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INFLUENCE OF FOLIAR SPRAY WITH YEAST EXTRACT ON FABA BEAN PLANT (*Vicia faba* L.)

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Abstract

Field experiments were carried out at the Agricultural Experiments and Researches Station, Faculty of Agriculture, Cairo University, Giza, Egypt during the two successive winter growing seasons of 2015/2016 and 2016/2017 in order to study the effect of foliar application with different concentrations of yeast extract (YE) (3, 5 and 7g yeast extract/L) on morphological, anatomical, leaf photosynthetic pigments and yield parameters as well as on seed quality of faba bean cv. Misr 3. The obtained results revealed that foliar application with yeast extract at concentrations of 3g /L and 7g/ L promoted some investigated characters of faba bean cv. Misr 3 without significant differences with the control plants in both studied seasons. While, foliar application with the relatively median used concentration of 5g YE/L induced significant promotive effects on all vegetative growth parameters expressed as plant height, number of branches/plant, number of leaves/plant, fresh and dry weight of shoot /plant, and yield characters such as number of pods/plant, number of seeds/plant, seed yield/plant (g) and specific weight of seeds (average weight of 100 seeds) as well as induced favorable changes in seed quality of faba bean cv. Misr 3 as compared with the untreated plants .

Anatomical studies indicated that spraying faba bean plant with the most effective concentration (5 g YE/L) induced favorable enhancement in most of included tissues of the main stem and leaves especially in xylem tissue.

Keywords : Faba bean, Yeast extract, Morphology, Anatomy, Photosynthetic Pigments, Yield, Seed quality.

Introduction

Faba bean (*Vicia faba* L.), also known as broad bean, fava bean, field bean, bell bean, English bean and horse beanis one of the fourth most important legume crops in the world, after pea, chickpea and lentil (According to FAOSTAT, 2018) and an essential food crop for human nutrition and livestock feed in Egypt due to its high- protein seeds content (20 and 40%) depending on the variety and the environmental conditions. Also, they are low fat and a good source of dietary fiber and B-complex vitamins. (Tafere *et al*., 2012). The origin of this legume is obscure, but it had been cultivated in the Middle East for 8,000 years before it spread to Western Europe (Metayer, 2004).

According to the United Nations Food and Agriculture Organization (FAO, 2014), China is currently the world's leading producer, accounting for approximately 60% of total. Other important production regions are northern Europe, the Mediterranean, the Nile Valley, Ethiopia, Central and East Asia. Faba bean has high nutritional value and thus, it is a rich available source of food for human beings by the seed all over the world (Sahile *et al*., 2011). Some varieties are remarkable livestock feed and used for fodder, hay, straw and silage (Prolea, 2014). It also played a key role as an excellent component of crop rotation and green manure in most parts of the world. When it grows in rotation with other crops, under certain environmental conditions, it can improve soil fertility and reduce the incidence of weeds, diseases and pests (Bendahmane *et al*., 2012 and McVicar *et al*., 2013).

The increase of faba bean yield in Egypt is highly recommended to meet the demand of human needs and livestock. Recently, a great attention has been focused on the possibility of using natural and safety substances in order to improve plant growth, flowering and fruit setting. The use of natural stimulants was shown to be promising for induce favourable changes in vegetative growth as well as for producing more seed yields from legumes.

Yeast extract (*Saccharomyces cerevisiae)* is considered as a natural safety bio-fertilizer which is usually added to soil or as foliar application. It is a rich source of phytohormones (gibberellins, auxins and cytokinins), amino acids (lysine, tryptophan, *etc*.,), minerals and trace elements (calcium, cobalt, iron, *etc*.) and vitamins (B1, B2, B6 and B12) (Barnett *et al*., 1990; Mahmoud, 2001 and Bevilacqua *et al*., 2008). It has stimulatory effect on cell division and enlargement, protein and nucleic acids synthesis and chlorophyll formation(Wanas, 2006 and Marzauk *et al*., 2014). Mekki and Amal, (2005) on soybean; Khalil and Ismael, (2010) on lupin; Nassar *et al*., (2011) on kidney bean and Mahmoud *et al*. (2013) on pea reported that foliar application of yeast extract significantly increased growth parameters, yield and yield attributes, proteins, photosynthetic pigments, total carbohydrates and minerals.

Thus, the present investigation is an attempt to bring to light more information about the effect of spraying different concentrations of yeast extract on vegetative growth, productivity, anatomy and chemical constituents of faba bean plant.

Materials and Methods

The Field experiments were carried out at the Agricultural Experiments and Researches Station, Faculty of Agriculture, Cairo University, Giza, Egypt, during two winter successive seasons of 2015/ 2016 and 2016/2017 in order to study the effect of different concentrations of yeast extract as foliar spray on morphological, anatomical and yield characteristics as well as chemical constituents of faba bean plant.

1. Source of seeds and yeast extract:

The source of faba bean cv. Misr 3 was obtained from Legume Research Department, Field Crop Institute, Agric. Res. Center, Egypt.

The growth stimulant, yeast extract, was obtained as a powder from El- Gomuhourria Company, Sheriff St,

Cairo, Egypt, which was imported from Lab M limited company, United Kingdom.

Three concentrations; namely 3, 5 and 7 g/L were used as spray application.

2. Field work procedure

Seeds of faba bean were sown on first of November in both seasons to provide the experimental plant materials. Cultivation was achieved according to a randomized complete block design at the rate of three replicates for each treatment. Each replicate was represented by one plot; the plot was 3 x 4 m. with 6 ridges 60 cm. apart. Seeds were sown in the one side of the ridge with two seeds/ hill and the hills were spaced at 20 cm. distance. The source of nitrogen, phosphours and potassium were ammonium sulphate (20.5%N), calcium superphosphate (15.5% P2O5) and potassium sulphate (48% K2O), respectively. All field practices, land preparation, irrigation, fertilization and other farming procedures were carried out as recommended for the investigated faba bean production in the vicinity.

The tested concentrations of yeast extract were applied twice by means of an atomizer sprayer. It was dissolved in distilled water and applied to the plants as a foliar spray. The first application was carried out after four weeks from sowing then the second application after two weeks from the first application. Volume of spraying solution per plot was almost 1.5 and 2.5 liters for first and second applications; respectively. This volume was adequate to wet the plants thoroughly with excess of dripping solution. Beside the control treatment, where the plants were sprayed with tap water.

3. Recording of data

Investigations involved data pertaining to morphological and yield characters of faba bean plant as affected by yeast extract throughout two successive seasons. A random sample of 15 plants for each tested treatments (5 plants from each replicate) was assigned for investigation. Data were recorded on individual plants at the age of 75 days after sowing for morphological and at harvest time (150 days after sowing) for yield characters.

Morphological characters of vegetative growth

• Plant height (cm), measured from the cotyledonary node up to the uppermost point of the plant.

• Number of branches / plant.

• Number of leaves / plant.

• Fresh weight of shoot (g) /plant (all above ground parts of the plants).

• Dry weight of shoot (g) /plant.

Yield characters

• Number of matured dry pods / plant.

• Average number of seeds / plant.

• Yield of seeds (g) / plant.

• Specific weight of seeds (average weight of 100 seeds, g).

4. Anatomical studies

It was intended to carry out a comparative microscopical analysis on plant materials which showed the most prominent response to foliar spray with yeast extract in addition to control. Specimens of the main stem at its median portion and the lamina of the first leaflet of the compound foliage leaf developed on the median portion of the main stem were taken in the first season at the age of 90 days from sowing date.

Specimens were killed and fixed for at least 48 hrs. in FAA (10 ml formalin, 5ml glacial acetic acid , 50 ml ethyl alcohol 95% and 35 ml distilled water). After fixation, the selected materials were washed in 50% ethyl alcohol at least twice then dehydrated in a normal butyl alcohol series before embedding in paraffin wax (melting point 56-580C), cross sections were cut on a rotary microtome to a thickness of 20 microns and were stained with crystal violet-erythrosine then cleared in xylene and mounted in Canada balsam (Nassar and El-Sahhar, 1998). Sections were read to detect histological manifestations of noticeable responses resulted from spraying with yeast extract compared to control and photomicrographed.

5. Chemical analysis

Chemical analysis was assigned at the Central Laboratory of Faculty of Agriculture, Cairo University, Giza, Egypt.

a.Determination of Photosynthetic pigments (mg/g FW)

Chlorophyll a, b and total carotenoids were determined quantitatively in fresh foliage leaves of treated and untreated plants at the age of flowering time according to Lichtenthaler and Wellburn (1985). Chlorophyll a, chlorophyll b and total carotenoids were measured by spectrophotometer (Sequoia- Turner model 340) at wavelengths 663, 647 and 470 nm, respectively. Chlorophylls and carotenoids were calculated according to the equation described by Nornai formula(1982).

b. Determination of total nitrogen content and crude protein

The determination of total nitrogen and crude proteinwas carried out according to Micro- Kjeldahel method. (A.O.A.C., 1995). Nitrogen content of seeds was multiplied by 6.25 factor to calculate the crude protein.

c. Determination of total carbohydrates

Total Carbohydrates were determined according to the method described by Kostas *et al*., 2016).

d. Determination of total amino acids content in seeds

Amino acids were extracted according to the methods described by Csomos and Simon- Sarkadi (2002) and measured using the Automatic Amino Acid Analyzer (AAA 400 INGOS Ltd). The concentration of amino acids was calculated as g A.A. /100 g protein.

Statistical analysis

Data on morphological and yield characters, chemical analysis of leaf photosynthetic pigments, chemical analysis of dry seeds including total nitrogen and crude protein percentages, total carbohydrate percentage and total amino acids of faba bean were subjected to conventional methods of analysis of variance according to Sendecor and Cochran(1982). The least significant difference (L.S.D.) at 0.05 level was calculated for each investigated character under different assigned concentrations.

Results and Discussion

a. Morphological characters of vegetative growth

The morphological characters of vegetative growth offaba bean cv. Misr 3 as affected by foliar application with different concentrations of yeast extract (3, 5 and 7 g/L) in two successive winter growing seasons of 2015/2016 and 2016/2017 were investigated. The investigated morphological characters included plant height (cm), number of branches per plant, total number of compound leaves developed per plant, fresh weight of shoot (g) per plant and dry weight of shoot (g) per plant.

1. Plant height (cm):

Results presented in Table (1) clearly show that all tested concentrations of yeast extract increased significantly height of faba bean plant cv. Misr 3 in both studied seasons except that of 3g YE/L. (the relatively low used concentration) where the difference with the control proved insignificant in the second season. The maximum significant increase in plant height was detected when faba bean plant was treated with 5g YE/L., being 36.51% and 39.32% more than the height of untreated plants in the first and second season; respectively. The enhancing effect of yeast may be due to yeast being a natural source of phytohormones especially cytokinins which enhance cell division and cell enlargement.

In this respect, Amer (2004) using 2g/L AYE, Nassar *et al*. (2011) using 100 ml/L AYE and Abdel-Hakim *et al*. (2012) using 4g/L YE recorded similar findings on bean plants. All, being in accordance with present findings.

2. Number of branches per plant:

Data given in Table (1) reveal that the relatively low (3g/L) and high (7g/L) used concentrations of yeast extract had no significant effect on number of branches of faba bean cv. Misr 3 in both studied seasons. By contrast, the relatively median used concentrations of yeast extract (5g/L) induced significant increases of 96.96% and 83.87% over the control in number of branches developed on faba bean plant in the first and second season; respectively.

Similar results were previously reported by Nassar *et al*. (2011) who found that treated kidney bean plants with 100 and 150 ml/L active yeast extract increased number of branches per plant; being in accordance with the present findings.

3. Number of leaves/plant:

It is clear from Table (1) that all tested concentrations of yeast extract increased significantly number of compound leaves developed on plant of faba bean cv. Misr 3 in both studied seasons. The highest number was recorded at treatment of 5g YE/L., being 65.31and 69.76% more than number of leaves developed on untreated plant in the first and second season; respectively.

Abou EL-Yazied and Mady (2012) and Abbas (2013) on field bean plants stated that number of leaves significantly increased by foliar application with yeast extract at 5 g/L. Likewise, Tartoura (2001) on pea, Amer (2004) , Fawzy *et al*. (2010) and Nassar *et al*. (2011) on common bean confirmed these findings.

4. Fresh weight of shoot/plant:

It is realized from Table (1) that the relatively low used concentration of 3g YE/L showed no significant effect on fresh weight of shoot of faba bean plant in both studied seasons. Also, the relatively high used concentration of 7g this respect. By contrast, the relatively median concentration YE/L in the second season showed no significant effect in of 5g YE/L in both studied seasons and high used concentration of 7g YE/L in the first season promoted significantly fresh weight of shoot per plant. The maximum significant increase was recorded when plants of faba bean were sprayed with 5g YE/L., being 71.54 and 65.11% more than untreated plant in the first and second season; respectively.

In this connection, Tartoura (2001) reported that fresh weight of shoot of pea plants was increased significantly by foliar application with 30 ml/L active yeast extract. Likewise, Amer (2004) on common bean found the same result when using 2g/L. active yeast extract, being in harmony with the present findings.

5. Dry weight of shoot/plant:

Data presented in Table (1) reveal that the relatively median used concentration of 5g YE/L in both studied seasons and the relatively high used concentration of 7g YE/L in first season increased significantly dry weight of shoot per plant of faba bean cv. Misr 3. While, the relatively low used concentration of 3g YE/L in both studied seasons and also the relatively high used concentration of 7g YE/L in the second season showed no significant effect in this respect. The maximum significant increase in dry weight of shoot per plant was achieved when plants of faba bean were sprayed with 5g YE/L., being 141.26 and 72.03% more than dry weight of shoot per untreated plant in the first and second season; respectively.

In this concern, Mady (2009) stated that the dry weight of shoot of faba bean was increased significantly by foliar application with active yeast extract at the rate of 50ml/L.

Likewise, the significant promotive effect of yeast extract on dry weight of shoot /plant of some legumes was reported by Tartoura (2001), Fawzy et al. (2010) on snap beans and Nassar *et al*. (2011) on kidney bean. All, being in harmony with the present findings.

b. Yield of seeds and its components

The mean values of yield characters of faba bean cv. Misr 3 as affected by foliar application with different concentrations of yeast extract (3, 5 and 7 g/L) in two successive winter growing seasons of 2015/2016 and2016/2017 were investigated. The investigated characters included number of pods/plant, number of seeds/plant, yield of seeds (g)/plant and weight of 100 seeds (g).

Table 1 : Morphological characters of vegetative growth of faba bean cv. Misr 3, aged 75 days, as affected by foliar application with different concentrations of yeast extract in two successive growing seasons of 2015/2016 and 2016/2017.

Treatments Conc. (g/L)		Morphological characters									
		Plant height(cm)		No. of branches / plant		No. of leaves / plant		Fresh weight of shoot (g) / plant		Dry weight of shoot (g) / plant	
		First Season	Second season	First Season	Second season	First Season	Second season	First Season	Second season	First Season	Second season
Control	0	49.3 B	44.5 C	3.3 B	3.1 B	39.5 C	34.4 C	74.5 C	66.5	12.6 C	11.8 B
Yeast extract (YE)	3	59.3 A	52.0 BC	4.1 B	3.3 B	50.3 B	43.0 B	87.2 BC	71.0 B	17.1 BC	12.1 B
	5	67.3 A	62.0 A	6.5 A	5.7 A	65.3 A	58.4 A	127.8 A	109.8 A	30.4 A	20.3 A
	7	63.1 A	58.6 AB	4.8 B	3.5 B	53.0 B	43.8 B	106.2 AB	79.8 B	20.9 B	14.3 B
(L.S.D. 0.05)		8.8	7.9	1.6	1.3	10.1	8.4	25.5	20.0	5.1	4.6

Means having the same letter are not significantly different at 0.05 level

Number of pods/plant:

It is clear from Table (2) that all tested concentrations of yeast extract increased significantly number of pods/plant of faba bean plant cv. Misr 3 in both studied seasons. The maximum significant increase in pods number was achieved when faba bean plant was sprayed with 5g YE/L., being66.12% and 69.95% more than pods number of untreated plants in the first and second season; respectively.

The same results were recorded by Marzauk *et al*. (2014) and Shafeek *et al*. (2014) using 6 ml/L yeast extract on faba bean plant. Also, Amer (2004) using 2 g/L active yeast extract, Nassar *et al*. (2011) using 100 ml active yeast extract / L and Al-Amery and Mohammed (2017) using 12 g/L yeast extract recorded similar findings on snap bean plants. Likewise, Tartoura (2001) using 30 ml/L active yeast extract (AYE) on pea crop, Khalil and Ismael (2010) using 8 g/L yeast extract on *Lupinus termis* L. plant, Abdel Rahman and Faisal (2012) using 2 mg ml-1 yeast extract on soybean plant and El-sharkawy (2013) on pea plants confirmed the same results.

Number of seeds/plant:

Data presented in Table (2) clearly show that all assigned concentrations of yeast extract, except that of low used one (3g YE/L) only in the second season significantly increased the number of seeds per plant of faba bean. The highest number was recorded when faba bean plant was sprayed with 5g YE/L., being 125.77 and 77.34% more than number of seeds per untreated plant in the first and second season; respectively.

These results agree with the findings of Hammad(2008) who stated that number of seeds per plant of pea plants was significantly increased by foliar application of yeast extract. Khalil and Ismael (2010) observed that foliar application of yeast extract at 8g/L increased number of seeds per plant of *Lupinus termis* L. plant. Also, Nassar *et al*. (2011) reached to similar conclusion using 100 ml AYE/L on kidney bean plants.

Yield of seeds (g) / plant:

It is recognized from Table (2) that all sprayed concentrations of yeast extract increased significantly yield of seeds per plant of faba bean cv. Misr 3 in both studied seasons. The maximum increase was achieved at 5g YE/L., being 164.47 and 101.40% more than seed yield per untreated plant in the first and second season; respectively.

Similar results were reported by Abou El-Yazied and Mady (2012) who indicated that sprayed broad bean plants with 5ml YE/L increased yield of seeds per plant. Abdel Rahman and Faisal (2012) using 2 mg ml-1 yeast extract recorded similar findings on soy bean plants. Also, Nassar *et al*. (2011) using 100 ml AYE/L on kidney bean plants and El- sharkawy (2013) on pea plants found that yeast extract induced significant promotive effects on seed yield per plant.

Specific weight of seeds (average weight of 100 seeds):

It could be mentioned from data outlined in Table (2), that the relatively median used concentration of 5g YE/L in both studied seasons and the relatively high used concentration of 7g YE/L in the first season only increased significantly specific weight of 100 seeds of faba bean plant. While, the relatively low used concentration of 3g YE/L in both studied seasons and also the relatively high used concentration in the second season showed no significant effect in this respect. The maximum increase in specific weight of 100 seeds of faba bean plant cv. Misr 3 was recorded when faba bean plants were sprayed with 5g YE/L., being 17.09 and 13.44% over the control in the first and second season; respectively.

The present results are generally in accordance with those recorded by Mady (2009) and Abou El-Yazied and Mady (2012) on broad bean plants as well as by Fathy and Farid (1996) and Amer (2004) on bean plants. Likewise, Tartoura (2001), Hammad (2008) and Abou-Aly *et al*. (2015) on pea plants pointed out that 100 seed weight per plant was increased significantly by foliar application with yeast extract. Similar results were also recorded by Khalil and Ismael (2010) on *Lupinus termis* L. plant.

c. Chemical analysis

1. Photosynthetic pigments

Data presented in Table (3) show the effect of different concentrations of foliar spray with active yeast extract (3, 5 and 7g/ L) on photosynthetic pigments in faba bean leaves (75 days old) in the first season. The obtained results revealed that all foliar applications enhanced the photosynthetic pigments compared with the control treatment. The lower concentration of active yeast extract did

not has significant increase in this respect and also, the high (7g/L) used concentration of yeast extract showed no significant effect on only carotenoids pigment. The highest values of photosynthetic pigments were recorded at 5g/ L yeast extract, being 79.1, 30.2 and 22.8 % over than the control plants for chl. a, chl. b and carotenoids; respectively.

Table 2 : Yield characters of faba bean cv. Misr 3 at harvest time, aged 150 days, as affected by foliar application with different concentrations of yeast extract in two successive winter growing seasons of 2015/2016 and 2016/2017.

Treatments Conc. (g/L)		Yield characters							
		No. of pods /plant		No. of seeds /plant		Seed yield (g)/plant		weight of 100 seeds (g)	
		First Season	Second season	First Season	Second season	First Season	Second season	First Season	Second season
Control	0	24.5 C	21.3 C	61.3 C	49.0 C	38.0 C	28.4 C	62.0 C	58.0 B
Yeast extract (YE)	3	32.3 B	27.7 B	90.4 B	63.7 BC	60.2 B	39.0 B	66.6 BC	61.2 AB
	5	40.7 A	36.2 A	138.4 A	86.9 A	100.5 A	57.2 A	72.6 A	65.8 A
	7	32.8 B	28.9 B	101.7 B	69.4 AB	69.2 B	43.5 B	68.0 AB	62.7 AB
L.S.D. (0.05)		6.3	5.5	20.7	17.8	12.6	8.5	5.9	4.7

Means having the same letter are not significantly different at 0.05 level.

The enhancing effect in photosynthetic pigments of yeast application could be attributed to the role of their content of cytokinins in delaying the aging of leaves by reducing the degradation of chlorophyll and enhancing the protein and RNA synthesis or may be attributed to bio-regulatores which affect the balance between photosynthesis and photorespiration in plants (Thomas, 1996; Shalaby and El- Nady, 2008; Abou El-Yazied and Mady, 2011).

Results of yeast extract were in agreement with reported by Abbas (2013) on *Vicia faba* L. cv. Giza3. She found that foliar application of dry yeast extract at the rate of 5 g/ L significantly increased pigments and carotenoids percentages in leaves compared to the control plants.

2. Chemical analysis of seeds (*Seed Quality*)

Percentage of the total nitrogen and crude protein

It is clear from Table (4) that all foliar application of active yeast extract increased significantly the percentage of the total nitrogen and crude protein in the seeds of faba bean plants. The highest percentage of the total nitrogen was recorded in the seeds of faba bean plants which were sprayed with 5g/L yeast extract, being 18.2% more than the control. At the same time, the maximum increase in the seed protein being 18.3 % for 5g/L yeast extract more than the seed protein of control plants.

These findings were in good accordance with that recorded by Khalil and Ismael (2010) on *Lupinus termis* L. plants; Abou El-Yazied and Mady (2012) on broad bean and Marzauk *et al*. (2014) on broad bean, who stated that the highest values of the total nitrogen and protein percentages were recorded by using dry yeast extract at the rate of 5ml/L, 6ml/L and 8g/L as compared to untreated plants.

Concerning to the percentage of crude protein, El-Tohamy and El-Greadly (2007) stated that foliar application of yeast extract, especially at high used concentration of 10 g/L., induced significant increase in the percentage of protein in fresh pods of snap beans compared to the control, being partially in accordance with the present findings. Likewise, Khalil and Ismael (2010) found that yeast application at the rate of 8g/L significantly increased the value of protein percentage of *Lupinus termis* L. plants.

Total carbohydrate percentage

It can be mentioned from data outlined in Table (4), that the highest carbohydrate percentage was achieved in seeds of the plants sprayed with yeast extract at 5g/L which increased by 31.56% compared with the control plants. While, the relatively low (3g/L) and high (7g/L) used concentrations of yeast extract showed no significant effect in this respect. These results are generally in agreement with Abbas (2013) on *Vicia faba* cv. Giza3. She observed that foliar spray with 5 g/L of yeast extract recorded the highest values of total carbohydrate percentage more than the control.

Table 3 : Effect of foliar application of yeast extract at different concentrations on photosynthetic pigments (mg/g F.W.) of leaves of *Vicia faba* L. plants.

Photosynthetic pigments (mg/g FW)			
Treatments Conc.(g/l)	**Chlorophyll a**	**Chlorophyll b**	**Carotenoids**
Control			
0.00	0.417 C	0.347 B	0.429 B
Yeast extract (YE)			
3g/L	0.463 C	0.367 AB	0.466 B
5g/L	0.747 A	0.452 A	0.527 A
7g/L	0.666 B	0.442 A	0.471 B
L.S.D (5%)	0.051	0.092	0.042

Table 4 : Effect of foliar application of yeast extract at different concentrations on Total nitrogen percentage, Total crude protein percentage (%) and Total carbohydrates percentage of dried seeds of *Vicia faba* L. plants.

Treatments Conc. (g/l)	Total Nitrogen (%)	Total Crude Protein (%)	Total Carbohydrates (%)
Control 0.00	3.67 C	22.96 C	46.25 B
Yeast extract (YE)			
3g/L	3.85 B	24.08 B	55.10 AB
5g/L	4.34 A	27.17 A	60.85 A
7g/L	4.26 A	26.66 A	52.03 AB
L.S.D (5%)	0.093	0.584	9.506

Amino acids content in seeds:

It is planned to determine quantitatively the individual amino acids in seeds of faba bean which showed high percentages of total protein content in comparison with the control as a result of the effect of 5g/L yeast extract treatment to disclose the qualitative changes in *Vicia faba* seeds with respect to amino acids composition in the second season. The obtained results are presented in Table (5) and illustrated in Figures (1, 2).

It is noted that Amino Acid Analyzer analysis proved the presence of 17 amino acids according to their retention times; *i.e*., Aspartic acid (Asp), Therionine (Thr), Serine(Ser), Glutamic acid (Glu), Proline (Pro), Glycine (Gly), Alanine (Ala), Valine (Val), Methionine (Met), Isoleucine(Ile), leucine (Leu), Tyrosine (Tyr), Phenylalanine (Phe), Histidine (His), Lysine (Lys), Nitric acid (NH3) and Arginine(Arg). It is clear that Lysine represents the major component(main amino acid) in all investigated seeds followed by Aspartic acid, Glutamic acid, Glycine, Phenylalanine, Alanine, Tyrosine, Leucine ,Serine, Valine and Histidine. Whereas, NH3, Therionine,

Isoleucine, Arginine, Methionine and Proline represent the minor components. Concerning to the influence of active yeast extract on the individual amino acids in faba bean seeds as g/100g protein, it is realized from Table (5) that foliar application with 5g/L yeast extract caused a marked increase in the concentration of some measured amino acids comparing with the control plants. The noticeable increments in the amino acids, being 15.64%, 13.98%, 23.58%, 9.09% , 2.10%,15.14%, 17.65%, 54.03%, 19.17% and 5.85% in Asp, Thr, Glu, Pro, Gly, Ala, Met, Phe, His and Lys over the control plants; respectively.

But the remarkable decrease in the amino acids content below the control was about 13.15% in Ser, 34.17% in Val, 3.73% in Ile, 2.72% in Leu, 78.17% in Tyr, 3.66% in NH3 and 12.76% in Arg. Among the identified17 amino acids, Lysine recorded the highest value in faba bean seeds of 5g/L yeast extract treatment, being 17.35 g/100g protein against 16.39 g/100g protein in seeds of the control. On the contrary, Proline recorded the lowest value in faba bean seeds of 5g/L yeast extract treatment, being0.12g/100g protein against 0.11g/100g protein in seeds of the control. Also, remarkable increase in total amino acids reached about 6.21% more than the control plants.

From the above mentioned results, it could be generally stated that the increase in total protein content, which was observed in seeds of the 5g/L yeast extract treatment was reflected in increased concentrations of individual amino acids components.

In this respect, Mady (2009) and Abou EL-Yazied and Mady (2012) indicated that the yeast extract in different concentrations (2.5 and 5 ml/L) increased the amount of amino acids of *Vicia faba* L. All, being in harmony with the present findings.

3. Anatomical studies:

a. Anatomy of the main stem

Microscopical measurements of certain histological characteristics in transverse sections through the medianinternode of the main stem of faba bean plants and of those sprayed with 5g yeast extract /L are provided in Table 6. Likewise, microphotographs illustrating this treatment and the untreated plants are in Fig.3. It is obvious from Table. 6 and Fig. 3 that foliar application with 5g yeast extract /L induced an increase inthe internode diameter by 57.8% compared with the control.

This increment in the internode diameter was primarily due to the prominent increase in thickness of the stem wall and in the diameter of the hollow pith by 11.0 and 176.6% over the control; respectively. Clearly, the increase that was observed in the stem wall thickness could be attributed to the increments induced in the thickness of most of included tissues, except that of phloem tissue and parenchymatous area of the pith which were decreased by 7.1 and 13.1% compared with the control. The increments due to the yeast effect were 25, 33.3, 21.8 and 66.6% compared with the control for the thickness of the epidermis, cortex, fibre tissue and xylem tissue; respectively. Likewise, vessel diameter was increased over the control by 24.0% due to foliar application with 5g yeast extract /L. As far as the authors are aware, previous information about the effect of spraying yeast extract on anatomical structure of the main stem of faba bean plants are not available in the literature. However, some investigators confirmed the present findings using yeast extract on other
different species; for instance, Hammad (2008) using 6g/L active yeast extract on pea plants and Nassar *et al*. (2011) using 100 ml/L active yeast extract on kidney bean plants.

Table 5 : The concentrations of amino acids, retention time and their percentages in seeds of faba bean cv. Misr 3 as affected by yeast extract (5g/L) in the second season of 2016/2017.

		Control			Yeast extract (5g/L)		
Peak No.	**Amino acids**	**Retention time (min.)**	**%**	**g AA/ 100 g Protein**	**Retention time (min.)**	**%**	**g AA/ 100 g Protein**
1	Asp	24.03	14.51	12.78	24.73	15.38	14.78
2	Thr	25.85	1.80	1.43	26.73	1.84	1.63
3	Ser	26.75	4.14	3.65	27.73	3.88	3.17
4	Glu	29.62	14.26	12.38	30.65	16.77	15.30
5	Pro	32.03	0.10	0.11	34.52	0.11	0.12
6	Gly	38.67	10.39	9.48	40.68	10.72	9.68
7	Ala	40.70	6.46	5.15	42.35	6.71	5.93
8	Val	43.83	3.86	3.16	44.88	2.35	2.08
9	Met	46.02	0.20	0.17	47.55	0.24	0.20
10	Ile	48.77	1.35	1.07	50.48	1.16	1.03
11	Leu	50.33	5.14	4.40	52.28	5.10	4.28
12	Tyr	54.22	5.63	4.49	55.25	1.10	0.98
13	Phe	57.95	6.99	5.57	59.12	9.24	8.58
14	His	62.20	3.66	2.92	63.68	4.09	3.48
15	Lys	66.67	18.61	16.39	68.52	19.17	17.35
16	NH3	72.32	2.40	1.91	74.32	2.08	1.84
17	Arg	78.02	0.59	0.47	78.43	0.46	0.41
T.A.A.				**85.53**			**90.84**

Key: T.A.A. means Total amino acids.

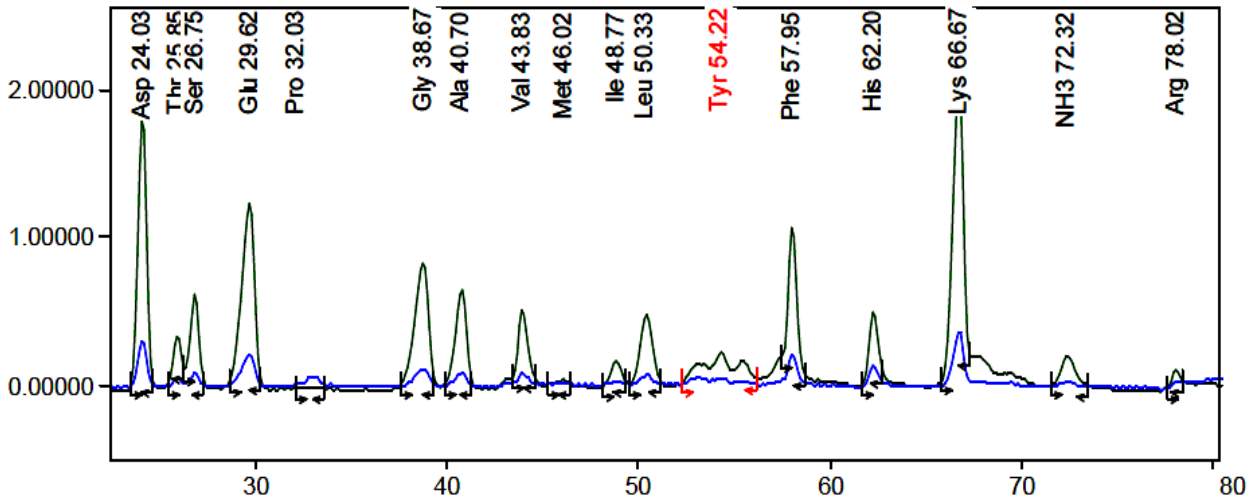


Fig. 1 : Amino Automatic Acid Analyzer analysis of amino acids in seeds of faba bean plants (Control).

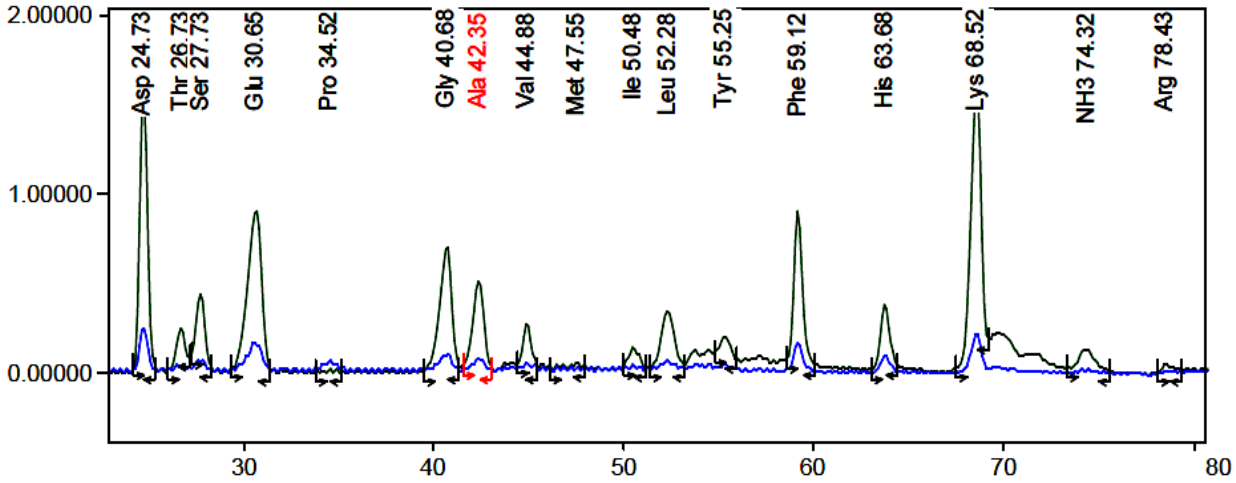


Fig. 2 : Automatic Amino Acid Analyzer analysis of amino acids in seeds of faba bean plants sprayed with 5g/L yeast extract.

They recorded favorable changes in anatomical structure of the main stem of each of the investigated plant species due to the effect of yeast extract which induced prominent increases in thickness of most of included tissues of the main stem of each investigated species, being in harmony with the present findings.

Anatomy of the leaf

Microscopical counts and measurements of certain histological characters in transverse sections through the first leaflet blade of the compound leaf developed on the median portion of the main stem of control plants of faba bean and of those sprayed with 5g yeast extract /L are given in Table 7.

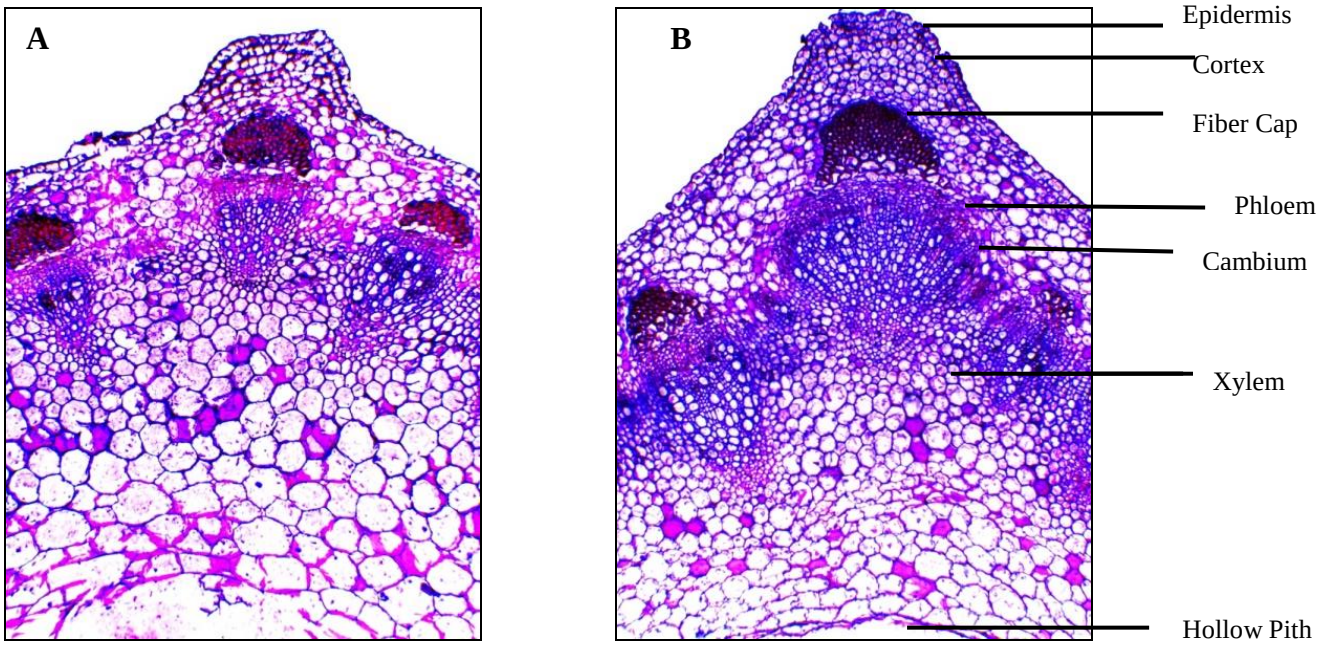
Also, microphotographs illustrating the effect of treatment are shown in Figure 4. It is realized from Table 7 and Figure 4 that spraying yeast extract at concentration of5g/L on faba bean increased thickness of both midvein and lamina of leaflet blades by 92.3 and 16.9% more than the control; respectively. It is clear that the increase in lamina thickness was only accompanied with 26.1% increment in thickness ofspongy tissue compared with control. Likewise, the main vascular bundle of the midvein bundle was increased in size as a result of spraying yeast extract. The increment was mainly due to the increase in length by 166.6% and in width by 135.2% more than the control. Also, average number of vessels per midvein bundle was increased by 124% over the control. Moreover, xylem vessels increased in diameter, being 84.7% more than the control, which amounted to more total active conducting area to cope with vigorous growth resulting from treatment with 5g yeast extract /L. The obtained results are generally in agreement with those results reported by Nassar *et al*. (2011) for kidney bean plants.

Table 6 : Measurements in microns (μ) of certain histological characteristics in transverse sections through the median internode of the main stem of faba bean plant at the age of 90 days and of those sprayed with 5g yeast extract /L .

	Treatment		
Characters	**Control**	**5g yeast extract/L**	**± % to Control**
Stem diameter	7580	11960	+ 57.8
Thickness of stem wall	2720	3020	+ 11.0
Epidermis thickness	40	50	+ 25
Cortex thickness	300	400	+ 33.3
No. of cortical layers.	8	11	+ 37.5
Measurements of big bundle:			
Fiber cap thickness	320	390	+ 21.8
Phloem thickness	140	130	- 7.1
Xylem thickness	480	800	+ 66.6
Vessel diameter	36.3	45	+ 24.0
Medullary sheath thickness	1440	1250	- 13.1
Diameter of hollow pith	2140	5920	+ 176.6

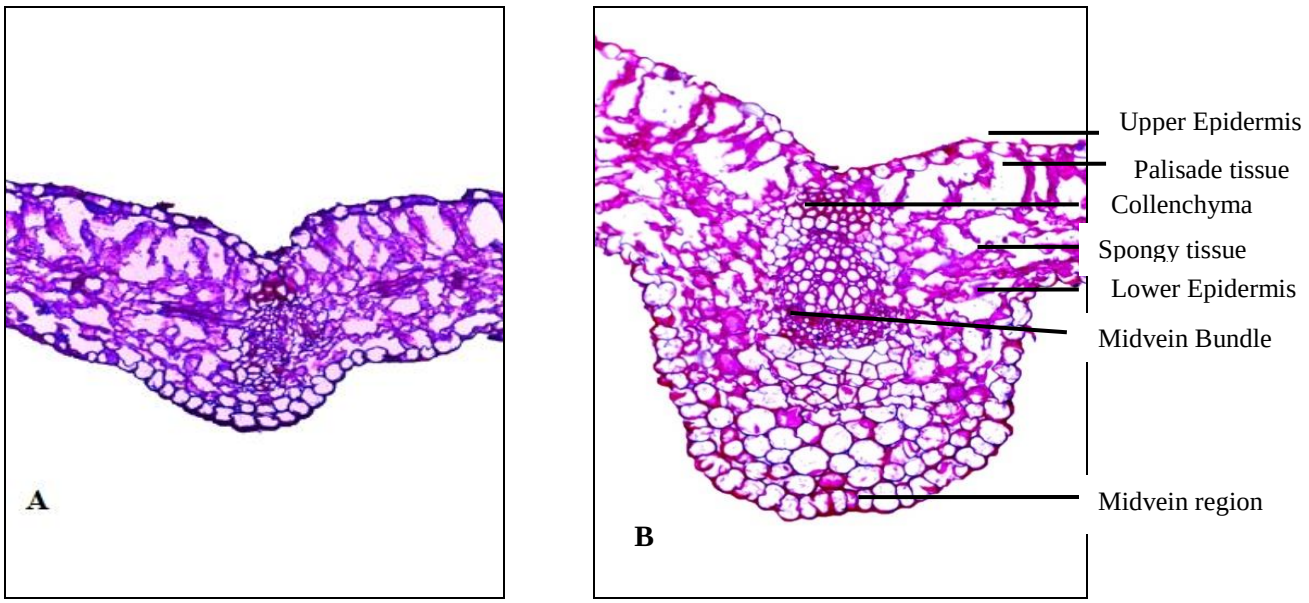
Table 7 : Counts and measurements in microns (μ) of certain histological characters in transverse sections through the first leaflet blade of the compound leaf developed on the median portion of the main stem of plant faba bean at the age of 90 days, as affected by foliar application with 5g yeast extract /L.

	Treatments		
Characters	**Control**	**5g yeast extract /L**	**± % to control**
Midvein thickness	390	750	+92.3
Lamina thickness	326.6	382	+16.9
Upper epidermis	25	35	+40
Lower epidermis	25	30	+20
Palisade tissue thickness	120	120	-
Spongy tissue thickness	156.6	197.5	+26.1
Dimension of the midvein bundle: Length Width	 90 85	 240 200	 +166.6 +135.2
Phloem thickness	30	60	+100
Xylem thickness	60	180	+200
No. of xylem vessels / bundle	25	56	+124
Vessel diameter	18.3	33.8	+84.7



A. From untreated plant (Control). **B.** From plant sprayed with 5g yeast extract /L.

Fig. 3 : Transverse sections through the median internode of the main stem of faba bean plant at the age of 90 days, as affected by foliar application with 5g yeast extract /L (x40).



A. From untreated plant (Control)

. **B.** From plant treated with 5g yeast extract/ L.

Fig 4 : Transverse sections through the first leaflet blade of the compound leaf developed on the median portion of the main stem of faba bean plant at the age of 90 days , as affected by foliar application with 5g yeast extract /L. (x100)

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