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Influence of Application Methods of Bio-Fertilization on Vegetative Growth, Seed Yield and Chemical Composition of Fenugreek Plants

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THE FIELD work was carried out at the experimental farm "Demo" in faculty of Agriculture, Fayoum University, during two successive seasons of 2013/2014 and 2014/2015. The aim was to investigate the effect of foliar, ground application (soil drenching) and both the two methods using (0, 5, 10 and 15g/l) of bio-fertilization with yeast (*Saccharomyces cerevisiae*) on the growth, yield and chemical constituents of Fenugreek plants. The results assured that Fenugreek plants highly reacted positively and significantly to different methods of bio-fertilization with active dry yeast either by spraying or soil drenching or using both together. Using the highest concentrations (10 and 15 g/l) of yeast by spraying or soil drenching, as individually, or applying them together as interaction proved to have the leadership in enhancing and increasing all vegetative growth characters, plant height, branches number plant^{-1}, fresh and dry weight plant^{-1}, seed yield and its contents of mucilage (%), trigonelline, protein and chemical composition of Fenugreek plants, chlorophyll a, b, carotenoids' contents and total carbohydrates content.

Fenugreek plants should be sprayed and drenched at a concentration of 10 and 15 g/l of yeast. Moreover, active dry yeast should be more mechanized and used in agriculture as a harmless bio-fertilizer with a marvellous ability in increasing seed yield and chemical constituents.

Keywords: Bio-fertilization, Fenugreek (*Trigonella foenum-graecum* L.), Active dry yeast (*Saccharomyces cerevisiae*), Mucilage and Trigonelline.

Fenugreek (*Trigonella foenum-graecum*) belongs to family (Fabaceae) that grows annually, and is widely cultivated in the Mediterranean countries and Asia. The dried seeds have been traditionally used in Egypt, India, China and in some parts of the Europe for their beneficial health effects such as galactogouge, antibacterial, anti-inflammatory, insulinotropic, and rejuvenating properties (Im and Maliakel 2008). Pleasantly bitter and slightly sweet fenugreek seeds, which are available in whole and ground forms, are used as a source of flavoring for foods including curry powders, spice blends and teas. The seeds have horny and relatively large layer of white and semi-transparent endosperm encircling central hard, yellow

embryo (Betty 2008). Wonderful functional and medicinal values of fenugreek are attributed to its chemical composition (20-25% protein, 45-50% dietary fiber, 20-25% mucilaginous soluble fiber, 6-8% fixed fatty acids and essential oils, and 2-5% steroidal saponins. Moreover, some minor components such as alkaloids (trigonolline, cholin, gentianine, carpaine, etc.), free unnatural amino acids (4-hydroxyisoleucine), and individual spirostanols and furastanols like diosgenin, gitogenin and yamogenin have also been identified and determined as the main components for its various biological effects (Trivedi *et al.*, 2007).

Bio fertilization of horticulture crops had drawn the attention of research workers and had become in the last decades a positive alternative to chemical fertilizers. Bio fertilizers are reasonably safer to the environment compared to chemical fertilizers. It is very important for medicinal and aromatic plants to produce the best product in both quantity and quality.

Active dry yeast (ADY), a natural biofertilizer, is safety and causes various promoted effects on plants and is a natural source of cytokinins which simulates cell division and enlargement as well as the synthesis of protein, nucleic acid and B-vitamin (Ezz El-Din and Hendawy, 2010). Aactive dry yeast releases Co_2 which reflected in improving net photosynthesis (Kurtzman and Fell, 2005). In addition, Yeast is a natural source of most nutritional elements (Na, Ca, Fe, K, P, S, Zn and Si) (Nagodawithana, 1991). Active dry yeast contains dry matter of 9.3%, protein 47.2%, arginine 2.6%, glycine2.6%, histidine 1.4% isolaysine 2.9%, lauicine 3.5%, hysine 3.8%, methionine cystine 0.6%, phenyl-alanine 3%, tyrosine 2.1%, threonine 2.6%, tryptophan 0.5% and vitamin B 2.9% (N.R.P., 1977). Yeast as well has tryptophan which is considered a precursor of IAA, so it increases size of fruit (Warring and Phillips, 1973 and Moor, 1979). Furthermore, cytokinins are one of yeast's important components which delay the aging of leaves by the way of retardation the degradation of chlorophyll and enhancing the synthesis of proteins and RNA. In soil solution to form low solubility substances called phosphate fixation. This is dominating with high soil pH and greater percentage of calcium carbonate. Soil microorganisms which convert the insoluble form of phosphorus to soluble one play an important role in supplying the plants with available phosphorus (Ahmed *et al.*, 1997).

El-Naggar *et al.* (2015) stated that the highest values of vegetative growth (plant height, number of branches, leaves numbers, leaf area and leaves dry weight) and total chlorophyll content were obtained by adding active dry yeast (ADY) at 6.0 g/L on *Ocimum basilicum* L.

Salman (2004), on *Ocimum basilicum*, found that inoculation of active dry yeast at 150 ml /plant alone increased number of branches, fresh weight /plant and per feddan, leaf area and herb, leaves and stems dry weight /plant, total carbohydrates content and chlorophyll "a" compared with the control.

Abd El-Azim and Abd El-Gawad (2008) concluded that using combinations of yeast applied as soil drench plus foliar spraying methods gave the best yield of *Thymus vulgaris*, L.

This investigation aimed to study the effect of bio-fertilization with yeast (*Saccharomyces cerevisiae*) applied as soil drench, and/or foliar spraying methods on the vegetative growth, seed yield and chemical composition of Fenugreek (*Trigonella foenum-graecum* L.) plants as individual and interaction effect.

Materials and Methods

The present investigation was carried out at the experimental farm "Demo" in Faculty of Agriculture, Fayoum University, during two successive seasons 2013/2014 and 2014/2015.

Seeds of Fenugreek were obtained from Medicinal and Aromatic Plants Research Department, Hort. Res. Inst., ARC, Ministry of Agriculture, Egypt. Seeds were threading on 17th and 18th of Oct. (for two seasons, respectively) and sown on one side of the ridge in sandy soil.

The layout of the experiment used was "factorial experimental" in complete randomized block design system with three replicates. Each replicate contained 3 plots, each plot contained four rows. The plot area was 2× 3 m and each row was 50 cm apart and 3m in length. All the plants received the recommended agriculture practices.

Active dry yeast was applied as foliar application and soil drench at 0, 5, 10 and 15g/l. These applications were used three times /season. The first one was added after 50 days from sowing, followed by the second and the third ones after 3 and 6 weeks from the first one, respectively. Later the solution was previously prepared by dissolving the active dry yeast from the above mentioned treatments in 2% of sugar solution (known weight 20 g sugar in 1 L of water), then leaving them for 7-8 hours allowing the yeast to propagate, then the volume was completed with water according to the concentration used.

The mechanical and chemical analysis of soil Table 1 used was carried out according to Klute (1986) and Page *et al.* (1982).

Data recorded

Vegetative growth

At the age of 160 days (during vegetative stage), the outer two rows (1st and 4th) of each plot were chosen from each experimental unit and cut off at ground level and submitted to the following determinations:

Plant height (cm), number of branches plant^{-1}, fresh and dry weights plant^{-1} (g), root weight plant^{-1} (g), root length (cm) plant^{-1}

Yield characters and chemical constituents of fenugreek seeds

At full maturity fruit stage (190 days), the central ridges were chosen from each experimental unit, to estimate the following yield characters:
Number of pods plant^{-1}, seed yield plant^{-1} (g), seed yield feddan^{-1} (kg), mucilage content (%) in seeds powdered dry matter according to (Sabale *et al*., 2009), content of seed trigonelline (mg.g^{-1} DW) according to (Zheng and Ashihara 2004) and seed protein content (g.g^{-1} DW) according to (Jani *et al*., 2009)

TABLE 1. Some mechanical and chemical analysis of used soil samples obtained from the experimental locations of Demo.

Years	Mechanical analysis			
	Sand %	Silt %	Clay %	Texture class
2013/2014	78.29	14.93	9.81	Sandy loam
2014/2015	77.97	15.95	8.68	Sandy loam

Years	Available nutrients (mg/kg)									
	Soil pH	ECe	N	P	K	Fe	Mn	Zn	Mg	$CaCo_3$ %
2013/2014	7.81	3.71	17.53	9.77	1.67	2.27	4.83	0.33	8.77	10.31
2014/2015	7.83	3.73	18.67	8.81	1.60	2.25	5.91	0.35	8.71	9.91

Chemical analysis of fenugreek plants

Fresh leaves at the age of 160 days, chlorophyll a, b and carotenoids contents were determined according to (Arnon 1949) and total carbohydrates content (%) in powdered dry matter of herb determined color-metrically according to (Herbert *et al*. 1971).

Statistical analysis

Results were statistically analysis using the LSD at probability level of 5% for comparison (Gomez and Gomez 1983).

Results and Discussion

Vegetative growth characters

Effect of bio-fertilization with yeast applied as foliar application spraying

Data presented in Table 2 show that spraying Fenugreek plants with active dry yeast caused a gradual significant increase in plant height, number of branches plant$^{-1,}$ fresh and dry weights plant^{-1}, leaf area plant^{-1} and leaves number plant^{-1} namely, the more concentration increased the values of these parameters

were obtained. Treating the plants with 15 g/l concentration was the most effective treatment in this respect as it gave the highest results in both seasons. The approximate increase mean in plant height, the number of branches plant^{-1}, fresh and dry weights plant^{-1}, leaf area plant^{-1} and leaves number plant^{-1} for this treatment in comparison with control was 37, 26, 26, 44.5, 71 and 43.5% in both seasons, respectively.

Differences between values of all vegetative growth characters treatments are significant in both seasons except for branches number which was insignificant in the first and second season.

The elongation and improving of plant height, increase in the number of leaves and increment of leaf area may be due to the role of (ADY) fertilizers by enhancing the cell division rate and cell enlargement (Shalaby and El- Nady, 2008 and Khedr & Farid, 2000) as yeast contains cytokinins that improving the accumulation of soluble metabolites (Muller and Leopold 1966) and also stimulate cell proliferation and differentiation, controlling shoot and root morphogenesis and chloroplast maturation (Amer, 2004). In addition, these results may be also due to the physiological roles of vitamins and amino acids in the yeast extract, as stated by Armanious, (1987), which increased the metabolic processes role and levels of indogenous hormones, i.e., IAA and GA_3 (Chaliakhyan, 1957). Moreover, the fermentation process that occurred in the presence of dry yeast produces Co_2 in high quantity, a factor that may increase photosynthesis and consequently plant growth, the high content of dry yeast from vit. B_5 and minerals might play a considerable role in orientation and translocation of metabolites from leaves into the productive organs (Mohamed *et al.*, 1999).

These results are in agreement with (Jacoub, 1999) on *Ocimum basilicum* and *Thymus vulgaris*, (Naga, 2004) on Fennel plants, (Abou-Dahab *et al.*, 2009) on Lovage plants, (Moghadam *et al.*, 2012) on *Lilium Asiatic*, (Khaled *et al.*, 2014) on Majoram plant, (Alves *et al.*, 2005) on *Coriandrum sativum*, (Carmen *et al.*, 2006) on *Ocimum basilicum*, (Heikal, 2005) on *Thymus vulgaris* and (Mady, 2009) on Marjoram and Sage.

Effect of bio-fertilization with yeast applied as soil drench

Shown results in Table 2 state that using high concentrations of yeast (10 and 15 g/l) gave a remarkable increase in all vegetative growth characters *i.e.*, plant height, number of branches plant^{-1}, fresh and dry weight plant^{-1}, leaf area plant^{-1} (cm^2) and leaves number plant^{-1}, in both seasons with significant differences between values except for results of dry weight plant^{-1} which reveal a little bit insignificant differences. The obtained values of this treatment in all parameters increase than the control with 18.5, 49.5, 33.5, 10.5, 33 and 21% as a mean in both seasons, respectively.

The given results are close to those declared by (Salman 2004) on *Ocimum basilicum*.

Effect of the interaction between application spraying and soil drench

As indicated in Table 2, spraying the plants and drenching the soil using the highest concentrations (15 g/L) for both treatments has the big share in achieving the optimum significant values concerning fresh and dry weight plant^{-1}, leaves number plant^{-1} and also the highest but insignificant records for leaf area plant^{-1} in both seasons. While, spraying with 15 g/L plus soil drenching at 10 g/L led significantly to obtain the highest plant height plant^{-1} and branches number plant^{-1} in both seasons.

The approximate increase mean in plant height, number of branches plant^{-1}, fresh and dry weight plant^{-1}, leaf area plant^{-1} and leaves number plant^{-1} for this treatments were 64, 135.5, 143.5, 146.5, 128.5 and 122.5% as a mean in both seasons, respectively than the control. These results are correspondent to those obtained by (Ahmed 2002) on *Leucaena leucocephala*.

Yield characters and chemical constituents of fenugreek seeds

Effect of bio-fertilization with yeast applied as foliar application spraying

Table 3 also, reveals that the use of the highest concentration of active dry yeast (15 g/l) recorded significantly the highest values of pods number plant^{-1}, seed weight plant^{-1}, seed yield feddan^{-1} and seed content of mucilage, trigonelline and protein, in both seasons. Such a treatment gave an increase the means of seed yield 79% in both seasons, respectively compared to the control.

In this concern Haridi (1987) working on *Salvia officinalis* concluded that the positive effect of active dry yeast may be attributed to its components as cytokinine and vit-B which are active in improving the growth and productivity.

These results are in line with those obtained by Ahmed *et al.* (1998) on *Hibiscus sabdariffa* and Ahmed *et al.* (2001) on *Ambrosia maritime*.

Effect of bio-fertilization with yeast applied as soil drench

It is clarified from Table 3 that drenching with the highest concentration of active dry yeast (10 and 15 g/l), resulted significantly in attaining the highest records of pods number plant^{-1}, seeds weight plant^{-1} (g), seeds yield feddan^{-1} (kg) and seeds mucilage (%) trigonelline and protein content in both seasons. The increase of seed yield occurred by applying this treatment was 58.5% than the control in both seasons.

Effect of the interaction between application spraying and soil drench

The interaction between spraying at 15 g/l and soil drenching at 10 g/L of active dry yeast was the best treatment for obtaining the highest records of seeds weight plant^{-1} and seeds yield feddan^{-1}, as revealed in Table 3. Such a treatment gave an increase of 111.5% in both seasons, respectively compared to the control treatment. As well as, the highest concentration of yeast (15 g/L) together either in spraying or in drenching resulted in giving the highest significant results regarding pods number plant^{-1} and seeds mucilage (%), trigonelline and protein content in both seasons. These given results are in harmony with those found by (Abd El-Azim and Abd El-Gawad 2008) on *Thymus vulgaris*.

TABLE 2. Effect of bio-fertilization with yeast applied as foliar application spraying, soil drench methods and their interaction on the vegetative growth characters of fenugreek plants.

Spraying(a) / Drenching(b)	1st season (2013\2014)					2nd season (2014\2015)				
	Plant height plant^{-1} (cm)									
	0 g/L	5 g/L	10 g/L	15 g/L	Mean	0 g/L	5 g/L	10 g/L	15 g/L	Mean
0 g/L	27.10	31.78	41.48	34.16	33.63	30.26	34.93	35.12	32.16	33.12
5 g/L	29.41	35.34	40.33	45.45	37.63	26.66	39.15	37.15	44.46	36.86
10 g/L	31.28	38.82	36.33	46.65	38.27	34.26	40.96	35.72	47.23	39.54
15 g/L	32.16	31.60	44.77	40.41	37.24	33.91	33.88	43.38	45.42	39.15
Mean	29.99	34.39	40.73	41.67		31.27	37.23	37.84	42.32	
L.S.D 5%	(a)= 3.11	(b) = 3.11	(axb)=6.21			(a)= 3.41	(b) = 3.41	(axb)=6.81		
Number of branches plant^{-1}										
0 g/L	2.33	5.00	2.00	4.33	3.42	2.69	4.14	3.08	4.67	3.65
5 g/L	4.67	3.33	5.00	4.00	4.25	4.45	3.78	6.07	5.08	4.85
10 g/L	5.33	4.33	5.00	5.67	5.08	5.72	4.72	5.34	6.12	5.48
15 g/L	4.00	4.33	5.33	5.33	4.75	3.13	4.69	5.74	5.81	4.84
Mean	4.08	4.25	4.33	4.83		4.00	4.33	5.06	5.42	
L.S.D 5%	(a)= n.s.	(b) = 0.51	(axb)=1.11			(a)= n.s.	(b) =0.51	(axb)=1.01		
Fresh weight plant^{-1} (g)										
0 g/L	13.10	15.43	23.94	22.41	18.72	18.83	18.62	29.94	19.88	21.82
5 g/L	23.42	23.64	20.19	26.18	23.36	24.48	23.38	22.07	30.41	25.09
10 g/L	27.61	24.99	22.63	26.01	25.31	26.11	28.86	21.22	31.24	26.86
15 g/L	23.41	23.55	23.75	33.94	26.16	23.42	25.5	24.61	37.72	27.81
Mean	21.89	21.90	22.63	27.14		23.21	24.09	24.46	29.81	
L.S.D 5%	(a)= 1.60	(b)= 1.60	(axb)=3.10			(a)= 2.10	(b)=2.10	(axb)=4.10		
Dry weight plant^{-1} (g)										
0 g/L	5.03	9.59	13.65	9.09	9.34	6.28	11.96	13.83	10.02	10.52
5 g/L	10.97	8.83	7.40	12.21	9.85	9.88	11.62	12.18	12.86	11.64
10 g/L	6.53	11.25	10.17	12.62	10.14	12.79	11.54	9.17	13.45	11.74
15 g/L	7.49	8.50	9.98	13.19	9.79	9.56	10.45	11.98	14.51	11.63
Mean	7.51	9.54	10.30	11.78		9.63	11.39	11.79	12.71	
L.S.D 5%	(a)= 0.80	(b)= n.s.	(axb)= 1.60			(a)= 1.70	(b)= n.s.	(axb)= 3.30		
leaf area plant^{-1} (cm)^2										
0 g/L	3.96	4.5	4.61	7.36	5.11	3.35	4.14	6.77	6.62	5.22
5 g/L	3.91	4.14	6.50	7.49	5.51	4.14	6.16	6.37	7.29	5.99
10 g/L	5.36	6.79	7.61	7.40	6.79	4.36	5.64	5.09	7.06	5.54
15 g/L	5.57	7.08	7.25	8.40	7.08	4.59	6.77	6.93	8.20	6.62
Mean	4.70	5.63	6.49	7.66		4.11	5.68	6.29	7.29	
L.S.D 5%	(a)= 1.06	(b)= 1.06	(axb)= n.s.			(a)= 1.04	(b)= 1.04	(axb)= n.s.		
Leaves number plant^{-1}										
0 g/L	42.41	52.11	54.16	65.87	53.64	38.74	46.96	52.47	63.92	50.52
5 g/L	43.25	53.46	53.22	64.16	53.52	48.08	51.90	47.92	67.30	53.80
10 g/L	51.24	57.95	62.81	63.81	58.95	46.29	57.20	57.84	63.52	56.21
15 g/L	47.19	55.49	57.57	85.14	61.35	45.87	57.7	59.76	94.95	64.57
Mean	46.02	54.75	56.94	69.75		44.75	53.44	54.50	72.42	
L.S.D 5%	(a)= 3.30	(b)= 3.30	(axb)=6.50			(a)= 4.60	(b)= 4.60	(axb)= 9.30		

TABLE 3. Effect of bio-fertilization with yeast applied as foliar application spraying, soil drench methods and their interaction on yield and chemical constituents of fenugreek seeds.

Spraying / Drenching	1st season (2013\2014)					2nd season (2014\2015)				
	Pods number plant^{-1}									
	0 g/L	5 g/L	10 g/L	15 g/L	Mean	0 g/L	5 g/L	10 g/L	15 g/L	Mean
0 g/L	3.60	5.73	10.70	6.71	6.69	6.31	13.97	7.30	10.31	9.47
5 g/L	6.35	10.69	7.35	8.36	8.19	9 .07	6.93	11.96	9.95	9.48
10 g/L	8.75	5.79	7.25	15.31	9.28	11.90	6.87	9.41	17.36	11.39
15 g/L	7.78	7.96	8.00	23.33	11.77	8.89	10.70	10.66	23.33	13.40
Mean	6.62	7.54	8.33	13.43		9.04	9.62	9.83	15.24	
L.S.D 5%	(a)=1.00 (b)=1.00 (axb)=1.90					(a)=1.30 (b)=1.30 (axb)=2.70				
Seeds weight plant^{-1} (g)										
0 g/L	2.05	2.41	2.96	4.23	2.91	2.09	2.16	2.90	4.29	2.86
5 g/L	2.53	2.36	3.57	4.23	3.17	2.38	2.35	3.76	3.93	3.11
10 g/L	2.55	2.62	3.81	4.27	3.31	2.71	2.49	3.94	4.50	3.41
15 g/L	2.37	3.03	3.69	3.90	3.25	2.18	2.94	3.38	4.04	3.14
Mean	2.38	2.61	3.51	4.16		2.34	2.49	3.50	4.19	
L.S.D 5%	(a)=0.20 (b) =0.20 (axb)=0.41					(a)=0.24 (b) =0.24 (axb)=0.48				
Seeds yield feddan^{-1} (kg)										
0 g/L	765.89	900.17	1102.84	1577.79	1086.67	778.33	805.68	1080.46	1601.41	1066.47
5 g/L	942.45	879.04	1330.37	1579.03	1182.72	886.50	877.79	1401.24	1464.65	1157.55
10 g/L	951.15	977.26	1422.37	1591.47	1235.56	1010.83	928.77	1470.86	1678.50	1272.24
15 g/L	882.77	1128.95	1377.61	1454.70	1211.01	814.38	1097.86	1259.50	1508.16	1169.98
Mean	885.57	971.36	1308.30	1550.75		872.51	927.53	1303.02	1563.18	
L.S.D 5%	(a)=76.00 (b) =76.00 (axb)=151.00					(a)=90.00 (b) =90.00 (axb)=180.00				
Content of seed mucilage (%)										
0 g/L	16.40	23.77	22.26	17.66	20.02	16.31	19.00	21.52	16.96	18.45
5 g/L	16.75	23.52	23.60	24.70	22.14	16.92	23.39	22.56	23.31	21.55
10 g/L	23.15	17.00	23.46	24.73	22.09	22.48	16.59	22.60	24.18	21.46
15 g/L	24.10	20.30	22.30	25.67	23.09	23.00	19.60	21.34	25.40	22.34
Mean	20.10	21.15	22.91	23.19		19.68	19.65	22.01	22.46	
Content of seed trigonelline (mg.g^{-1} DW)										
0 g/L	14.39	22.76	20.25	15.65	18.27	14.80	17.49	20.01	15.45	16.94
5 g/L	14.74	21.51	21.59	23.69	20.39	15.41	22.88	23.05	22.80	21.04
10 g/L	23.14	14.99	23.45	22.72	21.08	20.97	15.08	21.09	23.67	20.21
15 g/L	22.09	18.29	20.29	25.66	21.59	21.49	18.09	19.83	24.89	21.08
Mean	18.59	19.39	21.40	21.93		18.17	18.39	21.00	21.71	
Content of seed protein (g.g^{-1} DW)										
0 g/L	0.25	0.26	0.28	0.29	0.27	0.25	0.26	0.28	0.29	0.27
5 g/L	0.26	0.29	0.30	0.31	0.29	0.26	0.30	0.30	0.30	0.29
10 g/L	0.27	0.28	0.29	0.31	0.28	0.26	0.30	0.29	0.30	0.29
15 g/L	0.28	0.30	0.31	0.32	0.30	0.29	0.28	0.30	0.31	0.30
Mean	0.26	0.28	0.29	0.30		0.27	0.29	0.29	0.30	

Chemical analysis of fenugreek plants

Effect of bio-fertilization with yeast applied as foliar application spraying

Presented data in Table 4 clarifies that treating the plants with 10 g/l of active dry yeast resulted in the highest values of chlorophyll a, b and carotenoids contents in the fresh leaves $mg.g^{-1}$ while the highest significant records of total carbohydrates content of dry leaves were obtained due to using the highest concentration (15 g/l) in both seasons. It was noticed that using the moderate concentration (10g/l) gave, to an extent, approximate results to these of the highest concentration.

Such increase in photosynthetic pigments formation could be attributed to the role of yeast cytokinins which delaying the aging of leaves by reducing the degradation of chlorophyll and enhancing the protein and RNA synthesis (Castelfranco and Beale, 1983). These results were in agreement with (Costa *et al.,* 2008) on *Ocimum selloi*, (Abdou *et al.,* 2011) on clove Basil plant, (Abdou *et al.,* 2012) on Fennel plants, (Hussain, 2002) on *Majorana hortensis*, (Abd El-Latif, 2006) on *Salvia officinalis*, (Naguib, 2002) on *Cymbopogon flexuosus,* (Seleim, 2005) on *Mentha viridis* and *Salvia officinalis* and (Ahmed and Abdel-Wahid, 2007) using active dry yeast at 6 g/l increased the photosynthetic pigments in leaves and total carbohydrates percentage in the herb of *Calendula officinals*.

Effect of bio-fertilization with yeast applied as soil drench

The highest significant records of chlorophyll a, b, carotenoids' contents and total carbohydrates content in both seasons were produced from using the 15 g/l of active dry yeast in both seasons as declared in Table 4. These results are confirmed by authors like (Salman 2004) on *Ocimum basilicum*.

Effect of the interaction between application spraying and soil drench

Chemical constituents of Fenugreek plants, chlorophyll a, b, carotenoids' contents and total carbohydrates content were significantly affected and highly increased by the interaction between yeast plants' spraying at (10 g/l) along with soil drenching with yeast at (15 g/l) except for total carbohydrates content which showed great reaction to the application of 15 g/l in both spraying plus soil drenching in both seasons, as noticed in Table 4.

Conclusion

To end up with, all treatments, spraying or drenching or both together, led to a highly significant increase in all studied characters, namely, vegetative growth, yield and chemical constituents of Fenugreek plants. Among all concentrations of active dry yeast, the highest ones (10 and 15 g/l) used individually as spraying or drenching, were of more benefit than the control in recording the highest values of vegetative growth characters, seed yield and chemical constituents. All interaction treatments, spraying the plants with 15 g/l along with drenching the soil with 15 or 10 g/l of active dry yeast was of the most significant values in all vegetative

growth attributes and seed yield and its chemical constituents, mucilage (%) trigonelline and protein content. Spraying the plants with 10 g/l plus drenching the soil with 15 g/l was the most effective treatment for obtaining the highest values of the chemical constituents of Fenugreek plants, chlorophyll a, b, carotenoids' contents while highest total carbohydrates content was given from spraying with drenching at 15 g/l for both treatments. Hence, it can be concluded that Fenugreek plants responded greatly to foliar spraying with active dry yeast than soil drenching but the interaction of both treatments was the most effective than using each one individually. Generally speaking, there was a gradual increase in all vegetative growth, yield and chemical characters as increasing the concentration of active dry yeast (5, 10 and 15 g/l).

TABLE 4. Effect of bio-fertilization with yeast applied as foliar application spraying, soil drench methods and their interaction on chemical composition of fenugreek plants .

Spraying / Drenching	1st season (2013\2014)					2nd season (2014\2015)				
	Chlorophyll A (mg g^{-1})									
	0 g/L	5 g/L	10 g/L	15 g/L	Mean	0 g/L	5 g/L	10 g/L	15 g/L	Mean
0 g/L	0.89	1.27	1.29	1.66	1.28	0.93	1.31	1.45	1.70	1.35
5 g/L	0.90	1.14	1.64	1.70	1.35	0.93	1.19	1.67	1.75	1.39
10 g/L	1.43	1.44	1.62	1.25	1.44	1.47	1.47	1.58	1.44	1.49
15 g/L	1.39	1.30	1.81	1.57	1.52	1.42	1.31	1.80	1.61	1.54
Mean	1.15	1.29	1.59	1.55		1.19	1.32	1.63	1.63	
L.S.D 5%	(a)=0.02 (b)=0.02 (axb)=0.05					(a)=0.19 (b)= 0.19 (axb)=0.38				
Chlorophyll B (mg g^{-1})										
0 g/L	0.64	0.98	0.89	1.29	0.95	0.67	0.98	1.04	0.91	0.90
5 g/L	0.64	0.78	1.30	1.04	0.94	0.77	0.91	1.04	1.30	1.01
10 g/L	0.76	1.09	1.03	1.09	0.99	0.85	1.06	1.06	0.96	0.98
15 g/L	0.94	0.96	1.34	1.05	1.07	0.95	0.95	1.31	1.08	1.07
Mean	0.75	0.95	1.14	1.12		0.81	0.98	1.11	1.06	
L.S.D 5%	(a)=0.04 (b)=0.04 (axb)=0.09					(a)=0.13 (b)= 0.13 (axb)=0.25				
Carotenoids (mg g^{-1})										
0 g/L	0.36	0.44	0.46	0.56	0.46	0.37	0.43	0.44	0.52	0.44
5 g/L	0.45	0.45	0.57	0.47	0.49	0.42	0.50	0.46	0.45	0.46
10 g/L	0.48	0.45	0.65	0.54	0.53	0.40	0.42	0.58	0.48	0.47
15 g/L	0.56	0.54	0.67	0.56	0.58	0.34	0.47	0.74	0.46	0.50
Mean	0.46	0.47	0.59	0.53		0.38	0.46	0.56	0.48	
L.S.D 5%	(a)=0.03 (b)=0.03 (axb)=0.05					(a)=0.07 (b)= 0.07 (axb)=0.14				
Total Carbohydrates content of leaves (%)										
0 g/L	24.92	26.62	22.06	30.80	26.10	22.44	24.45	20.11	25.79	23.20
5 g/L	26.64	24.25	28.32	29.53	27.19	21.46	23.11	25.70	27.45	24.43
10 g/L	27.55	26.62	26.16	29.33	27.42	24.08	23.71	22.80	26.41	24.25
15 g/L	26.23	30.32	25.31	30.88	28.19	27.65	24.44	24.15	29.14	26.35
Mean	26.34	26.95	25.46	30.14		23.91	23.93	23.19	27.20	
L.S.D 5%	(a)= 1. 90 (b)= 1.90 (axb)= 3.81					(a)=2.10 (b)= 2.10 (axb)= 4.20				

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تأثير طرق التسميد الحيوى على النمو الخضري ومحصول البذور والمكونات الكميائية لنبات الحلبة

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أجريت هذه الدراسة فى مزرعة دمو التابعة لكلية الزراعة جامعة الفيوم, خلال موسمين متتالين ٢٠١٣/٢٠١٤ و ٢٠١٤ /٢٠١٥ لدراسة تأثير التطبيق الورقى والأرضى (حقن التربة) وفى كلا الطريقتين تم إتعمال التركيزات (٠ و ٥ و١٠ و١٥ جرام/لتر) من التسميد الحيوى (الخميرة الجافة النشطة)على النمو الخضرى و محصول البذور والمكونات الكيماوية لنبات الحلبة. وأكدت النتائج أن نباتات الحلبة تأثرت تأثيرا ايجابيا معنويا نتيجة لمعاملتها بالخميرة الجافة النشطة سواء كان ذلك بالرش أو بالحقن بالتربة أو باستخدام الاثنين معا. فاستخدام التركيزات العالية من الخميرة (١٠ و ١٥ جم/لتر) فى المعاملات الفردية و الثنائية للرش والحقن كانت لها الريادة فى تعزيز و زيادة صفات النمو الخضري وهى: طول النبات, عدد الأفرع, الوزن الطازج و الجاف للنبات وكذلك انتاج البذور وأيضا المكونات الكميائية للنباتات (محتوى النبات من كلوروفيل أ& ب و الكاروتينات والكربوهيدرات).

و لهذا يمكن التوصية برش نباتات الحلبة أو بحقن التربة بتركيز ١٠ أو ١٥ جم/لترمن الخميرة للحصول على أفضل النتائج. علاوة على ذلك لابد من تفعيل استخدام الخميرة فى مجال الزراعة بدرجة أكبر كمخصب حيوى له قدرة عالية على زيادة محصول البذور ومكوناتها الكمياوية.