Bull. Fac. Agric., Cairo Univ., 70:461-472(2019)

EFFECTS OF SOIL APPLICATION OF DIFFERENT FERTILIZERS AND FOLIAR SPRAY WITH YEAST EXTRACT ON GROWTH AND YIELD OF FABA BEAN PLANTS

(Received: 10.12.2019)

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ABSTRACT

Increasing the need for food production leadto increasing the use of mineral fertilizationthat affects the soil and the ecosystem. A field trail was conducted to investigate the response of faba bean plants to the foliar application ofyeast extract, inoculation with bio-fertilizer and application of humic acid. The foliar application of yeast extract (10 g/l) significantly increased the growth and yield of faba bean plants. The uptake of N, P and K by faba bean plants sprayed by yeast extract were 32, 56 and 27%, respectively, higher than those of the non-treated ones. Application of humic acid and inoculation with phosphorine and rhizobactrine decreased soil pH but they increased soil organic carbon and available N, P and K. The yeast extract, humic acid and bio-fertilizer inoculation increased the economic return of faba bean. It can be concluded that using combination of humic acid and bio-fertilizer inoculation with yeast extract spraying increased the quality and economic return of faba bean as well as saved about 75 and 50% of N and P requirements, respectively.

Keywords: *Combined fertilizers, Yeast extract, Humic acid, Faba bean, and Soil properties.*

1. INTRODUCTION

Nowadays, fertilizers are the major input to maximize the agricultural production to meet the increasing demand of food. This approach provided the expected outcomes of increased yield, but withhazardous effects on human health and the environment. In many cases, over fertilization of cropsparticularly N-chemical fertilizers, causes severe environmental problems,such polluting the hydrosphere, atmosphere, and pedosphere due to its losses through leaching, volatilization, and denitrification, resulting in a loss of biota, and a threat of ecosystems integrity (El-Wakeil and El-Sebai, 2007; Jensen *et al*., 2010). Thus a great attention has been focused on the possibility of using natural or organic fertilizerand microbial safe agents as bio-fertilizersfor promoting plant growth and crop yield that mitigate the hazardous environmental effects (McIsaac, 2003).In addition, natural and bio-fertilizers were used to enhance growth parameters and yield of faba bean (El Naim *et al*., 2017).

Bio-fertilizers (contain many beneficial microorganisms), natural materials (seaweed) and organic matter utilization can increase nutrients availability for plant growth. Bio-fertilizers not only mobilize N and P, but also could be used to produce crops, with naturally yield quality. These natural materials are considered low cost, effective and renewable sources of plant nutrients. They became a positive alternative or supplement to chemical fertilizers. Hence, to increase the productivity of the soil, the use of bio-fertilizers is a must and help in stimulating the plant growth hormones, providing better nutrient uptake and increased tolerance towards drought. They can be applied to seeds, plant surfaces, roots, soils, rhizosphere or the interior of the plant.They are also considered as eco-friendly and organic agro input as well as they are most effective than chemical fertilizers (Shayan *et al*., 2013; Mazher *et al*., 2014; Rajasekaran *et al*., 2015 and Youssef, 2016).

Theuse of bread yeast (*Saccharomyces cerevisiae*) extract as a bio-fertilizer in agriculture has received considerable attention because of their bioactivity and safety for human and the environment (Youssef, 2016). Bread yeast extract is usually added to the soil or as a foliar spray to crops and vegetables. It contains many nutrient elements as well as having useful promotional and nutritional functions, due to their hormones, sugars, amino acids, nucleic acids, vitamins and minerals content. So, it has been used in improving the growth and productivity of some vegetable crops. The positive effect of foliar spraying bread yeast extract in increasing yield and quality parameters of many vegetables was reported by many researchers (Twfig, 2010; Ahmed *et al*., 2011; Kahlel, 2015; Taha *et al*., 2016).

Faba bean (*Viciafaba* L.) is one of the major leguminous crops grown world-wide as a protein source for humans and animals nutrition in developing countries such Egypt. In addition, various plant parts have been widely used as animal food, because they are rich in protein. Faba bean (winter crop) is an important main green leguminous crop grown on different soil types of Egypt. So, it is important to maximize its yield with free pollutants product (clean product). In this respect, many attempts took place in the last years in order to avoid the harmful effects of chemical fertilizers by using organic, bio-fertilizers and other natural sources of nutrients (humic acid, rock phosphate, inoculants strains and bread yeast extract) alone or in combination to enhance faba bean yield and its growth parameters (Jensen *et al*., 2010; Hamouda, 2013 and Multari *et al*., 2015). Moreover, Mady (2009) found that the use of yeast extract foliar spray at 50 ml/l increased the final yield and seed quality of faba bean plants. Abbas (2013) reported that the inclusion of the foliar application of bread yeast extract (5 g/l) and humic acid (20 g/l) fertilization significantly increased the yield of faba bean plants.

Slow release fertilizers are excellent alternatives to the soluble ones. Since, theyrelease the nutrients at a slow rate throughout the season and the plants are able to take upmost of the nutrients without loss by leaching. Thus, a slow release fertilizer is more convenient, since less frequent application is required. Slow-N-release fertilizers have been largely used to improve fertilizer use efficiency, reduce fertilizer input, and improve crop yield and quality (Shoji *et al*., 2001 and Seddik *et al*., 2011).

Bahr *et al.* (2006) found that the urea-formaldehyde (UF) had a positive effect on yield and its components for two successive seasons (sunflower, safflower, sesame, canola and peanut). Also, the nitrogen consumption ability was much more efficientwith applying nitrogen as (UF) than as ammonium nitrate (Abbady *et al*., 2011). However, Hutchinson *et al.* (2002) found that polymer-coated urea significantly improved potato tuber yield compared to ammonium nitrate.

Rock Phosphate (RP) is a raw material contains phosphate minerals that transform to chemical-P fertilizers. It can be used as direct applied fertilizer in acidic soils because of RP effects on soil properties and apparent P recovery through the slow release of P to the soil as well asits low input cost (Sale and Mokwunye, 1993). In acidic soils, Zin *et al.* (2005) revealed that RP fertilizers were beneficial in increasing soil pH and CEC, because of their high contents of calcium (24-33 %) resulting in crop yield increases. Danso *et al*. (2010) noted that the direct effect of RP application was pronounced on soil nutrient dynamics, growth, development and yield of oil palm. The soil chemical properties were affected to varying degrees and soil nutrient levels were more pronounced by using RP than those by using triple super phosphate.

Therefore, the main objective of the present study is to evaluate the response of yield component and nutrient composition of Faba bean plants as well as soil properties to the soil applications of some combined fertilizers and natural mineral rock as well as the foliarspray of yeast extract.

2. MATERIALS AND METHODS

2.1. Site description: A field trial was carried out during the winter season of 2017/2018 at the experimental farm, Faculty of Agric., Al-Azahar Univ., Assuit, Egypt (Longitude: 31°09ˉ36.86⁼ E, latitude: 27°12ˉ16.67⁼ N, height: 600 m) locatedat 375 km south of Cairo. Climate of this area is characterized by very hot but non-humid summer and chilly coldwinter. The study aims to assess the complementary effects of combined fertilizers (Commercial bio-fertilizers "Phosphorine and Rhizobactrine", humic acid, natural mineral rock (RP) and urea formaldehyde (UF) 40% N as a slow release nitrogen fertilizer called "Ansuyaben") under the foliar application of yeast extract (10g/l) on improving growth and chemical constituents of faba bean (*Viciafaba* L., cv. Giza 843) plants and some chemical soil properties. Some physical and chemical properties of the investigated soil and rock phosphate were determined according to Page *et al.* (1982) and Klute (1986) and there are shown in Table (1).

Table (1): Some physical and chemical properties of the experimental soil and the rock phosphate.

Soil properties								
Particle Size (%)			**Texture grade**	**Saturation (%)**	**Field capacity (%)**	**Wilting point (%)**	**Bulk density (g/cm^3)**	**Particle density (g/cm^3)**
Sand	**Silt**	**Clay**						
55.20	**29.60**	**15.20**	**Silty loam**	**51.50**	**25.75**	**12.87**	**1.49**	**2.54**
C.E.C ($cmol_c\ kg^{-1}$)	**$CaCO_3$ (%)**	**O.M (%)**	**ECe (dSm^{-1}) (1:2.5)**	**pH Susp. (1:2.5)**	**Total N (%)**	**Ava-N (mg/kg)**	**Ava-P (mg/kg)**	**Ava-K (mg/kg)**
13.90	1.29	1.59	1.43	7.12	0.18	62.72	11.57	169.41
Rock phosphate properties								
E.C (dSm^{-1}) (1:5)	pH (1:2.5)	O.M (%)	Total micro elements ($mg\ kg^{-1}$)				Total macro elements (%)	
			Fe	Cu	Zn	Mn	N	P	K
2.92	6.36	----	2144	342	152	387	---	24.82	0.01

*Each value in this table is the mean of 3 replicates.

2.2. Design and treatments: The experimental design was laid out in a split plot in randomized complete blocks with two factors with three replications. Combined fertilizers were assigned to the main plot and yeast extracts were randomly assigned to the sub-plots, including 12 treatments. The soil was carefully prepared and divided into plots (3.5 m X 3 m = 10.5 m^2, 1/400 fed^{-1}) each included 6 rows 50 cm wide, two plants per hill and 20 cm between hills. Faba bean seeds were obtained from Food Legumes Department, Field Crop Research Institute, Agriculture Research Center, Giza, Egypt. Seeds were sown on both sides of the row on October 21*st* winter season of 2017/2018. Plants were thinned to two plants/ hill after 20 days from sowing. Rock phosphate was obtained from Super phosphate Factory, northwest of Assiut city. The used commercial bio-fertilizers known as "Phosphorine and Rhizobactrine" were obtained from Agricultural Research Center, Ministry of Agriculture, Giza, Egypt. Seeds were immersed in adhesive liquid (Arabicgum solution 15 %) prepared by dissolving 15 gm of Arabic gum in 100 ml water and then mixed thoroughly with the commercial bio-fertilizers at level of 10 g /kg faba bean seeds and left in the shade for 2 h before cultivation.Yeast extract was prepared from brewer’s yeast (*Saccharomyces cerevisiae*) which was dissolved in water followed by adding sugar at a ratio of 1:1 and kept 24 hours in a warm place for reproduction according to the methods of Morsi *et al.* (2008). Ureaform fertilizer (50 kg/fed) was added to the soil before sowing and humic acid was applied in a granular form. Combined fertilizers consisted of twelve fertilization treatments that were divided into two groups. The first group was without foliar applications of yeast extract and consisted of six treatments as follows

T_1 = Recommended dose (RD) of NPK minerals fertilizers (40 kg N, 100 kg P_2O_5 and 70 kg K_2O fed^{-1}) by the Ministry of Agriculture. Both ammonium nitrate (33.5 % N) and potassium sulphate (48 % K_2O) were applied intwo equal doses (after 20 and 40 days from sowing). While the all amount of superphosphate (15% P_2O_5) was added before sowing.

T_2 = Half the RD of P_2O_5 (95 kg RP fed^{-1}) + ½ RD of N (50 kg fed^{-1} ansuyaben) + Rhizobactrine.

T_3 = Half RD of P_2O_5 (95 kg RP fed^{-1}) + ½ RD of N(50 kg fed^{-1}ansuyaben) + Phosphorine.

T_4 = Half RD of P_2O_5 (95 kg RP fed^{-1}) + ¼ RD of N(50 kg fed^{-1}ansuyaben)+10 kg fed^{-1} Humic acid + Rhizobactrine.

T_5 = Half RD of P_2O_5 (95 kg RP fed^{-1}) + ¼ RD of N (25 kg fed^{-1}ansuyaben) + 10 kg fed^{-1} Humic acid + Phosphorine.

T_6 = Half RD of P_2O_5 (95 kg RP fed^{-1}) + ¼ RD of N (25 kg fed^{-1} ansuyaben) + 10 kg fed^{-1} Humic acid + Phosphorine + Rhizobactrine.

The second group consisted of the previous six treatments plus 10 g/l foliar application of yeast extractto each treatment.

2.3. Recorded Data: At full maturity phase, six selected guarded randomly plants from the middle three rows of each plot were harvested and air-dried to determine the following characteristics:

1. Growth measurements: Plant height (cm), No. of branch's/plant, Straw yield/plant (g), Seed yield/plant (g) and biological yield/plant (g).

2. Yield and yield components: 100-seed weight (g), Seed yield (ton/fed), Straw yield (ton /fed), Protein content (%) = (N-content, % X

6.25) and Protein Yield (kg/fed) = (Protein content % X seed yield, ton/fed X 10).

3. Seed NPK contents (%), seed NPK uptake, (kg/fed) = (nutrient NPK contents, (%) X seed yield (ton fed^{-1}) X 10).

4. Soil chemical analysis: Soil pH (1:2.5) and ECe, (Page *et al*., 1982), organic carbon (Chapman and Pratt, 1961), available N (Bremner and Mulvaney, 1982), available P (Olson and Sommers, 1982) and available K by flame photometry (Baruah and Barthakur, 1997).

2.4. Economic evaluation:was done by usingthe method described by CIMMYT (1988) to estimate the following parameters:

* Total costs of faba bean production
* Gross income = yield X price
* Net return = gross income - total production costs
* Benefit cost ratio BCR = gross income / total costs

All estimations were based on the official and actual market prices determined by Ministry of Agriculture and Agricultural Credit and Development Bank, Egypt.

2.5. Data analysis: The collected data were subjected to statistical analysis using analysis of variance technique and LSD at 5% level with M stat computer statistical software, following Gomez and Gomez (1984) Economic analysis was done.

3. RESULTS

3.1. Growth and yield of Faba Bean

Tables 2 and 3 show the effect of soil application of different combinations of fertilizers and yeast extract foliar spray on the growth, yield and quality of faba bean plants. The tested treatments had positive significant (*P<0.05*) effects on those parameters, plant height, number of branch, straw yield, seed yield and biological yield of faba bean plants treated with yeast extract being 5, 10, 9, 24 and 15%, respectively, higher than those of the yeast non-treated ones (Table, 2). The highest significant values of plant height, branch's number, straw yield, seed yield and biological yield of faba bean plants were recorded in T_6 treatment that foliar sprayed with yeast extract.

The 100-seeds weight, seed yield, straw yield, seed protein and protein yield of faba bean were significantly affected (*P<0.05*) by the different combinations of fertilizers and yeast extract spraying (Table, 3). The highest values of these respective parameters were recorded in T_6 treatment that sprayed with the yeast extract. The protein in seed and protein yield of faba bean sprayed with yeast extract were higher by 95 and 32%, respectively, than these of the untreated ones.The seed and straw yields of faba bean significantly varied among the tested treatments and ranged between 1.8 to 3.4 ton/fed and between 2.7 to 4.7 ton/fed, respectively.

Table (2): Effects of different combinations of fertilizers and yeast extract on foliar spray of some growth parameters of faba bean.

Yeast	Treatment	Plant height (cm)	No. of branch's /plant	Straw yield /plant (g)	Seed yield /plant (g)	Biological yield /plant (g)
With	T_1	117.67±2.44	3.39±0.03	41.34±0.85	27.90±0.19	69.24±0.72
	T_2	124.10±0.40	4.47±0.07	34.19±0.36	27.32±0.93	61.51±0.88
	T_3	132.83±1.72	4.65±0.98	49.64±0.79	30.63±0.11	80.27±0.68
	T_4	129.47±0.65	3.48±0.15	47.69±2.08	28.08±0.43	75.77±2.40
	T_5	138.47±2.95	3.83±0.50	54.45±0.30	37.88±3.66	92.33±3.36
	T_6	139.87±1.86	4.67±0.00	55.46±0.68	40.95±0.43	96.41±1.06
	Mean	130.4	4.08	47.13	32.13	79.26
Without	T_1	103.50±9.85	3.03±0.34	40.43±2.13	22.73±2.23	63.16±0.17
	T_2	121.30±1.93	3.39±0.06	32.09±3.85	21.90±1.63	53.98±2.25
	T_3	130.90±1.64	4.40±0.69	45.11±0.09	27.12±0.51	72.23±0.42
	T_4	126.00±2.72	3.33±0.00	44.58±0.41	23.16±0.37	67.74±0.04
	T_5	134.07±0.55	3.67±0.00	50.64±0.20	32.24±0.34	82.88±0.53
	T_6	126.10±1.20	4.43±0.19	47.50±0.18	27.71±0.65	75.21±0.48
	Mean	123.65	3.71	43.39	25.81	69.20
F_{test}		**	*	**	**	**
$LSD_{treatments}$		15	1.20	5.2	4.2	15

Table (3): Effects of different combinations fertilizers and foliar spray yeast extract on the quality and yield of faba bean.

Yeast	Treatment	100-seeds weight (g)	Seed yield (ton/fed)	Straw yield (ton/fed)	Seed protein (%)	Protein yield (kg fed^{-1})
With	T_1	83.67±0.97	2.343±0.02	3.473±0.07	26.32±0.47	616.80±13.83
	T_2	82.11±0.65	2.295±0.08	2.872±0.03	25.48±0.50	584.96±31.48
	T_3	87.65±0.70	2.573±0.01	4.170±0.07	24.89±0.21	640.24±4.13
	T_4	86.32±0.50	2.359±0.04	4.006±0.17	29.61±0.38	698.31±1.64
	T_5	93.09±1.75	3.182±0.31	4.574±0.03	28.84±0.26	918.28±96.88
	T_6	97.45±0.70	3.440±0.04	4.659±0.06	29.86±0.60	1027.07±26.78
	Mean	88.38	2.70	3.96	27.50	747.61
Without	T_1	77.71±1.20	1.909±0.19	3.396±0.18	25.34±0.37	484.11±52.39
	T_2	76.59±1.23	1.839±0.14	2.695±0.32	24.40±0.47	449.11±42.23
	T_3	82.09±0.51	2.278±0.04	3.789±0.01	23.87±0.22	543.75±9.82
	T_4	80.72±0.48	1.945±0.03	3.745±0.03	27.82±0.36	533.21±18.64
	T_5	88.23±2.04	2.709±0.03	4.254±0.02	27.37±0.40	741.30±9.37
	T_6	85.35±0.57	2.327±0.05	3.990±0.02	27.86±0.98	648.77±37.42
	Mean	81.78	2.17	3.64	26.11	566.71
F_{test}		**	*	**	**	**
$LSD_{treatments}$		10	1.30	1.20	2.7	220

The highest values of the seed and straw yields were recorded in T_6 treated with foliar sprayed with yeast extract. The lowest value was obtained from T_2 treatment without yeast spraying. The seed and straw yields of faba bean plants in T_6 treatment that sprayed with yeast extract were 111 and 72%, respectively, higher than those of the faba bean plants in T_2 treatment without yeast spraying. The total protein yield significantly varied among the tested treatments and ranged between 449 to1027 kg fed^{-1} (Table, 3). The highest significant value of the total protein yield was recorded for faba bean plants in T_6 treatment and yeast spraying while the lowest one was in T_2 treatment without yeast spraying. The total protein yield of faba bean plants in T_6 treatment and sprayed with yeast extract was 129% higher than that of the faba bean plants in T_2 treatment without yeast spraying.

3.2. N, P and K uptakes by Faba Bean

The effect of different combinations of fertilizers and the foliar spray of yeast extract on the uptakes of nitrogen, phosphorus and potassium by faba bean plants are presented in (Table, 4). The tested treatments had positive significant (P<0.05) effects on NPK content. The highest values of N, P and K content and uptake by faba bean plants were recorded in T_6 treatment that sprayed with yeast extract. The uptakes of N, P and K by faba bean plants sprayed with yeast extract were 32, 56 and 27%, respectively, higher than those of non-treated ones.

The highest uptake values of N, P and K were recorded in T_6 treatment that sprayed with yeast while the lowest one were obtained for T_2 treatment without yeast spraying. The uptake of N, P, and K in T_6 treatment that sprayed with yeast extract increased by 128, 160 and 103%, respectively, above those in T_2 treatment without yeast spraying.

3.3. Soil Chemical Characteristics and Available N, P and K

The effects of the combination of different fertilizers on the soil pH and organic carbon as well as available N, P and K are illustrated in (Figs. 1, 2, 3, 4 and 5) respectively. The tested treatments had positive significant (P<0.05) effects on those parameters.

The treatments which contained humic acid reduced the soil pH and increased the soil organic matter compared to the other treatments (Figs. 1 and 2). The highest values of available N, P and K were recorded in the plot received humic acid (Figs. 3, 4 and 5). The soil pH was reduced by 6.6% while the soil organic carbon was increased by 30% in T_6 treatment compared to T_1 one. The available N, P and K in T_6 treatment increased by 120, 97, and 32%, respectively, above those in T_1 treatment (Figs. 3, 4 and 5).

Table (4): Effects of different fertilizer combinations and yeast extract spray on N, P, K content and uptake by faba bean seeds.

Yeast	Treatment	N content (%)	N uptake (kg fed^{-1})	P content (%)	P uptake (kg fed^{-1})	K content (%)	K uptake (kg fed^{-1})
With	T_1	4.21±0.08	98.69±2.21	0.29±0.00	6.71±0.05	1.68±0.05	39.27±0.96
	T_2	4.08±0.08	93.59±5.04	0.28±0.01	6.42±0.37	1.65±0.02	37.85±0.88
	T_3	3.98±0.03	102.44±0.66	0.30±0.00	7.67±0.08	1.78±0.01	45.67±0.47
	T_4	4.74±0.06	111.73±0.26	0.29±0.01	6.64±0.03	1.81±0.02	42.58±0.42
	T_5	4.61±0.04	146.92±15.50	0.31±0.01	9.41±0.93	1.79±0.00	56.91±5.56
	T_6	4.78±0.10	164.33±4.29	0.32±0.01	10.39±0.23	1.80±0.01	61.83±0.58
	Mean	4.40	119.62	0.30	7.87	1.75	47.35
Without	T_1	4.05±0.06	77.46±8.38	0.23±0.00	4.38±0.46	1.65±0.04	31.51±2.73
	T_2	3.90±0.08	71.86±6.76	0.22±0.00	4.08±0.29	1.64±0.01	30.09±2.03
	T_3	3.82±0.03	87.00±1.57	0.24±0.00	5.32±0.14	1.72±0.00	39.16±0.80
	T_4	4.45±0.06	86.61±2.41	0.23±0.00	4.37±0.10	1.75±0.01	34.10±0.83
	T_5	4.38±0.06	118.61±1.50	0.25±0.01	6.39±0.03	1.73±0.01	46.88±0.37
	T_6	4.46±0.16	103.80±5.99	0.26±0.01	5.66±0.16	1.74±0.01	40.48±0.79
	Mean	4.18	90.89	0.24	5.03	1.71	37.04
F_{test}		**	*	**	**	**	**
$LSD_{treatments}$		0.52	25	0.20	2.0	ns	7.5

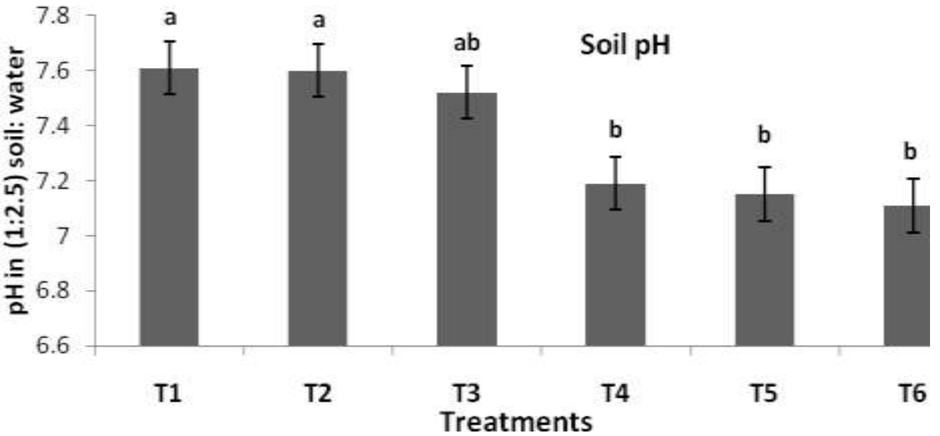

Fig. (1): Effects of different combinations of fertilizers and yeast extract foliar spray on faba bean plants on soil pH.

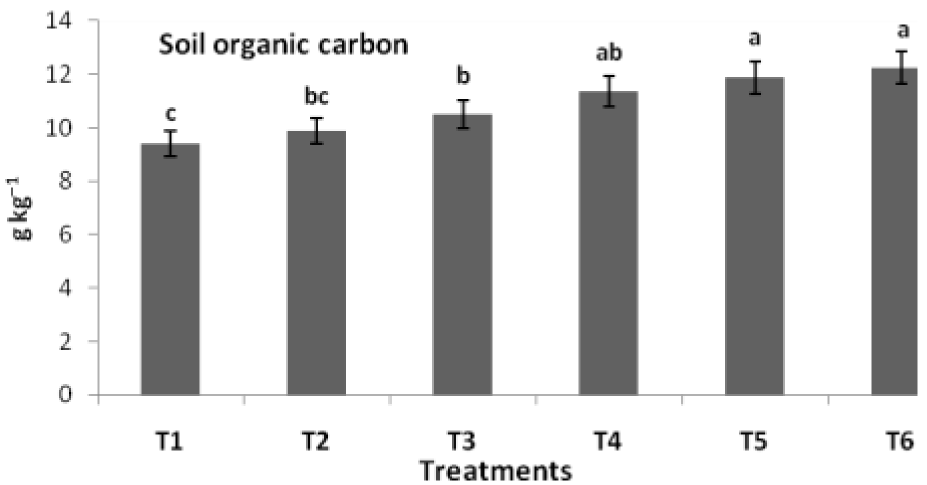

Fig. (2): Effects of different combinations of fertilizers and yeast extract spray on faba bean plants on soil organic carbon.

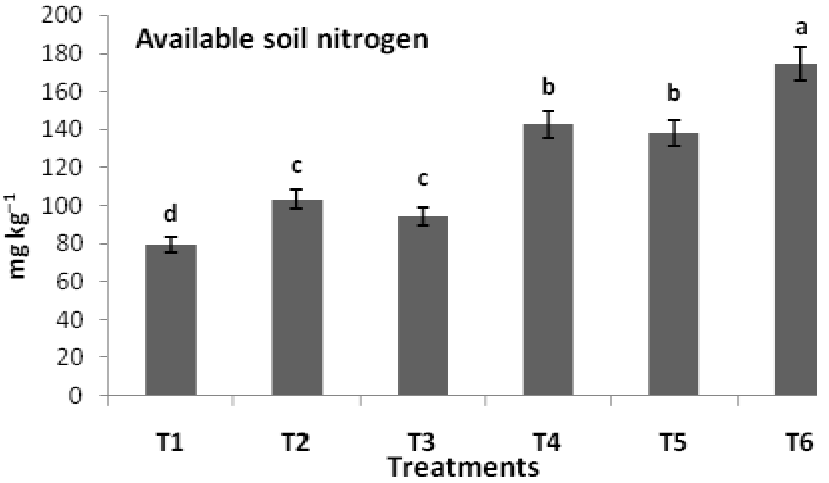

Fig. (3): Effects of different combinations of fertilizers and spraying faba bean plants with yeast extract on the soil available soil nitrogen.

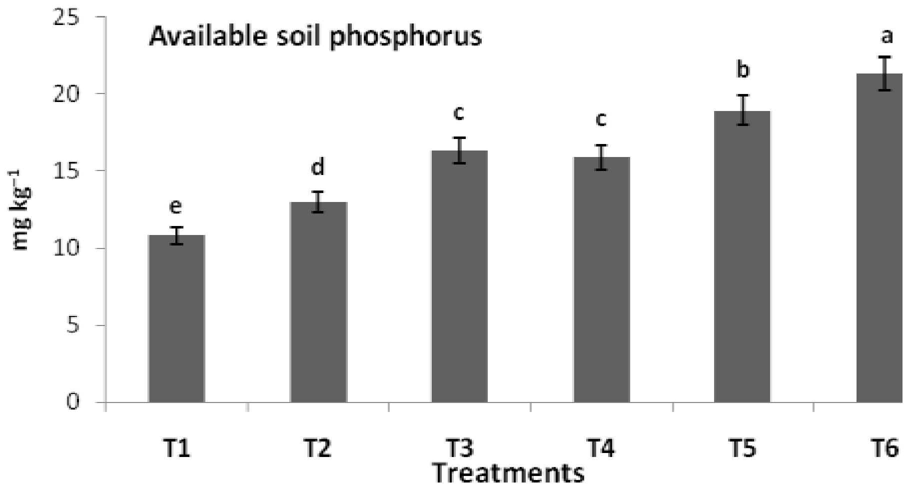

Fig. (4): Effects of different combinations of fertilizers and spraying faba bean plants with yeast extract on the soil available soil phosphorus.

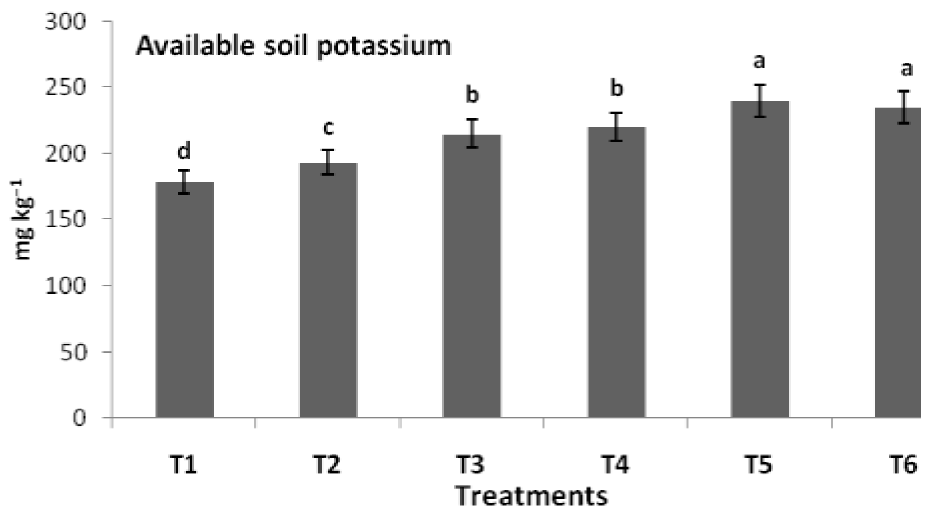

Fig. (5): Effects of different combinations of fertilizers and yeast extract spray on faba bean plants on available soil potassium.

3.4. Economic Return

The net return, gross income and the total cost of faba bean plants were significantly ($P<0.05$) affected by the combinations of different fertilizers and spraying the yeast extract (Table 5). The highest significant net return values were found for faba bean plants in T_6 treatment sprayed with yeast extract. However, the lowest significant ones were obtained for the plants in T_2 treatment without yeast spraying. Spraying yeast extract on plants of T_6 treatment increased the net return by 104% compared to that of T_2 treatment without yeast extract spraying. The use of yeast, rhizobactrine, phosphorine and humic acid in T_6 treatment increased the gross income by 84% compared to that of T_2 treatment without yeast spraying. The net return ranged between 471 to 963 $/fed and the highest significant values were recorded in the case of T_6 with the plants sprayed with yeast extract on the other hand, the lowest ones were recorded in case of T_2 without spraying yeast extract. The gross income ranged from 628 to 1156 $/fed and the highest significant values were obtained in case of T_6 treatment with spraying yeast extract. The lowest one was found in case of T_2 treatment without spraying yeast extract. The use of yeast extract reduced the total cost by only 3% and increased the gross income and net return by 21 and 26%, respectively, compared to the unsprayed plants.

4. DISCUSSION

The current study clearly showed that the foliar application of faba bean plants with yeast extract increased the growth, nutrient uptake, quality and yield. Bread yeast extract (*Saccharomyces cervicisae*, L.) is one of the bio-fertilizers used for many crops (Twfig, 2010 and Ahmed *et al*., 2011). It activates many physiological processes in plants such as photosynthesis through enhancing CO_2 release (Kahlel, 2015; Taha *et al*., 2016). In addition, it contains some natural growth regulators such as auxins (Barnett *et al*., 2000), as well as it increases the uptake of various nutrients, i.e. N, P and K and some common amino acids (Khafagy *et al*., 2010). Yeast as a natural source of cytokinins stimulates cell division and enlargement as well as the synthesis of protein, nucleic acid and chlorophyll (Fathy and Farid, 1996). It's used as a kind of bio-fertilizers that foliar applied on the shoots of vegetable crops (El-Ghamriny *et al.*, 1999). Moreover, Gomaa *et al.* (2005) reported that inclusion the foliar application of yeast to the organic fertilization significantly increased potato yield in comparison with either the positive control or the corresponding treatment is on the same line with those obtained by Kahlel (2015) and Taha *et al*., (2016).

The other factor which increased the quality and yield of faba bean in the current study was the bio-fertilization (phosphorine and

Table (5): Economics return of faba bean plants induced by different fertilization combinations and yeast extract foliar spray.

Yeast	Treatment	Total costs ($)	Gross income ($/fed)	Net return ($ fed)
With	T_1	207	802	595
	T_2	164	760	596
	T_3	163	898	735
	T_4	193	832	639
	T_5	193	1082	890
	T_6	193	1156	963
	Mean	185	922	736
Without	T_1	200	681	481
	T_2	157	628	471
	T_3	157	800	643
	T_4	187	707	521
	T_5	186	939	753
	T_6	187	823	636
	Mean	179	763	584
F_{test}		*	**	**
$LSD_{treatments}$		30	200	120

Fed (Feddan) = 4200 m^2. Net return = Gross income- Total costs rhizobactrine). The bio-fertilization with both phosphorine and rhizobactrine enhanced the growth and yield of faba bean plants. Bio-fertilizers have been used in crop production for decades (Zaki *et al*., 2012 and Youssef, 2016). The main functions of these microbes are (1) to supply nutrients to crops, (2) to stimulate plant growth, *e.g.*, through the production of plant hormones, (3) to control or inhibit the activity of plant pathogens, (4) to improve soil structure, and (5) to increase bioaccumulation or microbial leaching of in organics (Brierley, 1985 and Ehrlich, 1990). The increases in vegetative growth might be due to the increases in the soil microbial flora whichoccur by bio-fertilization (Zaki *et al*., 2012). Using bio-fertilizers that contain different microbial strains has led to decrease the use of chemical fertilizers and provided high quality products free of harmful agrochemicals and safety for human consumption (El Naim *et al*., 2017). Furthermore, the application of bio-fertilizers also supports the conditions of root growth, increase the growth of the above ground parts and finally improve the biological functions of the plant (Youssef, 2016; Youssef and Eissa, 2017 and Mona and Camilia, 2018).

Humic acid maximized the availability of N, P and K and reduced the soil pH. Organic matter in humic acid plays a critical role in soil ecosystem because it provides substrates for decomposing microbes, improves soil structure and water holding capacity (Abiven *et al.*, 2009). Eissa (2014) reported similar results for the effect of organic amendments on N, P and K uptake and availability. Soil organic matter is the principal indigenous source for soil available nitrogen (N), as well as it contains about 65% of the total soil phosphorus (P) and provides significant amounts of sulfur (S) and other nutrients that are essential for plant growth (Bauer and Black, 1994). El-Ghamry *et al.* (2005) found that the application of compost to the soil significantly increased the available N, P and K compared to the control. Ahmed *et al*. (2011) found that the application of organic fertilizers significantly increased available P in each cropping season compared to the control. The decrease in soil pH due to the organic amendment treatments might be resulted from the release of organic acids and carbon dioxide (CO_2) into the soil during the decomposition of the organic materials (Eissa, 2014).

Conclusion

It might be concluded that the foliar application of yeast extract increased the nutrient uptakes, growth and yield of faba bean plants. The maximum yield and economic return were obtained from T_6 treatment (½ recommended dose of P + ¼ recommended dose of N+ 10 kg fed^{-1} humic acid + phosphorine + rhizobactrine) with yeast spraying. The application of humic acid and inoculation with phosphorine and rhizobactrine decreased the soil pH and increased the soil organic carbon and the available of N, P and K. The yeast extract, humic acid and bio-fertilizer inoculation increased the economic return and reduced the production cost of faba bean. The application of these materials saved 75 and 50 % of nitrogen and phosphorus requirements, respectively.

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تأثيرات الإضافة الأرضية للأسمدة المختلفة والرش الورقي بمستخلص الخميرة على نمو نبات الفول البلدي

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ملخص

نظراً لزيادة الحاجة إلى الإنتاج الغذائي أدي ذلك إلي زيادة استخدام التسميد المعدني مما تسبب عنه حدوث تأثيرات سلبية على التربة والنظام البيئي. تم إجراء تجربة حقلية وذلك للتحقق من استجابة نبات الفول البلدي لبعض مخاليط المعادن الطبيعية مع حمض الهيوميك والأسمدة الحيوية بدون أو مع الإضافة الورقية لمستخلص الخميرة، وكان من أهم النتائج المتحصل عليها ما يلي :- أدي استخدام مستخلص الخميرة بمعدل (10جرام/ لتر) إلى زيادة معنوية في صفات نمو وإنتاجية نبات الفول البلدي. كما زاد معدل امتصاص كلاً من النيتروجين والفوسفور والبوتاسيوم بنسبة (32، 56 و27 % على التوالي) مقارنة بالكنترول. من ناحية أخرى أدي استخدام حمض الهيوميك مع التلقيح بالأسمدة الحيوية، الفوسفورين والريزبكتيرين إلى انخفاض في رقم حموضة التربة وزيادة الكربون العضوي، كما زاد من توفرعناصر النيتروجين والفوسفور والبوتاسيوم الميسرة بالتربة. يمكن أن نستخلص مما سبق أن أستخدام خليط من حمض الهيوميك والأسمدة الحيوية مع رش مستخلص الخميرة أدى إلى زيادة العائد الأقتصادي من المحصول نتيجة لزيادة وتحسين جودة محصول نبات الفول البلدي. علاوة على خفض تكلفة الإنتاج باستخدام هذه التوليفة وأيضاً وفر ما يقرب من 50- 70% من احتياجات النبات لعنصري النيتروجين والفوسفور على التوالي .

المجلة العلمية لكلية الزراعة – جامعة القاهرة – المجلد (70) العدد الرابع (أكتوبر 2019):461-472.