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Effect of Mineral Fertilization and Some Organic Compounds on Faba Bean Crop in some Soils at the New Valley, Egypt

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FIELD experiments were carried out during two successive years in two sites at the New Valley, Egypt. The first site was clay soil located at El-Kaser Village, El-Dakhlla Oasis and the second site was sandy soil located at El-Monera village, El-Kharaga Oasis. Seeds of faba bean variety Rebaya were cultivated in both the two studied locations. This study was designed in order to improve the yield of faba bean under conditions of the New Valley soils by the combination of mineral fertilizers and some organic compounds. Nitrogen (N), phosphorus (P) and potassium (K) fertilizers were applied as soil and foliar applications at different rates. Different rates of boron (B), molybdenum (Mo) and zinc (Zn) were applied as foliar applications. Some organic compounds viz., humic acid (HA), amino acid (AA), ascorbic acid (AS) and licorice extract (LC) were combined with mineral fertilizers.

Application of N, P and K along or with B, Mo and Zn increased yield and nutrient contents of faba bean. The treatments of mineral fertilizers and organic compounds further increased yield components, nutrient contents, total antioxidants activity and total phenol of faba bean in both soils. Organic compounds increased the yield and their effectiveness could be arranged as: LC < HA < AA< AS in ascending order. Mixing these compounds had higher effect on yield and nutrient contents than individual applications. Their effect could be arranged in ascending order as: LC + HA< LC + HA + AA< AS + AA + HA< AS + AA + HA + LC. The AS had the highest effect on total phenols and antioxidants. The LC had higher values than HA and AA treatments, respectively. The most effective treatment in the yield was (AS + AA + HA + LC + $N_2P_2K_2$ + with micronutrient), which achieved 5.95 and 2.73 t fed^{-1} of shoot and seed, respectively in sandy soil. In clayey soil, these values were 8.91 and 4.30 t fed^{-1}, respectively. Regarding total antioxidants and phenols, the same treatment could achieve the highest values in both soils recording 216 and 227 μg ascorbic acid ml^{-1} extract and 791 and 876 μmol of gallic acid ml^{-1} extract for shoot and seed, respectively in sandy soil. These values were 231 and 243 μg ascorbic acid ml^{-1} and 891 and 983 μmol of gallic acid ml^{-1} in clayey soil, respectively. This study demonstrated that incorporating some organic compounds along with mineral fertilizers has a beneficial effect on yield and quality of faba bean.

Keywords: Mineral fertilizers, Organic compound, Yield, Faba bean, Sandy and clay soils in New Valley.

Several studied have reported that combing macro- and micronutrients as soil and foliar applications have the ability to improve plant quantity and quality yield. For instance, foliar N, P and Mo application enhanced the growth and nutritional status of common bean seed (Eduardo *et al.,* 2010). In the same trend, Kandil *et al*. (2013) observed that the highest number of pods per plant, length of pod and protein content were produced when P and Mo were foliar applied to common bean. Growth parameters of mungbean plant enhanced with increasing the levels of P (Ali *et al*., 2014). Abd El Hamid *et al*. (2010) concluded that soil and foliar applications of K to faba bean increased the yield quantity and quality as well as plant resistance to foliar diseases. Combing N, P and K foliar applications increased the yield and nutritional status of faba bean in sandy soil (Fawy, 2010). However, application of N fertilizer in soil combined with foliar Zn recorded the highest yield parameters of faba bean (Bozorgi *et al.,* 2011). Jasim and obaid (2014) observed that foliar spray of N, P and K with B increased faba bean yield and seed quality. Ati and Ali (2011) reported that foliar application of B achieved highest yield of faba bean and improved water use efficiency. Furthermore, Sharaf *et al*. (2009) reported that hotosynthetic pigments, soluble carbohydrates, soluble proteins, total phenols, levels of gibbrellic acid and indole acetic acid in broad bean and lupin plants increased with foliar application of B and Zn.

Several studies have reported that foliar application of some organic compounds could enhance yield and biochemical contents of many crops. For example, Sadak *et al*. (2013) reported that foliar application of indole acetic acid and kinetin individually or in combination had positive effects on photosynthetic pigments, total carbohydrate, polysaccharide, free amino acid, proline and total phenolic contents of faba bean . Abou EL-Yazied and Mady (2012) concluded that foliar application of B and yeast extract either individually or mixture to broad bean increased yield components.

Amino acids had many functions in plant such as protein synthesis, stress resistance, photosynthesis, action on the stomas, chelating effect, activation of phytohormones, pollination with fruit formation and equilibrium of soil flora, as reported in Ortiz-Lopez *et al*. (2000), Abd El-Samad *et al.* (2010) and Gioseffi *et al.* (2012). Application of humic substances could increase morphological criteria, metabolism, mineral contents and yield of many crops (Fahramand *et al*., 2014; Canellas & Olivares, 2014; and El-Bassiouny *et al*., 2014). Khaled and Fawy (2011) concluded that foliar application of humic substances increasing nutrients uptake and leaf water retention under salt and water stress conditions.

Application of licorice extract to plant strengthened the germination process and increased the plant's ability to withstand and resist the salinity and drought stress. For example, several studies have reported that licorice extract elevated the chlorophyll content and increased anthocyanin content and thus the resistance against phytopathogenic (Scherf *et al.,* 2010; Srivastava *et al.,* 2009; and Schuster *et al.,* 2010).

Antioxidants have the ability to protect cells from the damage caused by free radicals; therefore, the yields and quality of plants were improved when high level of antioxidants were applied in fruits and vegetables. The key components of antioxidants are antioxidant enzymes, ascorbic acid, carotenoids and flavonoids (Hamid *et al.,* 2010; Gill & Tuteja, 2010; Agatia *et al.,* 2012; and Brunetti *et al*., 2013).

El-Ghamry *et al*. (2009) reported that foliar application of humic and amino acids improved growth and mineral content and decreased the damage of chocolate spot and rust diseases in faba bean. Gad El-Hak *et al.,* (2012) also reported that foliar application of humic acid produced highest quantity and best quality of green pods and dry seed yield of peas plants. Shafeek *et al.* (2013) stated that foliar application of humic acid recorded highest values of growth and protein content of broad bean seed. Ibraheim (2014) reported that foliar application of yeast extract and Mega Power (19 % humic acid, 2% fulvic acid, 5% free amino acids, 0.5% Zn chelated, 0.025% Fe chelated, 0.05% Mn chelated and 2% K-citrate) increased N, P and T.S.S (%) in pea plant. Amin *et al.* (2014) reported that foliar application of thiourea and aspartic acid (amino acid) individual or in combination improved the yield, nutrients values and quality of faba bean seed. Spraying licorice root extract in a concentration of 4gm L^{-1} and Zn in a concentration of 100 mg L^{-1} achieved the highest yield parameters of berry plant (Zuhair and Mohammed 2010). However, foliar applications of licorice roots extract along with amino-K and yeast recorded highest yields of grape trees (Al Dulaimy and Jumaa 2012). Azooz *et al.* (2013) stated that foliar application of ascorbic acid improved salt tolerance and nutrient contents of broad bean. Abdelgawad (2014) reported that the foliar application of ascobin (ascorbic acid and citric acid at ratio 2:1) improved salt tolerance, total soluble sugars, proline, glycine and N, P and K contents of cowpea plant. Keeping in view the above mentioned points, this study was designed in order to optimize quality and quantity of faba bean yield by integrating mineral fertilizers and some organic compounds in two different soils at the New Valley, southern Egypt.

Material and Methods

Field experiments in two successive seasons (2012/13–2013/14) were carried out in split-split plot design with three replications in two sites at the New Valley, Egypt. The first experiment carried out at El-Monera, El-Kharaga Oasis location at 27º 34' 21" N and 30º 57' 56" E representing sandy soils, while the second experiment was at Al-Kaser location at 28º 21.9' 28" N and 31º 27.6' 25" E representing clay soils. Analytical data of the studied soils are presented in Table (1). Micronutrients (Zn, B and Mo) treatments constituted the main plots; N, P and K treatments constituted the sub plots, and the organic compounds treatments were maintained in the sub-sub plots (Table 2). The plot area was (9x10m) 90 m^2 at Al-Kaser location while was (8x8m) 64 m^2 at the El-Monera location. The irrigation system in both sites was flood irrigation. Faba bean variety Rebaya was cultivated at 20 cm between plants in row, 40 cm apart in both locations. Before cultivation faba bean seeds were treated with rhizobium bacteria according to El Habbasha *et al.* (2007).

TABLE 1. Some physical and chemical properties of the soil and chemical analyses of the irrigation water at the experimental sites.

Depth Cm	pH 1:1	EC dS m^{-1}	OM	$CaCO_3$	Sand	Silt	Clay	CEC me/100g	Texture
			%						
Sandy soil									
0-30	7.58	0.79	0.56	1.18	90.21	6.45	3.34	2.65	Sandy
30-60	7.36	0.48	0.29	1.02	86.63	8.81	4.56	3.79	Sandy
Clay soil									
0-30	8.36	2.15	1.16	1.71	25.42	24.41	50.17	25.1	Clayey
30-60	8.18	1.21	0.75	1.58	22.93	23.75	53.32	27.6	Clayey

Soluble cations and anions (meq L^{-1}), amount of total antioxidants and total phenols in the studied soils									
	Na	K	Ca	Mg	HCO_3	Cl	SO_4	T. phenol	T.A.A
Sandy soil									
0-30	2.58	1.19	1.83	2.34	1.62	3.42	2.86	287	72
30-60	1.96	0.68	0.97	1.23	0.86	2.45	1.52	165	43
Clay soil									
0-30	11.14	1.35	4.11	4.93	2.23	15.65	3.64	395	118
30-60	6.74	0.82	1.83	2.75	1.84	7.11	3.18	254	85

Available nutrients (mg kg^{-1}) in soil							
	N	P	K	Fe	Mn	Zn	Cu
	Sandy soil						
0-30	14.8	1.53	38	14.5	5.49	0.18	0.08
30-60	11.5	1.08	51	16.8	6.85	0.25	0.11
Clay soil							
0-30	34.5	2.68	239	28.5	11.2	0.51	0.21
30-60	27.2	2.19	276	35.8	16.1	0.43	0.25

Some chemical properties of irrigation water									
Soils	pH	EC	Na	K	Ca	Mg	HCO_3	Cl	SO_4
		dS/m	me/L						
Sandy	7.91	0.52	1.92	0.86	1.03	1.41	1.12	3.46	0.65
Clay	8.12	0.81	2.98	1.09	1.71	2.35	2.18	4.83	1.12

TABLE 2. The treatments of mineral fertilizers and organic compounds in the experimental sites.

Fertilizers	Sandy soil			Clay soil		
Soil fertilizers (kg/fed) for the studied soils						
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
$N_1P_1K_1$	50	25	40	40	35	20
$N_2P_2K_2$	70	50	60	60	65	40
Foliar of micronutrients applied at two rates (with and without)						
Micronutrients	Applied at two rates B (0, 50ppm), Mo (0, 5ppm) and Zn (0, 300ppm)					
Foliar of macronutrients applied at one rate for all the studied treatments and soils						
Dose A	first dose (0.75kg of 20/20/20) /200L					
Dose B	second dose (0.5 kg of 20/20/20 + 0.25 kg of 0/80/0+0.4kg 0/0/50)/200L					
Dose C	third dose (0.4kg of 20/20/20 + 0.35kg of 0/80/0+ 0.5 kg 0/0/50)/200L					
Organic compounds applied at two rates as foliar solutions (0, 1000ppm)						
Humic acid	23.3g of humic acid 86% dissolved in 20L					
Amino acid	100 ml of amino acid 20% dissolved in 20L					
Ascorbic acid	20g of ascorbic acid 100% dissolved in 20L					
licorice	800 ml of licorice extract (0.5kg/20L) dissolved in 20L					

N, P and K fertilizers were applied as soil application at two rates and a rate of foliar application at three equal split doses (Table 2). N and K were applied in three equal split doses that were applied after 25, 50 and 75 days after sowing, while the whole rate of P was applied with soil preparation. The foliar mineral fertilizers were applied after one week of N and K soil application. N was applied as ammonium nitrate, P as calcium superphosphate and K as potassium sulfate. B as boric acid at 50 mg L^{-1}, Mo as ammonium molybdate at 5mg L^{-1} and Zn as zinc sulphate at 300 5mg L^{-1} were applied at two rates as foliar application. The studied organic compounds were humic acid (HA), amino acid (AA), ascorbic acid (AS) and licorice extract (LC). Two rates of organic compounds were applied at the same times of foliar mineral application (Table 2). Farm yard manure was applied at one rate of 10 and 20 m^3 fed^{-1} in clay and sandy soils, respectively, with soil preparation for sowing.

Soil samples were collected at two layers (0-30 and 30-60cm) before sowing for physical and chemical analyses. Plant samples were collected at physiological maturity. Faba bean yield parameters such as weight of shoot and seed (ton fed^{-1}) were recorded. Soil and plant samples were analyzed for macro and micronutrients according to Cottenie *et al.* (1982). Different analyses of the studied soils were accomplished according to Page *et al*., 1984; and Klute, 1986). Measurements of total antioxidants and total phenol in soil and faba bean plants were estimated according to Rimmer (2009). The analysis of variance (ANOVA) was used to determine the effect of treatments on yield parameters. Least significant differences (LSD) test was used to determine the differences between treatments means at 5% probability level according to Gomez and Gomez (1984).

Results and Discussion

Effect of mineral fertilizers and organic compounds on yield of faba bean

Data in Table 3 show that the highest yields of faba bean were obtained when the application rates of N, P and K fertilizers were increased and micronutrients were foliar applied in both soils. The organic compounds application increased yield parameters in the presence of mineral fertilization. The best treatment for yield parameters in the two studied soils was (AS+AA+HA+LC+$N_2P_2K_2$+ with Micronutrients) which recorded 5.95 and 2.73 ton fed^{-1} for shoot and seed in sandy soil, while in the clay soil were 8.91 and 4.30 ton fed^{-1}, respectively. This could be due to the integration between mineral fertilizers and organic compounds optimized the nutritional status of faba bean and suppressed the constraints of growth and consequantely improved plant growth and yield. These results agreeable with those obtained by Al Dulaimy & Jumaa (2012); and Jasim & obaid (2014).

Regarding the organic compounds either individual or in combinations, their foliar applications were increased quantity and quality of faba bean. Applications of organic compounds as individual forms were lower in yield than in combination forms. The LC was lowest in increasing shoot and seed yield compared with control treatment was an average increase of 47.0 and 50.4 % in sandy soil; While were about 43.2 and 49.8 % in clayey soil, respectively. The highest treatment was AS which increased yield over control by about 59 and 70% for shoot and seed in sandy soil; while were about 51.4 and 64.5% in clayey soil, respectively. In case of applying organic compounds in combination form, the highest treatment was AS+AA+HA+LC which recorded yield increase over control by about 64.9 and 76.3% for shoot and seed in sandy soil; while were about 59.1 and 70.7% in clay soil, respectively. The lowest combination treatment was HA+LC which increased the yield over control by about 56.5 and 63.1% for shoot and seed in sandy soil; while were about 51.9 and 65.7% in clay soil, respectively. The organic compounds can be arranged in ascending for its effectiveness in increasing faba bean yield as: LC < HA< AA< AS in individual forms; while in combination forms as follow: LC+HA < LC+ HA+AA < AS+AA+HA < AS+AA+HA+LC. These results proved the fact that organic compounds have a vital role in improving plant growth and productivity. These findings paralleled with Scherf *et al.* (2010) and Schuster *et al.* (2010) for LC role in plant; Canellas & Olivares (2014) and El-Bassiouny *et al.* (2014) for HA role in plant; Abd El-Samad *et al.* (2010) and Gioseffi *et al.,* (2012) for AA functions in plant; while antioxidants role in plant was reported by Agatia *et al*. (2012) and Brunetti *et al.* (2013).

Table 3 shows the effect of mineral fertilizers effect on shoot and seed yield of faba bean without application of micronutrients. The $N_1P_1K_1$ treatment increased the yield by about 48.3 and 58.6 % over control for shoot and seed in sandy soil; while were 43.8 and 56.2 % in clayey soil, respectively. The $N_2P_2K_2$ treatment took the same trend and increased the yield over control by about 59.5 and 70.4% for shoot and seed in sandy soil; while were about 54.4 and 65.7 % in clayey soil, respectively. Combing micronutrients, the $N_1P_1K_1$ treatment recorded increase over control by about 55.8 and 63.7 % of shoot and seed in sandy soil; while were about 50.4 and 62.7 % in clayey soil, respectively. The $N_2P_2K_2$ treatment along or with micronutrients increased the yield by about 65.2 and 74.7% over control for shoot and seed in sandy soil; while were about 58.6 and 69.9 % in clayey soil, respectively.

Micronutrients (Zn, B and Mo) application as foliar achieved increase over control by about 13.6 and 8.0 % for shoot and seed under $N_1P_1K_1$ treatment; while were about 8.7 and 5.8% under $N_2P_2K_2$ treatment in sandy soil, respectively. In clayey soil, micronutrients increased the yield by about 12.9 and 10.4 % over control for shoot and seed under $N_1P_1K_1$ treatment; while under $N_2P_2K_2$ treatment were about 7.2 and 6.0%, respectively.

Faba bean response to mineral fertilizers and organic compounds was higher in sandy soil than clayey soil. This is true due to the fact that the fertility status of clay soils is higher than sandy soils (Table 1). The available nutrients and plant nutrient contents, yield components and biochemical compounds increased by application of mineral fertilizers and organic compounds. The results of organic compounds treatments agreed with that obtained by Zuhair & Mohammed (2010) and Al Dulaimy & Jumaa (2012). While the mineral fertilizers treatments results agreed with that obtained by Fawy (2010), Hamid *et al.,* (2010) and Jasim & obaid (2014).

Effect of mineral fertilizers and organic compounds on nutrient contents in faba bean

Tables 4, 5 and 6 show that the interactions between mineral fertilizers and organic compounds in combination forms significantly increased nutrient contents in faba bean. The most effective treatment for nutrient contents was AS + AA + HA + LC+ $N_2P_2K_2$ with micronutrients when compared with other treatments, while the lowest treatment was HA + LC + $N_1P_1K_1$ without micronutrients.

Applications of organic compounds in combination forms increased macronutrient contents in shoot and seed of faba bean in sandy and clay soils (Tables 4) were in HA + LC treatment; while the highest values were recorded in AS + AA + HA + LC treatment. The most effective treatment for all nutrient contents in shoot and seed was AS + AA + HA + LC + $N_2P_2K_2$ with micronutrients when compared with the other treatments; while the lowest treatment was HA+LC+ $N_1P_1K_1$ without micronutrients.

Figures 1, 2- 4) and Table 4 illustrate the effect of macronutrients fertilizers (NPK) application on nutrient contents in shoot and seed. Macronutrients applications could achieve nutrient content over control by about 65.6 and 40.6% N, 75.6 and 70% P, 60 and 52.4% K in sandy soil; while were about 48.5 and 42.0% N, 78.0 and 62.2% P, 65.5 and 40.3% K in the clayey soil. Micronutrients fertilizers (B, Mo and Zn) significantly increased nutrient contents in shoot and seed over control by about 7.0 and 13.3% N, 3.7 and 1.5% P, 8.8 and 5.8% K in sandy soil; while were about 8.3 and 11.0 % N, 5.5 and 9.5% P, 3.6 and 8.9% K in the clay soil.

TABLE 3. Effect of studied treatments on faba bean yield in the studied soils during two seasons.

Treatments			Yield of faba bean (ton fed^{-1}) in sandy soil		Yield of faba bean (ton fed^{-1}) in clay soil	
			Shoot weight	**Seed weight**	**Shoot weight**	**Seed weight**
Control			1.50	0.56	2.40	0.92
Without B, Mo and Zn addition	$N_1P_1K_1$	Licorice (LC)	2.17	0.84	3.79	1.42
		Humic acid (HA)	2.47	1.02	4.27	1.65
		Amino acids (AA)	2.64	1.30	4.56	1.93
		Ascorbic acid (AS)	2.86	1.53	4.82	2.15
		LC+HA	2.75	1.16	4.69	1.92
		LC+HA+AA	3.09	1.45	5.52	2.24
		AS+AA+HA	3.54	1.77	5.79	2.50
		AS+AA+HA+LC	3.60	1.79	5.87	2.54
	$N_2P_2K_2$	Licorice (LC)	3.50	1.24	5.03	1.95
		Humic acid (HA)	3.66	1.39	5.28	2.18
		Amino acids (AA)	4.13	1.73	5.62	2.43
		Ascorbic acid (AS)	4.37	1.93	5.87	2.61
		LC+HA	4.24	1.83	5.48	2.25
		LC+HA+AA	4.57	2.17	6.45	2.95
		AS+AA+HA	5.02	2.51	6.77	3.22
		AS+AA+HA+LC	5.22	2.58	6.80	3.31
With B, Mo and Zn addition	$N_1P_1K_1$	Licorice (LC)	2.59	0.98	4.43	1.66
		Humic acid (HA)	2.84	1.21	4.82	1.97
		Amino acids (AA)	3.20	1.46	5.15	2.35
		Ascorbic acid (AS)	3.45	1.73	5.68	2.76
		LC+HA	3.09	1.39	5.10	2.20
		LC+HA+AA	3.62	1.64	6.18	2.53
		AS+AA+HA	4.05	2.00	6.99	2.88
		AS+AA+HA+LC	4.10	2.08	7.01	2.89
	$N_2P_2K_2$	Licorice (LC)	3.86	1.44	6.35	2.60
		Humic acid(HA)	4.17	1.63	6.74	2.92
		Amino acids (AA)	4.65	2.05	7.42	3.39
		Ascorbic acid (AS)	4.83	2.51	7.92	3.74
		LC+HA	4.65	2.27	7.16	3.34
		LC+HA+AA	5.13	2.57	8.25	3.80
		AS+AA+HA	5.85	2.67	8.86	4.03
		AS+AA+HA+LC	5.95	2.73	8.91	4.30
$LSD_{0.05}$ Micronutrients			0.16	0.08	0.35	0.21
$LSD_{0.05}$ Macronutrients			0.09	0.06	0.13	0.09
$LSD_{0.05}$ Organic compounds			0.04	0.03	0.06	0.04
LSD 0.05 Micro x Macro.			0.07	0.08	0.19	0.12
LSD 0.05 Micro x Organic			0.06	0.04	0.08	0.05
LSD 0.05 Macro. x Organic			0.07	0.05	0.10	0.06
LSD 0.05 3 factors			0.10	0.07	0.14	0.09

TABLE 4. Effect of the studied treatments on macronutrient contents of faba bean in the studied soils during two seasons.

Treatments			Nutrients contents in sandy soil						Nutrients contents in clay soil					
			shoot			seeds			shoot			Seeds		
			N	P	K	N	P	K	N	P	K	N	P	K
			%						%					
Control			0.47	0.07	0.29	0.89	0.12	0.35	0.85	0.11	0.35	1.05	0.21	0.66
Without B, Mo and Zn	$N_1P_1K_1$	LC+HA	0.96	0.24	0.62	1.19	0.36	0.69	1.47	0.38	0.92	1.51	0.45	0.99
		LC+HA+AA	1.32	0.27	0.65	1.64	0.4	0.76	1.52	0.41	0.95	1.65	0.48	1.09
		AS+AA+HA	1.38	0.29	0.69	1.68	0.43	0.81	1.57	0.43	0.97	1.72	0.51	1.13
		AS+AA+HA+ LC	1.41	0.31	0.71	1.71	0.45	0.84	1.59	0.45	0.98	1.77	0.53	1.16
	$N_2P_2K_2$	LC+HA	1.43	0.32	0.89	1.25	0.48	0.75	1.65	0.61	1.08	1.88	0.63	1.13
		LC+HA+AA	1.69	0.35	0.93	1.73	0.52	0.82	1.93	0.66	1.16	2.09	0.67	1.16
		AS+AA+HA	1.74	0.38	0.95	1.75	0.57	0.89	1.98	0.68	1.18	2.13	0.69	1.19
		AS+AA+HA+ LC	1.78	0.39	0.96	1.78	0.58	0.91	2.03	0.61	1.19	2.15	0.71	1.21
With B, Mo and Zn	$N_1P_1K_1$	LC+HA	1.19	0.27	0.76	1.33	0.37	0.75	1.52	0.49	1.01	1.57	0.52	1.09
		LC+HA+AA	1.52	0.31	0.79	1.84	0.42	0.82	1.73	0.53	1.04	1.83	0.57	1.16
		AS+AA+HA	1.63	0.33	0.81	1.87	0.45	0.88	1.76	0.55	1.07	1.88	0.63	1.19
		AS+AA+HA+ LC	1.65	0.34	0.82	1.89	0.46	0.91	1.79	0.58	1.09	1.92	0.66	1.21
	$N_2P_2K_2$	LC+HA	1.52	0.35	0.96	1.34	0.49	0.81	1.73	0.68	1.17	2.05	0.71	1.21
		LC+HA+AA	1.84	0.37	0.99	1.87	0.54	0.89	1.98	0.71	1.21	2.34	0.76	1.24
		AS+AA+HA	1.92	0.39	1.03	1.91	0.59	0.96	2.08	0.72	1.23	2.38	0.79	1.26
		AS+AA+HA+ LC	1.96	0.4	1.05	1.94	0.61	0.98	2.11	0.74	1.25	2.41	0.82	1.28
$LSD_{0.05}$ Micro x Macro.			0.049	0.005	0.029	0.007	0.008	0.007	0.038	0.026	0.014	0.057	0.012	0.006
$LSD_{0.05}$ Micro x Organic			0.026	0.006	0.013	0.022	0.009	0.012	0.021	0.010	0.016	0.021	0.010	0.011
$LSD_{0.05}$ Macro. x Organic			0.032	0.007	0.016	0.027	0.010	0.014	0.026	0.013	0.020	0.026	0.012	0.014
$LSD_{0.05}$ 3 factors			0.045	0.010	0.023	0.029	0.011	0.020	0.036	0.018	0.028	0.036	0.012	0.020

LC= Licorice, HA=Humic acid, AA= Amino acids and AS= Ascorbic acid.

TABLE 5. Effect of the studied treatments on micronutrient contents of faba bean in the studied soils during two seasons.

Treatments			Micronutrients of shoot in sandy soil						Micronutrients of seeds in clay soil					
			Zn	**B**	**Mo**	**Fe**	**Mn**	**Cu**	**Zn**	**B**	**Mo**	**Fe**	**Mn**	**Cu**
			mg kg^{-1}						**mg kg^{-1}**					
Control			2.24	7.4	0.42	213	125	1.35	3.16	8.9	0.54	236	129	1.41
Without B, Mo and Zn	$N_1P_1K_1$	LC+HA	4.3	13.7	0.81	201	108	1.72	5.29	15.9	1.02	215	115	1.86
		LC+HA+AA	4.43	14.2	0.83	200	105	1.76	5.43	16.1	1.04	209	114	1.91
		AS+AA+HA	4.6	14.6	0.85	198	100	1.79	5.7	16.4	1.07	204	111	1.94
		AS+AA+HA+ LC	4.66	15.1	0.87	196	97	1.98	5.79	16.7	1.09	177	109	1.98
	$N_2P_2K_2$	LC+HA	4.71	15.9	0.83	197	103	1.76	5.71	18.1	1.04	206	112	1.91
		LC+HA+AA	4.91	16.4	0.86	195	99	1.82	5.86	18.5	1.08	203	110	1.96
		AS+AA+HA	5.15	16.8	0.89	193	97	1.87	5.98	18.7	1.12	201	109	1.99
		AS+AA+HA+ LC	5.2	17.2	0.92	190	94	1.89	6.04	19	1.16	196	107	2.03
With B, Mo and Zn	$N_1P_1K_1$	LC+HA	50.4	44.5	1.22	148	80	1.76	61.8	52.8	1.58	157	83	1.97
		LC+HA+AA	52.8	45.3	1.26	146	78	1.8	64.7	53.4	1.62	155	83	2.03
		AS+AA+HA	55.3	45.9	1.29	143	74	1.85	67.7	53.9	1.67	153	81	2.08
		AS+AA+HA+ LC	57	46.5	1.32	142	72	1.88	70.2	54.6	1.71	150	79	2.12
	$N_2P_2K_2$	LC+HA	54.1	46.8	1.28	143	72	1.8	63.4	55.9	1.66	149	78	2.03
		LC+HA+AA	56.4	47.5	1.31	142	71	1.85	66.3	60.6	1.69	147	77	2.08
		AS+AA+HA	58.1	48.1	1.36	140	68	1.91	69.1	61.5	1.74	145	75	2.14
		AS+AA+HA+ LC	59.4	48.8	1.39	138	65	1.94	71.2	62.4	1.78	143	74	2.18
LSD $_{0.05}$ Micro x Macro.			0.29	0.30	0.007	0.59	0.80	0.007	0.19	0.46	0.008	0.9	0.3	0.004
LSD $_{0.05}$ Micro x Organic			0.79	0.60	0.015	1.09	0.91	0.011	0.95	0.73	0.019	1.5	0.8	0.013
LSD $_{0.05}$ Macro. x Organic			0.89	0.74	0.018	1.33	1.12	0.014	1.06	0.89	0.023	1.8	1.0	0.016
LSD$_{0.05}$ 3 factors			1.03	0.78	0.019	1.41	1.18	0.020	1.23	1.26	0.033	2.5	1.4	0.017

LC= Licorice, HA=Humic acid, AA= Amino acids and AS= Ascorbic acid.

The organic compounds as individual forms increased macronutrient contents in shoot and seed over control by about 61 and 32% N, 72 and 66% P, 54 and 44% K in sandy soil; while were about 45 and 39% N, 77 and 59% P, 63 and 37% K in the clay soil. The highest values of N, P and K contents were recorded by AA, HA and AS applications, respectively; while the lowest values were in LC treatment. This could be due to the important role of organic compounds in plant as a growth regulator plant, nutrients sources, protecting the plant from diseases (Schuster *et al.,* 2010), Gioseffi *et al.,* 2012), Brunetti *et al.,* 2013) and El-Bassiouny *et al.,* 2014).

Data in Tables 5 and 6 and Fig. 5-8 show that mineral fertilizers significantly increased of micronutrient contents in shoot and seed, except Fe and Mn contents. the values of Fe and Mn contents were decreased to a percentage about 26.3 and 32.8% Fe and 39.5 and 34.7% Mn in sandy soil; while were 31.3 and 32.9% Fe and 43.3 and 50.9% Mn in clayey soil compared with control when N, P and K fertilizers were applied. Micronutrients fertilizers (B, Mo and Zn) applications also reduced Fe and Mn contents in shoot and seed compared to control to a percentage about 39.1 and 40.8% Fe and 45.1% and 45 Mn in sandy soil; while were 43.6 and 46.1% Fe and 58.6 and 66.0% Mn in clayey soil. It appears that mineral fertilization reduced the negative impact of high levels of Fe and Mn on faba bean. This could be due to the antagonistic interaction between P and Zn from one side and Fe and Mn in the other side. These results are agreeable with Handreck (2006) who reported that the high P additions reduced accumulation of Fe into leaves, while the high rate of Fe additions reduced accumulation of P in the leaves.

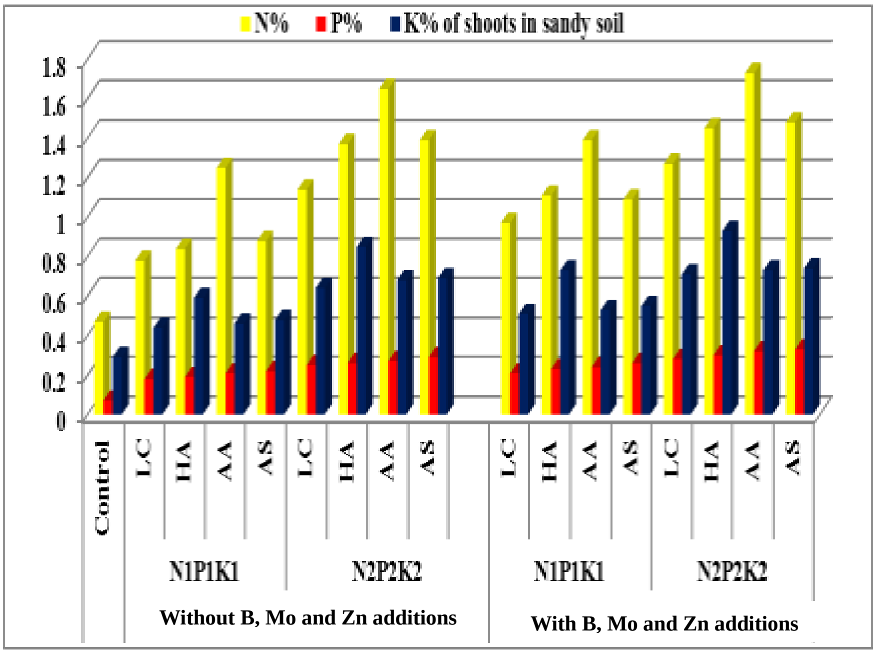

Fig. 1. Effect of studied treatment on macronutrient contents in faba bean shoot in sandy soil.

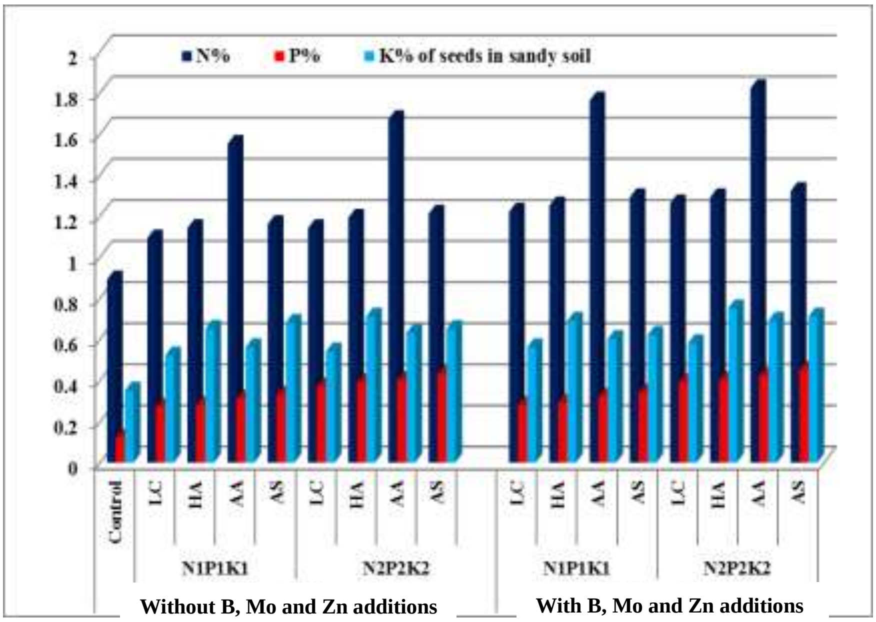

Fig. 2. Effect of studied treatments on macronutrient contents in faba bean seed in sandy soil.

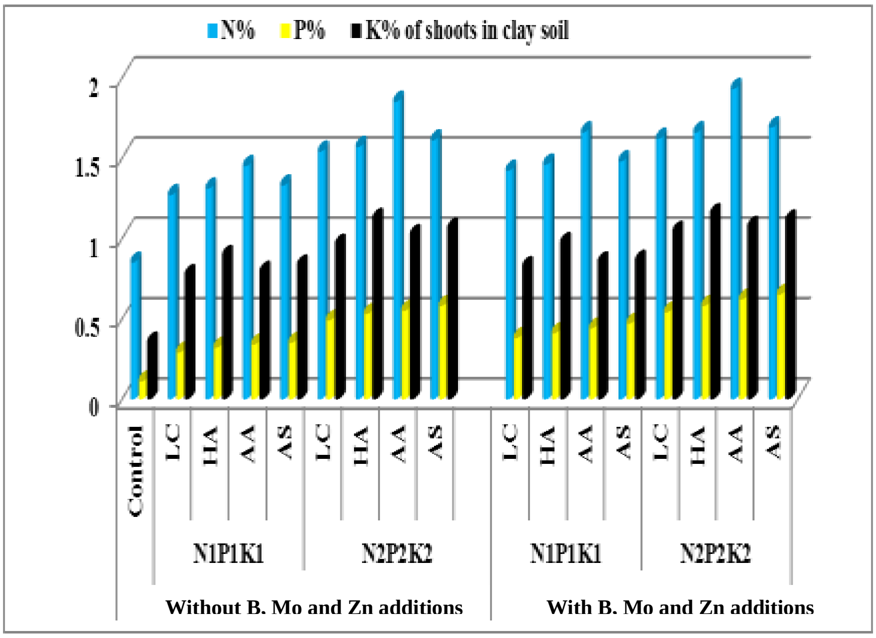

Fig.3. Effect of studied treatments on macronutrient contents in faba bean shoot in clay soil.

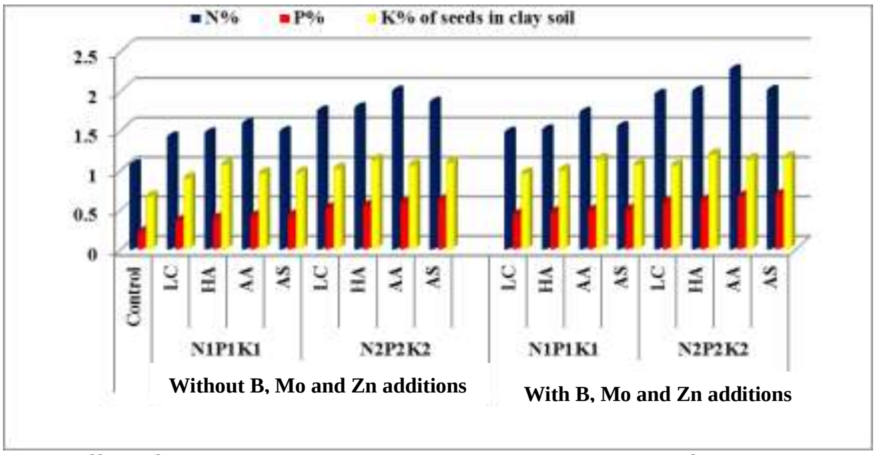

Fig.4. Effect of studied treatments on macronutrient contents in faba bean seed in clay soil.

TABLE 6. Effect of the interaction between mineral fertilizers and some organic compounds on micronutrient contents in faba bean in clay soil during two seasons.

Treatments			Micronutrients in shoot						Micronutrients in seeds					
			Zn	B	Mo	Fe	Mn	Cu	Zn	B	Mo	Fe	Mn	Cu
			mg kg^{-1}						mg kg^{-1}					
Control			4.21	11.6	0.93	286	153	2.14	6.58	15.3	1.08	314	174	2.37
Without B, Mo and Zn	$N_1P_1K_1$	LC+HA	6.71	18.1	1.31	267	135	2.59	8.6	22.5	1.65	298	155	2.81
		LC+HA+AA	6.76	18.5	1.35	261	131	2.63	8.64	22.9	1.69	295	151	2.85
		AS+AA+HA	6.81	18.8	1.38	257	127	2.65	8.68	23.3	1.73	292	147	2.9
		AS+AA+HA +LC	6.85	19.2	1.42	249	123	2.68	8.71	24.1	1.78	290	145	2.93
	$N_2P_2K_2$	LC+HA	6.85	18.7	1.36	253	130	2.62	8.61	24.6	1.74	271	138	2.92
		LC+HA+AA	6.9	19.1	1.38	249	127	2.66	8.66	25	1.78	269	135	2.96
		AS+AA+HA	6.94	19.4	1.42	244	123	2.69	8.7	25.2	1.82	267	131	3
		AS+AA+HA +LC	6.99	19.9	1.46	239	120	2.73	8.74	25.7	1.86	265	127	3.03
With B, Mo and Zn	$N_1P_1K_1$	LC+HA	77.6	65.2	2.17	197	90	2.79	97.7	79.5	2.66	209	95	2.88
		LC+HA+AA	79.8	65.8	2.21	193	86	2.83	100.5	80.2	2.69	206	94	2.92
		AS+AA+HA	81.9	66.5	2.25	191	83	2.86	103	80.9	2.74	202	91	2.97
		AS+AA+HA +LC	83.8	67.1	2.28	186	79	2.89	105.5	81.6	2.77	201	88	3
	$N_2P_2K_2$	LC+HA	82.2	67.8	2.32	183	85	2.91	103.6	83.2	2.71	193	90	3.08
		LC+HA+AA	84.3	68.5	2.36	179	82	2.95	106.1	83.9	2.76	188	88	3.11
		AS+AA+HA	86.7	69.2	2.39	175	79	2.97	108.4	84.6	2.79	185	86	3.14
		AS+AA+HA +LC	88.6	69.8	2.44	170	77	2.99	110.1	85.2	2.84	183	83	3.19
LSD $_{0.05}$ Micro x Macro.			0.40	0.26	0.013	1.20	0.66	0.012	0.48	0.39	0.009	2.90	1.57	0.020
LSD $_{0.05}$ Micro x Organic			1.18	0.85	0.022	1.74	1.16	0.014	1.46	1.02	0.027	1.85	1.38	0.013
LSD $_{0.05}$ Macro. x Organic			1.32	0.95	0.027	2.13	1.42	0.017	1.63	1.25	0.033	2.27	1.69	0.016
LSD$_{0.05}$ 3 factors			1.52	1.10	0.038	3.02	1.50	0.024	1.89	1.32	0.035	3.20	2.40	0.023

LC= Licorice, HA=Humic acid, AA= Amino acids and AS= Ascorbic acid.

Organic compounds applications in combination forms as shown in Tables 5 and 6 increased micronutrient contents in shoot and seed, expect Fe and Mn where their concentrations were decreased with organic compounds applications. The most efficient treatment about the increase micronutrient contents in shoot and seed was AS+AA +HA+LC+ $N_2P_2K_2$ with micronutrients. The organic compounds in individual forms (Fig. 5-8) reduced Fe and Mn contents in shoot and seed compared with control to a percentage about 20.9 and 25.2% Fe and 28.0 and 26.1% Mn in sandy soil; while were 24.5 and 25.8% Fe and 29.6 and 36.6% Mn in clayey soil. The highest values reduction in Fe and Mn were observed in AS treatment; while the lowest values were in LC treatment. These observations have been noted by Wandruszka (2006), Handreck (2006), Fawy (2010), Bozorgi *et al.* (2011) and Jasim & obaid (2014).

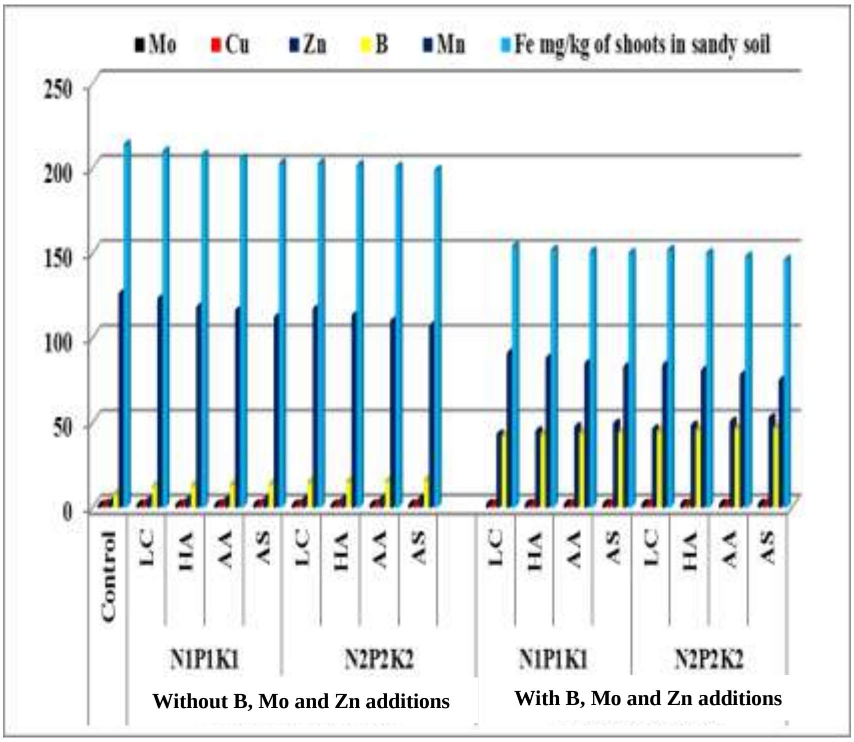

Fig. 5. Effect of studied treatments on micronutrient contents in faba bean shoot in sandy soil.

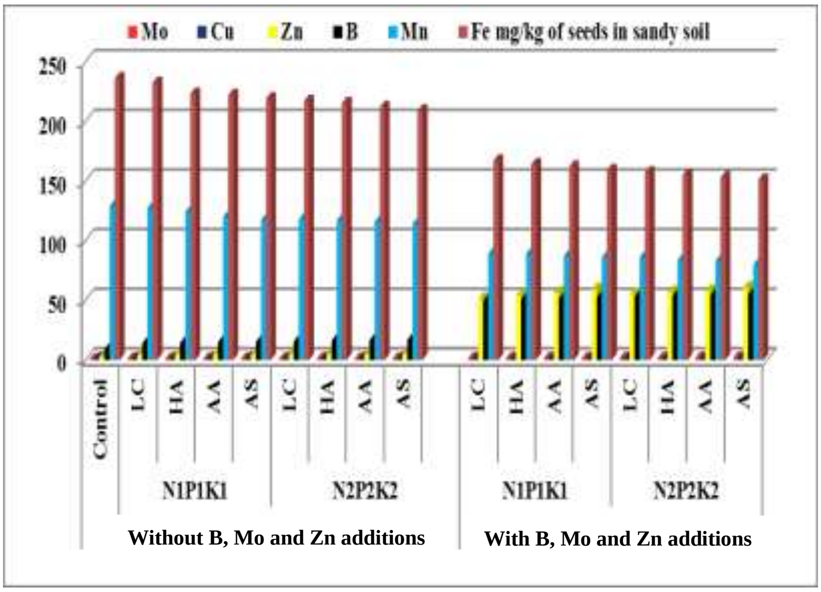

Fig.6. Effect of studied treatments on micronutrient contents in faba bean seed in sandy soil.

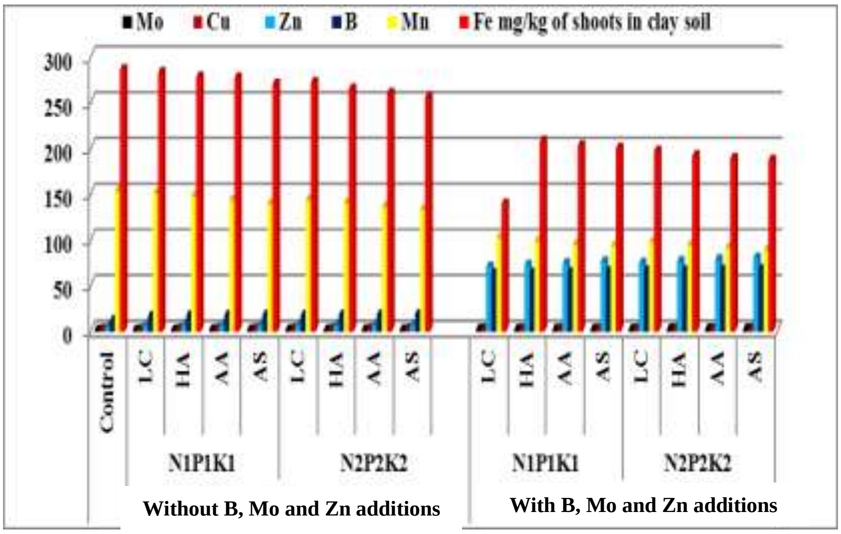

Fig. 7. Effect of mineral fertilizers and some organic compounds on macronutrient contents of faba bean shoot in clay soil.

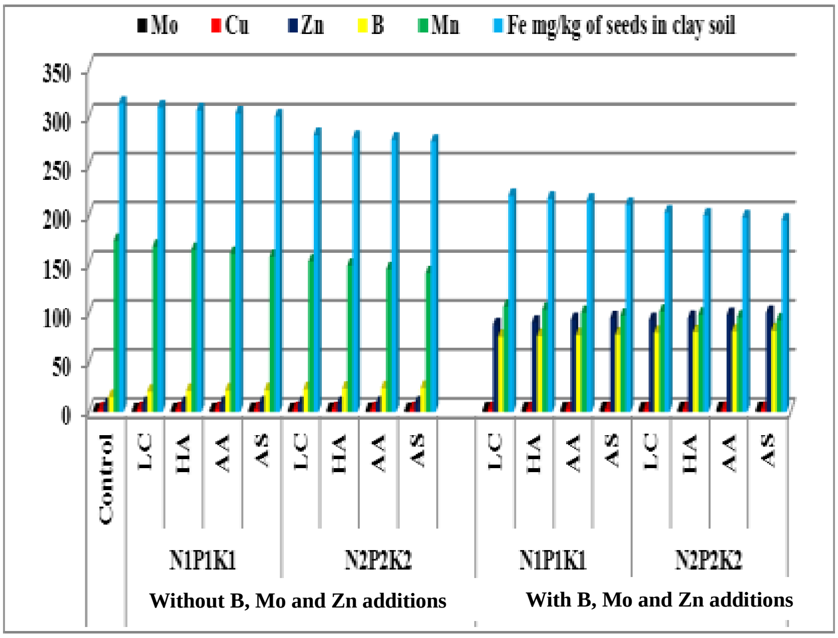

Fig. 8. Effect of mineral fertilizers and some organic compounds on macronutrient contents in faba bean seed in clay soil.

Effect of mineral fertilizers and some organic compounds on total phenols and antioxidants

As shown in Table 7, application of mineral fertilizers especially micronutrients significantly increased total phenols and total antioxidants activities in shoot and seed of faba bean. This has been reported by Hamid *et al.* (2010), Gill & Tuteja (2010), Agatia *et al.* (2012), and Brunetti *et al.* (2013).

The best treatment for total phenol and total antioxidant activities in shoot and seed were AS + AA + HA + LC + $N_2P_2K_2$ + with micronutrients which achieved 216 and 227 µg Ascorbic acid ml^{-1} extract of total antioxidants and 791 and 876 µmol of Gallic acid ml^{-1} extract total phenols for shoot and seed, respectively in sandy soil; while were 231 and 243 µg Ascorbic acid ml^{-1} extract of total antioxidants and 891 and 983 µmol of Gallic acid ml^{-1} extract of total phenols in clayey soil, respectively. The AS and LC treatments had higher values of total phenols and antioxidants contents than HA and AA treatmen.

TABLE 7. Effect of mineral fertilizers and some organic compounds on biochemical contents in faba bean in the studied soils during two seasons.

Treatments			Sandy soil				Clay soil			
			T. antioxidants		T. phenols		T. antioxidants		T. phenols	
			µg Asc ml^{-1}		µg Gal ml^{-1}		µg Asc ml^{-1}		µg Gal ml^{-1}	
			Seed	Shoot	Seed	Shoot	Seed	Shoot	Seed	Shoot
Control			28	36	103	139	47	60	181	245
Without B, Mo and Zn	$N_1P_1K_1$	Licorice (LC)	69	75	253	289	86	93	332	379
Without B, Mo and Zn	$N_1P_1K_1$	Humic acid (HA)	39	48	143	185	63	78	243	314
Without B, Mo and Zn	$N_1P_1K_1$	Amino acid (AA)	43	52	158	201	68	82	262	333
Without B, Mo and Zn	$N_1P_1K_1$	Ascorbic acid (AS)	158	166	579	640	181	190	698	770
Without B, Mo and Zn	$N_1P_1K_1$	LC+HA	84	89	308	343	97	103	374	416
Without B, Mo and Zn	$N_1P_1K_1$	LC+HA+AA	105	112	385	432	112	119	432	484
Without B, Mo and Zn	$N_1P_1K_1$	AS+AA+HA	169	176	619	679	198	206	764	835
Without B, Mo and Zn	$N_1P_1K_1$	AS+AA+HA+LC	188	194	689	748	208	215	802	869
Without B, Mo and Zn	$N_2P_2K_2$	Licorice (LC)	75	83	275	320	97	107	374	435
Without B, Mo and Zn	$N_2P_2K_2$	Humic acid (HA)	49	56	180	216	68	78	262	315
Without B, Mo and Zn	$N_2P_2K_2$	Amino acid (AA)	54	61	198	235	73	82	282	334
Without B, Mo and Zn	$N_2P_2K_2$	Ascorbic acid (AS)	172	185	630	714	197	212	760	858
Without B, Mo and Zn	$N_2P_2K_2$	LC+HA	93	107	341	413	106	122	409	494
Without B, Mo and Zn	$N_2P_2K_2$	LC+HA+AA	115	126	421	486	121	133	467	537
Without B, Mo and Zn	$N_2P_2K_2$	AS+AA+HA	184	197	674	760	209	224	806	906
Without B, Mo and Zn	$N_2P_2K_2$	AS+AA+HA+LC	197	209	722	806	216	229	833	928
With B, Mo and Zn	$N_1P_1K_1$	Licorice (LC)	86	97	315	374	106	120	409	484
With B, Mo and Zn	$N_1P_1K_1$	Humic acid (HA)	54	59	198	228	74	81	285	327
With B, Mo and Zn	$N_1P_1K_1$	Amino acid (AA)	58	67	213	258	79	91	305	370
With B, Mo and Zn	$N_1P_1K_1$	Ascorbic acid (AS)	183	198	671	764	208	225	802	911
With B, Mo and Zn	$N_1P_1K_1$	LC+HA	98	112	359	432	114	130	440	528
With B, Mo and Zn	$N_1P_1K_1$	LC+HA+AA	124	133	454	513	129	138	498	560
With B, Mo and Zn	$N_1P_1K_1$	AS+AA+HA	195	212	715	818	217	236	837	955
With B, Mo and Zn	$N_1P_1K_1$	AS+AA+HA+LC	208	219	762	845	225	237	868	959
With B, Mo and Zn	$N_2P_2K_2$	Licorice (LC)	91	103	333	397	115	130	444	527
With B, Mo and Zn	$N_2P_2K_2$	Humic acid (HA)	58	67	213	258	79	91	305	370
With B, Mo and Zn	$N_2P_2K_2$	Amino acid (AA)	63	74	231	285	85	100	328	404
With B, Mo and Zn	$N_2P_2K_2$	Ascorbic acid (AS)	194	208	711	802	219	235	845	951
With B, Mo and Zn	$N_2P_2K_2$	LC+HA	106	115	388	444	121	131	467	532
With B, Mo and Zn	$N_2P_2K_2$	LC+HA+AA	129	138	473	532	132	141	509	572
With B, Mo and Zn	$N_2P_2K_2$	AS+AA+HA	207	219	759	845	223	236	860	956
With B, Mo and Zn	$N_2P_2K_2$	AS+AA+HA+LC	216	227	791	876	231	243	891	983
$LSD_{0.05}$ Micronutrients			5.41	6.16	19.8	23.8	5.1	5.86	19.7	23.7
$LSD_{0.05}$ Macronutrients			0.81	0.99	3.0	3.8	0.75	0.92	2.9	3.7
$LSD_{0.05}$ Organic acids			2.88	2.94	10.6	11.4	2.9	2.92	11.2	11.8
$LSD_{0.05}$ Micro x Macro.			1.15	1.4	4.2	5.4	1.06	1.31	4.1	5.3
$LSD_{0.05}$ Micro x Organic			4.07	4.16	14.9	16.1	4.1	4.13	15.8	16.7
$LSD_{0.05}$ Macro. x Organic			4.99	5.1	18.3	19.7	5.02	5.06	19.4	20.4
$LSD_{0.05}$ 3 factors			5.27	5.39	19.3	20.8	5.31	7.15	20.5	28.9

Total Antioxidants µg of Ascorbic acid/ml extract, Total phenol µmol of Gallic acid/ml extract .

Conclusions

Application of mineral fertilizers and some organic compounds increased yield components, nutrient contents, total antioxidants activity and total phenols in faba bean. The lowest values of faba bean yield were in LC treatment; while the highest values obtained in AS treatment. The organic compounds could be arranged in ascending order as: LC < HA< AA< AS. The integration between the organic compounds had higher values than individual applications and could be arranged in ascending order as: LC+HA < LC+ HA+AA < AS+AA+HA < AS+AA+HA+LC. Application of N, P and K along with micronutrients (B, Mo and Zn) reduced Fe and Mn contents in shoot and seed of faba bean and increased other nutrients which reflected positively on faba bean yield and quality. The LC treatment had higher values of total phenols and antioxidants contents than HA and AA treatments; while AS treatment had the highest values. The most effective treatment was AS+AA+HA+LC+$N_2P_2K_2$ with micronutrients which recorded 5.95 and 2.73 tfed^{-1} for shoot and seed, respectively in sandy soil; while were 8.91 and 4.30 t fed^{-1} in clayey soil, respectively. Also this treatment could achiev 216 and 227 µg Ascorbic acid ml^{-1} extract of total antioxidants and 791 and 876 µmol of Gallic acid ml^{-1} extract of total phenols in shoot and seed respectively in sandy soil; while were 231 and 243 µg Ascorbic acid ml^{-1} extract of total antioxidants and 891 and 983 µmol of Gallic acid ml^{-1} extract of total phenols in clay soil, respectively.

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تأثير التسميد المعدنى وبعض المركبات العضوية على محصول الفول البلدى فى بعض اراضى الوادى الجديد، مصر

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اقيمت التجارب الحقلية خلال عامين متتالين فى قرية القصر تمثل الاراضى الطينية بالواحات الداخلة وفى قرية المنيرة تمثل الاراضى الرملية بالواحات الخارجة فى الوادى الجديد، مصر. بذور الفول البلدى صنف Rebaya زرعت فى كلا من موقعى الدراسة. الهدف من هذة الدراسة هو تحسين انتاج الفول البلدى تحت ظروف اراضى الوادى الجديد باستخدام المزيج بين الاسمدة المعدنية وبعض المركبات العضوية. المعدلات المختلفة للنيتروجين والفوسفور والبوتاسيوم تمت اضافتها للتربة وبطريقة الرش الورقي في حين المعدلات المختلفة من عناصر الموليبددنيوم والبورون والزنك تمت اضافتها بطريقة الرش الورقي. بعض المركبات العضوية مثل أحماض الهيوميك – الأحماض الأمينية – حمض الأسكوربيك – مستخلص العرق سوس، تمت اضافتها مع الأسمدة المعدنية.

النتائج المتحصل عليها اظهرت ان اضافة الاسمدة المعدنية والمركبات العضوية زادت من قياسات المحصول، ومحتوى المغذيات، مضادات الاكسدة النشطة الكلية، الفينولات الكلية للفول البلدى. قياسات محصول الفول البلدى زادت مع زيادة معدلات أضافة أسمدة العناصر الغذائية الكبرى (نتروجين، فوسفور، بوتاسيوم)، والصغرى (بورون، موليبدنيم، زنك) أضافة المركبات العضوية عند المقارنة بمعاملة الكنترول فى كلا من اراضى وموسمى الدارسة. المركبات العضوية رتبت تصاعديا من حيث تاثيرها على محصول الفول البلدى كالاتى: العرقسوس < حامض الهيومك < الاحماض الامينية < حامض الاسكوربيك بينما الاضافة الورقية للصورة المختلطة بينهم كانت الاعلى فى قياسات المحصول ومحتوى المغذيات و مضادات الاكسدة النشطة الكلية، الفينولات الكلية عند المقارنة بصورة الاضافة الفردية وقد ترتبت تصاعديا كالاتى:(العرقسوس+ حامض الهيومك) < (العرقسوس+ حامض الهيومك+ الاحماض الامينية) < (حامض الاسكوربيك + حامض الهيومك+ الاحماض الامينية) < (حامض الاسكوربيك + حامض الهيومك+ الاحماض الامينية+ مستخلص العرقسوس) . أضافة أسمدة العناصر الغذائية الكبرى (نتروجين، فوسفور،

بوتاسيوم)، والصغرى (بورون، موليبدنيم، زنك) خفضت من الاثر الضار لارتفاع محتوى الحديد والمنجنيز فى التربة على انتاجية الفول البلدى وأيضا زادت من محتوى المغذيات الذى ينعكس ايجابيا وبزيادات معنوية لكمية وجودة بذور الفول البلدى. اعلى قيم لمحتوى النتروجين والبوتاسيوم والفوسفور سجلت لمعاملات الاحماض الامينية وحامض الهيومك وحامض الاسكوربيك على التوالى بينما كانت اقل القيم عند معاملة العرقسوس. معاملة العرقسوس كانت الاعلى فى محتوى مضادات الاكسدة الكلية والفينولات الكلية من معاملة حامض الهيومك ومعاملة الاحماض الامينية على التوالى بينما معاملة حامض الاسكوربك هى الاعلى قيمة. المعاملة الاكثر تاثيرا على المحصول :

(AS + AA + HA + LC + $N_2P_2K_2$ + With B, Mo and Zn)

(حامض الاسكوربيك + الاحماض الامينية + حامض الهيومك + مستخلص العرق سوس + التركيز الاعلى للنتروجين والفوسفور والبوتاسيوم + عناصر صغرى زنك وبورون و موليبدنيم) احرزت 5,59 و 2,73 طن/فدان للقش والبذور على التوالى فى الاراضــى الرمليـة بينما كانت 8,91 و 4,3 طـن/فـدان فـى الاراضى الطينيـة. وايضا المعاملة الاكثـر تاثيرا (AS+AA+HA+LC+P_2+Z_1) سجلت (216 and 227 µg ascorbic acid/ml) من مضادات اكسدة كلية و (791 and 876 µmol of gallic acid/ml) من الفينولات الكلية للقش والبذور على التوالى فى الاراض الرملية ، بينما كانت من مضادات الاكسدة الكلية (231 and 243 µg ascorbic acid/ml) ومن الفينولات الكلية كانت (891 and 983 µmol of gallic acid/ml) فى الاراضى الطينية. الاراضى الطينية سجلتأ قياسات محصولية للفول البلدى بالمقارنة بالاراضى الرملية.