38
	4g/l	12.33 g	68.92	13.67 e	68.70
	6 g/l	8.33 hi	79.00	9.00 fg	79.39
Plantvax 20% EC		6.67 i	83.19	5.00 h	88.55

Values within the same column followed by the same letter(s) are not significantly different (*P*=0.05)

Table (4): Effect of nutritional elements on growth parameter of faba bean plant after 90 days from sowing.

Treatments		Plant height (cm)		No. of branches	
		2005/2006	2006/2007	2005/2006	2006/2007
Control		123.67 f	119.33 hi	4.33 b	4.00 h
Ferrous	2 g/l	141.00 b-d	137.67 ef	5.00 ab	5.33 f
	4 g/l	143.33 bc	148.00 c	4.67 ab	4.33 gh
	6 g/l	126.33 ef	123.00 h	7.33 ab	7.67 ab
Zinc	2 g/l	138.00 b-e	142.33 d	5.67 ab	5.00 fg
	4 g/l	162.33 a	170.67 a	4.33 b	6.33 ed
	6 g/l	140.00 b-d	141.00 de	7.33 ab	8.00 a
Manganese	2 g/l	137 b-e	144.00 cd	6.33 ab	6.67 cd
	4g/l	141.67 bc	153.00 b	6.33 ab	6.67 cd
	6 g/l	119.33 f	117.00 i	6.67 ab	7.00 b-d
Calcium	2 g/l	127.67 d-f	133.00 g	5.00 ab	7.33 a-c
	4g/l	139.00 b-e	144.00 cd	6.00 ab	7.67 ab
	6 g/l	146.00 b	152.67 b	7.67 a	8.00 a
Diathine M-45		123.33 f	119.00 hi	4.33 b	4.33 hg
Plantvax 20% EC		131.33 c-f	135.67 fg	5.33 ab	5.67 ef

Values within the same column followed by the same letter(s) are not significantly different (*P*=0.05)

Concerning the effects of microelements, calcium and fungicides on number of pods/plant and weight of 100-seeds, data in table (5) shows that, number of pods/plant was increased significantly with increasing calcium levels from 2 to 6 g/l. The high level of calcium (6 g/l) was the most effective in this respect. Moreover, the moderate level of any microelements gave the best results compared with the low or high level.

Table (5): Effect of nutritional elements on yield components at harvest stage of faba bean plant.

Treatments		Number of pods/ plant		Weight of 100 seed (g)	
		2005/2006	2006/2007	2005/2006	2006/2007
Control		48.33 f	52.33 k	61.23 e	61.67 h
Ferrous	2 g/l	65.33 d	62.33 hg	62.50 e	63.00 f-h
	4 g/l	76.00 c	66.33 ef	63.97 de	64.33 ef
	6 g/l	46.00 f	47.67 l	61.43 e	62.00 gh
Zinc	2 g/l	63.33 de	60.00 h-j	66.07 cd	67.33 d
	4 g/l	78.33 c	67.00 ed	68.40 c	71.67 c
	6 g/l	53.33 ef	57.67 j	63.87 de	64.00 e-g
Manganese	2 g/l	62.33 de	58.33 j	66.93 cd	70.00 c
	4g/l	80.33 c	69.33 d	71.97 b	74.00 b
	6 g/l	56.67 de	58.67 ij	64.17 de	65.33 de
Calcium	2 g/l	83.67 bc	73.00 c	68.80 c	70.00 c
	4g/l	90.33 ab	78.00 b	73.30 b	75.00 b
	6 g/l	96.00 a	84.67 a	76.33 a	77.67 a
Diathine M-45		58.00 de	61.00 hi	62.90 e	65.00 ef
Plantvax 20% EC		60.67 de	64.00 fg	67.47 c	70.67 c

Values within the same column followed by the same letter(s) are not significantly different (*P*=0.05).

The high level of ferrous or zinc had no significant effect on number of pods/plant.

As for the effects of fungicides (Diathine M-45 and Plantvax 20% EC) data shows that, number of pods/plant was increased significantly by the application of both fungicides. Diathine M-45 came to late, but no significant differentiation between both fungicides and the low level of any microelements used.

Data in the same table shows that, weight of 100-seeds was increased significantly under the treatments of zinc, manganese and calcium as well as plantvax except, the high level of zinc or manganese (6 g/l) which showed no significant effect in this parameter. Also, any level of ferrous and Diathine M-45 had no significant effect on weight of 100-seeds. The high level of calcium gave the highest value of 100-seeds weight followed by calcium at moderate level then manganese at 4 g/l.

c. Total phenol contents:

It is well-known that plant phenolics, in general, are highly effective antioxidants. The total phenols in fresh faba bean plants were determined colorimetrically and calculated as catechol equivalents. Calcium (2 g/l) followed by calcium (4 g/l), ferrous (6 g/l) and manganese (6 g/l) showed significant increases in total phenol contents compared with other treatments as shown in (Table 6). These treatments showed no significant in total phenols contents compared with fungicide Plantvax 20% EC.

d. Photosynthetic pigments content:

Data in table (6) show that calcium (2 g/l) followed by calcium (4 g/l), ferrous (4 g/l), manganese (6 g/l) and zinc (4 g/l) showed a significant increase in chlorophyll a content compared with other treatments. Moreover, all treatments showed significant increase in chlorophyll a content compared with check.

Chlorophyll b content showed a significant increase by using of calcium at 2 g/l followed by manganese at 6 g/l, calcium at 4 g/l, ferrous at 4 g/l and zinc at 4 g/l as a foliar spray. Moreover, all treatments showed significant increase in chlorophyll b content compared with check.

Calcium (2 g/l) followed by ferrous (4 g/l), calcium (4 g/l), manganese (6 g/l) and zinc (4 g/l) showed a significant increase in carotenoids content compared with other treatments. All treatments showed significant increase in carotenoids content compared with check.

There was no obvious difference between all significant treatments and fungicide Plantvax 20% EC in total phenol content and photosynthetic pigments content.

Table (6): Effect of nutritional elements on phenol content and Photosynthetic pigments content of faba bean plant after 60 days from sowing.

Treatments	Phenol mg/100g fresh weight	Chlorophyll A mg/g fresh weight	Chlorophyll B mg/g fresh weight	Caroteinoids mg/g fresh weight
Control	560.00 e	0.85 e	0.65 d	0.45 c
Ferrous 2 g/l	583.56 de	1.28 a-e	0.97 b-d	0.67 a-c
Ferrous 4 g/l	774.10 ab	1.50 a-c	1.18 a-c	0.78 ab
Ferrous 6 g/l	808.10 a	0.99 de	0.78 cd	0.53 bc
Zinc 2 g/l	658.20 cd	1.23 b-e	0.88 b-d	0.66 a-c
Zinc 4 g/l	709.63 bc	1.42 a-d	1.09 a-c	0.75 ab
Zinc 6 g/l	778.03 ab	1.07 b-e	0.81 cd	0.55 bc
Manganese 2 g/l	638.60 c-e	1.19 b-e	0.91 b-d	0.63 a-c
Manganese 4g/l	665.40 cd	1.01 c-e	0.80 cd	0.54 bc
Manganese 6 g/l	804.80 a	1.48 a-d	1.18 a-c	0.76 ab
Calcium 2 g/l	838.72 a	1.72 a	1.38 a	0.87 a
Calcium 4g/l	832.57 a	1.57 ab	1.12 a-c	0.76 ab
Calcium 6 g/l	655.93 cd	1.11 b-e	0.85 b-d	0.59 bc
Diathine M-45	702.20 bc	1.21 b-e	0.88 b-d	0.59 bc
Plantvax 20% EC	826.60 a	1.51 a-c	1.23 ab	0.77 ab

Values within the same column followed by the same letter(s) are not significantly different *P*=0.05

DISCUSSION

Regarding to the effects of some nutritional elements on growth and sporulation of *B. faba* as well as the severity of faba bean foliar diseases, the results of this study showed that all foliar application of calcium and microelements concentration reduced the fungus linear growth and mycelium dry weight as well as sporulation except ferrous at 2 g/L and calcium at 8 g/L which showed no effect on neither linear growth nor mycelial dry weight of *B. faba*. All concentrations of microelements and calcium reduced the injurious effects of foliar diseases (chocolate spot and rust) of faba bean except ferrous at 6g/L which showed no effect. Calcium followed by manganese then zinc were the most effective in reducing faba bean infection by chocolate spot and rust diseases. In addition to, all of treatments used enhanced plant growth productivity and yield.

In this investigation, the induced resistance against chocolate spot and rust diseases by using microelements and calcium might be due the decrease in fungal linear growth and sporulation (Table 1) as well as the increase in phenol contents (Table 6).

It is composed mainly of pectic compound possibly combined with calcium (Freywyssling, 1959). Hence, calcium is one of the most elements which enters in middle lamella structure of the cell wall. No one can deny that the cell wall is considered as a first barrier against plant pathogens invasion, calcium gave strength to cell wall. Calcium also increased significantly the pod yield (Saran, 1989). Moreover, (Inanaga *et al.*, 1990) found that many immature seeds were produced in soil poor in Ca, and that seed weight may depend on the quantity of Ca absorbed through the shell. To obtain fill seed, the soil must be sufficient rich in Ca during growth of the fruit.

Any factor causes increase in photosynthetic pigments it will be that lead to increase in carbohydrate content so, all tested microelements and calcium will increases carbohydrate contents in faba bean plant due to its increase of photosynthetic pigments (Table 4). Carbohydrates are the main repository of photosynthetic energy; they comprise structurally polysaccharides of plant cell walls, principally cellulose, hemicelluloses and pectin. Also associated with the structural polysaccharides and phenolic compounds which play a major role in plant defense due to phenols are essential for biosynthesis of lignin which consider an important structural compound of plant cell walls (Hahlbrock and Scheel, 1989)

Manganese is activates photosynthesis especially (photosystem II). Moreover, it plays a role in regulating the levels of auxin in plant tissues by activating the auxin oxidase system (Marschner, 1986).

The role of zinc in enhancement the vegetative growth which followed by stimulation in resistance of faba bean to foliar fungi diseases might be due to that, zinc is known to be an essential constituent of three plant enzymes i.e. carbonic anhydrase, alcohol dehydrogenase and superoxide dismutase. In addition, zinc has a marked effect on the level of auxin by it appears to be required in the synthesis of intermediates in the metabolic pathway, through tryptophan to auxin (Ohki, 1978) which in turn encourage the meristemic activity of the plant which resulted in more cell division and cell enlargement (Devlin and Witham, 1983). Auxin may also induce the systemic resistance. Moreover, (Sandmann and Bogger, 1983) stated that such yield increment might be attributed to the favorable influence of zinc on plant enzyme activity and improving the photosynthetic production and/or mobilization in plants (Abou Leila *et al.*, 1992). They added that zinc is required for the synthesis of tryptophan which considers the precursor of auxin (IAA).

The stimulatory effects of microelements on yield components may be attributed to the increase in number of branches (Table 5) and photosynthetic pigments (Table 4). Results of similar nature were obtained by (Ohki, 1977) and (El-Samnoudi, 1990) who reported that the application of micronutrients (Zn, Mn and Fe) accelerated flowering and thus increased flowering capacity, yield of seeds and pods of faba bean.

Some of the iron can be stored in the leaves as a ferric phosphoprotein, phytoferritin, which serves as a reserve for developing plastids and hence for photosynthesis (Kabata and Pendias, 1984).

Based in the previous results and discussion, it is highly recommended to replace fungicides with microelements (Zinc, Ferrous and Manganese) as well as calcium during the cultivation faba bean where they maximizing the yield and its components as well as minimizing faba bean chocolate spot and rust diseases. In addition to the beneficial effects on the environment and health.

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تخفيف ضرر أمراض التبقع الشيكولاتى والصدأ فى الفول البلدى بإستخدام بعض العناصر المغذية

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أجريت هذه الدراسة بمحطة البحوث الزراعية بتاج العز دقهلية حيث عوملت النباتات بالعناصر المغذية (الزنك، الحديد، المنجنيز، الكالسيوم) مقارنة بالمبيدات الفطرية دياثين م-45 وبلانتفاكس 20% EC لدراسة تأثيرها على أمراض التبقع الشيكولاتى والصدأ فى الفول البلدى وكذلك على بعض الصفات المورفولوجية والفسيولوجية للنبات ويمكن تلخيص النتائج فى الآتى:

أظهرت التجارب المعملية أن إستخدام الزنك والمنجنيز عند تركيز 6 جم/لتر أو أكثر أدت إلى تثبيط كامل للنمو الميسليومى والتجرثم وكذلك الوزن الجاف لميسليوم فطر *Botrytis fabae* .

لم يسجل أى تأثير لإستخدام الحديد 2 جم/لتر أو الكالسيوم 8 جم/لتر على النمو الميسليومى وكذلك الوزن الجاف للميسليوم.

أوضحت التجربة الحقلية أن المعاملة بالكالسيوم بتركيز 6 جم/لتر أدى إلى إنخفاض كبير فى الشدة المرضية لأمراض التبقع الشيكولاتى والصدأ متبوعاً بالمعاملة بالمنجنيز 4 جم/لتر ثم الزنك 4 جم/لتر. بينما كانت أعلى قيم فى إرتفاع النبات تحت المعاملة بالزنك 4 جم/لتر ثم الكالسيوم 6 جم/لتر والتى أدت أيضاً إلى زيادة معنوية فى عدد الأفرع لكل نبات. كما وجدت علاقه إيجابية بين زيادة عدد القرون لكل نبات وزيادة مستويات الكالسيوم من 2-6 جم/لتر. وكانت أعلى القيم فى وزن 100 بذرة بإستخدام الكالسيوم 6 جم/لتر ثم الكالسيوم 4 جم/لتر يليه المنجنيز 4 جم/لتر.

كان أعلى محتوى للفينولات الكلية عندما تم المعاملة بالكالسيوم 2، 4 جم/لتر يليها المعاملة بالحديد 6 جم/لتر ثم المنجنيز 6 جم/لتر. وكان أعلى محتوى للأوراق من الكلورفيل (أ، ب) وكذلك الكاروتينويدات بإستخدام الكالسيوم بتركيز 2 جم/لتر.

أوضحت هذه الدراسة أنه لا يوجد إختلافات معنوية بين تأثير الكالسيوم 4، 6 جم/لتر ومبيد دياثين م-45 فى تقليل الإصابة بمرض التبقع الشيكولاتى فى الفول البلدى وكذلك لم توجد إختلافات معنوية بين إستخدام المنجنيز 4 جم/لتر أو الكالسيوم 6 جم/لتر ومبيد البلانتفاكس فى تقليل الإصابة بمرض الصدأ فى الفول البلدى.

وعموماً كان للعناصر المغذية تأثير إيجابى فى مقاومة أمراض التبقع البنى والصدأ فى الفول البلدى بالإضافة لتأثيرها فى الحد من التلوث البيئى علاوة على إنخفاض التكاليف إذا ما قورنت بإستخدام المبيدات الفطرية.