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Full Length Research Paper

Effects of foliar spraying with microelements and different fertilizer sources on quality and yield of *Pisum sativum,* L. plant

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Two field experiments were carried out at El-Bramoon Agricultural Research Farm of Mansoura Horticultural Research Station during the two successive winter seasons of 2009 and 2010. The investigated effects of foliar spray with some microelements (Fe, Zn and Mn, 100 ppm) at different fertilizer sources (FYM, mineral fertilizer and control) and bio-fertilization with *Rhizobium* as well as their interactions on yield and yield components and chemical constituents of pea plant (*Pisum sativum, L.*) cv. Master-B. The foliar spraying pea plants with a mixture of microelements 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) and chemical constituents such as NPK, carbohydrates (%) and protein (%) of green seeds of pea plant in both seasons. The fertilization with FYM was the most reliable treatment compared with chemical fertilizer and control treatments in both seasons. All studied characteristics of pea plants were generally greater with bio-fertilizer treatment (*Rhizobium*) than the Chemical fertilizer. The best results were obtained from spraying pea plants with a mixture of microelements and application of FYM in the presence of *Rhizobium* inoculation.

Keywords: *Pisum sativum,* L., microelements, bio-fertilization, *Rhizobium*, chemical fertilizer.

INTRODUCTION

Great efforts have been directed to improve pea production and quality for the purpose of increasing exported yield. Application of adequate amounts of microelements is one of the most important factors involved in improving plant growth, yield and quality of pea. The nutrition of plants by foliar application is not only an addition channel of nutrients but also a mean of regulating root absorption by such plants (El-Hawary, 1999). The importance of spraying microelements, i.e., Fe, Zn and Mn can be accounted by its essential role in respiration, their metabolism activation of the enzyme, photosynthesis, chloroplast formation, chlorophyll synthesis and natural hormone biosynthesis (Epstien, 1972; Nijjar, 1985).

The addition of organic matter improves the physical, chemical and biological properties of soils and natural organic material are broken down slowly by soil microorganisms (Shafeek et al., 2001; Rizk et al., 2002) resulting more release of plant available nutrients. *Rhizobium* (*Rhizobium leguminosarum*) plays a principle role in N-fixation in soil which increases the uptake of N through plant roots. Many investigators reported that *Rhizobium* increased plant growth, yield components and chemicals composition of legumes plants (Tartoura, 2002, on pea and Sobh et al., 2000, on faba bean).

Therefore, this study was conducted to investigate the effects of some microelements, bio-and mineral fertilizer source treatments and their interactions on yield and yield components and chemical constituents of pea plant.

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Table 1. Some Physical and Chemical Analysis of Experiments Soil.

Soil Properties	Value
Texture Class	**Clayey**
Clay %	65.63
Silt %	12.37
Sand %	22
pH	7.6
EC ds/m	0.85
O.M.	1.78
N (ppm)	75.1
Available P (ppm)	16.4
Available K (ppm)	350

Table 2. Chemical analysis of cattle manure used during the experiment

Character of Organic fertilizer	Cattle Manure
pH	7.8
EC ds/m	13.95
O.M.	20.10
Total N %	1.2
Total P %	0.85
Total K %	1.1
Fe ppm	811
Zn ppm	100
Mn ppm	150
Cu ppm	89
C:N Ratio	17.6:1

MATERIALS AND METHODS

Two field experiments were carried out at El-Bramoon Agricultural Research Farm of Mansoura Horticultural Research Station during the two successive winter seasons of 2009 and 2010. The experiments were designed to investigate the effects of some microelements, bio-and mineral fertilizer source treatments and their interactions on yield and yield components and chemical constituents of pea plant (*Pisum sativum,* L) cv. Master-B.

The physical and chemical properties of the soil experiment

Collect the soil at the depth of 0-50 cm for the experiments the physical and chemical properties determined according to Black (1965) and Page et al. (1982), were shown in Table 1 and 2.

The experimental design and treatments:

The split-split plot system in a randomized block design with three replicates was used in both growing seasons. The foliar treatments were randomly located in the main plots whereas the sub-plots were devoted for the fertilizers sources and the bio-fertilizer treatments were assigned to the sub-sub plot. The sub-sub plots area was 15.60 m2, which consisted of 8 ridges, 3.25 m length and 0.60 m width. The experiment included 12 treatments, which were the combination between two treatments of foliar applications, three sources of fertilizers and two levels of bio-fertilizers.

Planting method

Seeds were sown on November 10th in 2009 and 2010 seasons, respectively. Seeds were sown in hills 5 cm apart on one side of each ridge. Microelements: A mixture of chelated microelements, i.e., Zn-EDTA (13% Zn), Mn-EDTA (13% Mn) and Fe-EDTA (13% Fe), was sprayed on plants - after 30, 40, 50 and 60 days from sowing. The mixture of microelements was applied at 0 and 100 ppm.

Mineral fertilizers

The experimental plots were fertilized according to the recommendation of Ministry of Agriculture (30 kg N/fed. in the form of ammonium sulphate (20.5% N), 30 kg P_2O_5 /fed as a form of calcium superphosphate (15.5 % P_2O_5). and 50 kg K_2O /fed. as potassium sulphate (50 % K_2O).

Cattle manure

20 m3/fed. were mixed with the soil during bed shaping. The chemical analysis samples is shown in Table (2).

Bio-fertilizers

he pea seeds were inoculated at sowing with nitrogen fixing bacteria (*Rhizobium leguminosarum*).

Studied traits

1. Green pods of four ridges of each plot were harvested three times and the dry pods of the other four ridges were harvested at the end of experiment, threshed and the following characters were calculated:
a- Average pod length
b- Average pod weight
c- Number of green seeds/pod .
d- Weight of 100- green seed
e- Seed index (1000-dry seed weight).
2. Seed chemical constituents: A representative samples of 100 g. of green seeds from each experimental plot were taken randomly to determine the following characteristics:
1- Total nitrogen was determined as described by A.O.A.C. (1975).
2- Phosphorous was determined colorimetrically according to the standard method of Jackson (1967) using 660 nm was length.
3- Potassium was determined using flame photometer according to Jackson (1967).
4- Total carbohydrates content was determined colorimetrically according to the method described by Michel et al. (1956).
5- Total protein % was calculated by multiplying nitrogen % content by 6.25. 3.8.

Statistical analysis

The obtained data were subjected to statistical analysis as technique of split plot design with three replicates in both growing seasons. All data were subjected to the analysis of variance according to Gomez and Gomez (1984), and *L.S.D values* were used for comparison.

RESULTS AND DISCUSSION

Effect of microelements on Nitrogen, Phosphorous and Potassium (N.P.K.) contents:

Data concerning total N, P and K contents in green seeds as affected by foliar treatments are illustrated in Table (3). It's evident from such data that foliar application with microelements significantly increased N, P and K content of pea green seeds compared with control. These results are true in the two seasons. These increases in elemental constituents of pea seeds may be due to the effect of micronutrients on stimulating biological activities, i.e., enzyme activity, chlorophyll synthesis, rate of translocation of photosynthetic products and increased nutrient uptake through roots after foliar fertilization (Follett et al., 1981). The spraying potato and sweet potato plants with micronutrients were significantly increased N, P and K concentrations in different plant parts (Omran et al., 1991; Nofal et al., 1998; Radwan and Tawfik, 2004 and Hassan et al., 2005).

Fertilizer sources:

Data in Table (3) 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, but FYM recorded the higher values during the two seasons of study. The obtained results are in harmony with those of Kotb (1994) who stated that application of organic manure increased the total uptake of N, P and K by pea plants than control treatment.

Effect of Bio-Fertilizer:

Data in Table (3) clearly showed that application of biofertilizer with *Rhizobium* increased significantly N, P and K content of pea seeds. These results were true in the two seasons of study. Such obtained results are in agreement with those mentioned by El-Neklawy et al. (1985), Sarg and Hassan (2003), Abo El-Salehein et al. (2005) on pea.

Effect of interactions:

Table 3 showed the effect of interactions on N, P and K in pea seeds, the data showed that the concentrations of N, P and K in seeds were not significantly affected by the interaction among all studied factors in the two growing seasons except the interaction between foliar application x fertilizer sources on N content in both seasons, fertilizer sources x bio-fertilizer on NPK contents in one season only and the interaction between the three factors on N and k contents in both seasons and P content in the first one.

Table 3. Effect Of Foliar Applications, Fertilizer Sources, Bio-Fertilizer And Their Interactions on NPK Content in Green Seeds During 2009 and 2010 Seasons

Characters / Seasons	Nitrogen (N %)		Phosphorus (P %)		Potassium(K %)	
	2009	2010	2009	2010	2009	2010
Foliar Applications						
Control	3.284	2.955	0.417	0.436	1.513	1.435
With Micronutrients	3.561	3.180	0.494	0.455	1.630	1.549
L.S.D. 5%	0.191	9.110	0.020	0.022	0.050	0.043
Fertilizer Sources						
Control	3.250	2.797	0.414	0.405	1.536	1.400
FYM	3.606	3.291	0.483	0.477	1.596	1.594
With N.P.K. Fertilizer	3.411	3.113	0.489	0.455	1.584	1.454
L.S.D. 5%	0.081	0.082	0.029	0.021	0.041	0.045
Bio-fertilizer						
With Bio-fertilizer	3.430	3.133	0.476	0.478	1.604	1.530
Without Bio-fertilizer	3.415	3.002	0.435	0.413	1.539	1.454
F. Test	*	**	*	**	**	**
Interaction						
A x B	*	*	NS	NS	NS	NS
A x C	NS	NS	NS	NS	NS	NS
B x C	NS	*	NS	*	*	NS
A x B x C	*	*	*	NS	*	*

NS = No significant, * = Significant at 5%, ** = High significant at 1%

The effect of foliar application of microelements on Total carbohydrates (%) and total protein (%):

Data in Table (4) clearly illustrated that spraying with microelements significantly increased the concentration of total carbohydrates % and total protein % in green seeds of pea plants compared with control plants in both seasons. The positive effect of micronutrients on chemical contents of green pea seeds may be due to their involvement in one or more of important biological functions such as synthesis of chlorophyll, electron transport system, oxidation-reduction reactions, protein synthesis, degradation (Dwivedi, 1991; Nofal et al., 1998; Radwan and Tawfik, 2004).

Fertilizer sources:

As shown in Table (4), seeds content of total carbohydrates % and total protein % was significantly increased due to using the fertilizer treatments compared with control plants. FYM recorded the highest values in this respect compared with mineral fertilizer or control in both seasons. These results agree with reported on cowpea by Alia (2005) who indicated that the highest values of protein and carbohydrates in seeds were observed with addition FYM in both seasons.

Effect of bio-fertilizer:

Data in Table (4) revealed that inoculation of pea plants with *Rhizobium* bacteria led to significant increases in the concentration of total carbohydrates % and total protein % in green seeds of pea plants in both seasons of the study compared with control. The increase in seed chemical constituents is a result of nitrogen fixation by Rhizobium bacteria from the atmospheric nitrogen in the root media, since more than 90% of fixed nitrogen is rapidly translocated from bacteria to the different plant organs (Marschner, 1995). The obtained results are in agreement with those mentioned by Abou El-Salehein et al. (2005) on pea who reported that nutritive value of pea seeds, i.e., protein and total carbohydrates percentage were significantly affected by Rhizobium inoculation.

Effect of interactions:

As presented in Table 4, No significant differences were found except the interaction between foliar applications x fertilizer sources on protein content in both season, The interaction between foliar application x biofertilizer recorded. A significant effect on the carbohydrates % in the second season. Also, the interaction between the fertilizer sources x

Table 4. Effect of foliar applications, fertilizer sources, bio-fertilizer and their interactions on Carbohydrates % and Protein % of pea seeds during 2009 and 2010 seasons

Characters / Seasons	Carbohydrates (%)		Proteins (%)	
	2009	2010	2009	2010
Foliar Applications				
Control	49.378	47.413	20.52	18.47
With Micronutrients	52.236	49.123	22.26	19.87
L.S.D. 5%	1.235	1.052	1.250	0.965
Fertilizer Sources				
Control	49.099	47.409	20.31	17.48
FYM	51.902	49.901	22.53	20.57
with N.P.K. Fertilizer	51.244	47.507	21.32	19.45
L.S.D. 5%	1.312	1.211	0.125	0.198
Bio-fertilizer				
With Bio-fertilizer	51.383	48.850	21.44	19.56
Without Bio-fertilizer	50.231	47.693	21.35	18.76
F. Test	*	*	*	*
Interaction				
A x B	NS	NS	*	*
A x C	NS	*	NS	NS
B x C	*	*	NS	*
A x B x C	NS	NS	*	*

NS = No significant, * = Significant at 5%, ** = High significant at 1%

biofertilizer affected significantly on carbohydrate content in both season and protein % in the second one . The interaction effect among the three factors was significant on protein in both seasons.

Effect of microelements on Weight of 100-green seed and 1000-dry seed:

It's clear from data in Table (5) that both weights of 100-green seed and 1000-dry seed were significantly increased as a result of application of microelements treatments comparing with untreated plants in both seasons of study.

Fertilizer sources:

The results in Table (5) revealed that fertilization with FYM was the most reliable treatment among the three fertilizer sources on weight of 100 green and 1000 dry seed in both seasons.

Effect of bio-fertilizer:

Data in the same Table showed that inoculation with bio-fertilizers led to significant increases in the weight of 100-green seed and 1000-dry seed of pea in both seasons of the study compared with check plants.

Effect of interactions:

As presented in Table 5, significant differences were observed in the two seasons except the interaction between foliar applications x fertilizer sources in the first season and

Table 5. Effect of foliar applications, fertilizer sources, bio-fertilizer and their interactions on weight of 100-green seed and 1000-dry seed during 2009 and 2010 seasons

Characters / Seasons	weight 100 green seed (g)		weight 1000 dry seed (g)	
	2009	2010	2009	2010
Foliar Applications				
Control	47.14	45.32	326.04	302.41
With Micronutrients	51.34	48.82	360.47	347.52
L.S.D. 5%	2.76	1.69	20.15	22.11
Fertilizer Sources				
Control	45.51	45.20	313.36	314.25
FYM	51.69	48.43	365.98	332.85
with N.P.K. Fertilizer	50.52	47.58	350.58	327.80
L.S.D. 5%	1.12	1.60	10.32	8.52
Bio-fertilizer				
With Bio-fertilizer	50.50	48.39	358.24	346.48
Without Bio-fertilizer	47.98	45.75	328.27	303.45
F. Test	**	**	**	**
Interaction				
A x B	NS	*	NS	*
A x C	*	*	*	*
B x C	*	*	*	*
A x B x C	NS	*	NS	*

NS = No significant, * = Significant at 5%, ** = High significant at 1%.

the interaction among the three factors on both characters.

Effect of microelements on Green pod character (fresh pod length, pod weight and number of seeds/pod):

Concerning the effect of microelements on yield components, data presented in Table 6 indicated that application of micronutrient mixture as foliar spray was generally more effective than the control plants in both seasons of study. Improving effect of Fe, Zn and Mn on yield and its components might be attributed to their positive role on enhancing photosynthesis, biosynthesis of proteins and carbohydrate assimilation (Epstien, 1972). This is in coincidence with the findings of Hassan et al., (2005) on sweet potato, Abd El-Hadi et al. (1986) and Nofal et al. (1998) on potato plants, where they found that yield and its components increased markedly by foliar spray of micronutrients compared with the untreated plants. Generally, more effective as compared with chemical fertilizer or control where they significantly increased the previous measurements in the two growing seasons. The obtained results are in harmony with those of El-Mansi et al. (1999) and Soubeih (2004) on pea plants who pointed out that application of FYM significantly increased average pod weight, pod length and number of seeds/pod.

Fertilizer sources:

The results in Table (6) showed that application of FYM was generally more effective as compared with chemical fertilizer or control where they significantly increased with previous measurements in the two growing seasons. The obtained

Table 6. Effect of foliar applications, : fertilizer sources: bio-fertilizer and their interactions on fresh pod length, pod weight and number of seeds/pod during 2009 and 2010 seasons

Characters / Seasons	Fresh pod Length(cm)		Fresh pod Weight (g)		No. of seeds/pod	
	2009	2010	2009	2010	2009	2010
Foliar Applications						
Control	8.80	8.33	5.17	4.66	8.94	8.90
With Micronutrients	9.50	8.97	5.69	5.20	9.50	9.40
L.S.D. 5%	0.10	0.13	0.27	0.29	0.15	0.19
Fertilizer Sources						
Control	8.92	8.54	4.78	4.53	8.92	8.90
FYM	9.33	8.97	5.28	5.02	9.41	9.36
with N.P.K. Fertilizer	9.19	8.82	5.12	4.90	9.32	9.20
L.S.D. 5%	0.18	0.24	0.13	0.16	0.19	0.23
Bio-fertilizer						
With Bio-fertilizer	9.32	8.84	5.12	5.01	9.34	9.21
Without Bio-fertilizer	8.98	8.46	5.00	4.85	9.10	9.09
F. Test	**	**	*	*	**	**
Interaction						
A x B	*	*	*	*	NS	*
A x C	NS	NS	NS	NS	*	*
B x C	NS	*	NS	NS	NS	*
A x B x C	NS	*	*	NS	*	NS

NS = No significant, * = Significant at 5%, ** = High significant at 1%

results are in harmony with those of El Mansi et al. (1999) and Soubeih (2004) on pea plants who pointed out that application of FYM significantly increased average pod weight, pod length and number of seeds/pod.

Effect of biofertilizer:

Data in Table 6 revealed that inoculation with Rhizobium bacteria led to significant increases in yield components of pea in both seasons of the study compared with untreated plants. These results are in agreement with those reported by Abou El-Salehein et al. (2005), on pea, El-Oksh et al. (1991), and Shafeek et al. (2004), on bean, who observed that inoculation of seeds with Rhizobium reflected significant effect on pod characters compared with control plants.

Effect of interactions:

Data in Table (6) showed that there were a significant effects as a result of the interaction between microelements x fertilizer sources on fresh pod length and fresh pod weight in both seasons and No. of seeds in the second season only. The interaction between microelements x bio-fertilizer caused a significant effects on No. of seeds/pod in both seasons. Also, the interaction between fertilizer sources x bio-fertilizer showed a significant effect on fresh pod length and No. of seeds /pod in the second season only. The interaction among the three factors affected significantly on

fresh pod length in the second season and fresh pod weight and No. of seeds/pod in the first season only.

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