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BIOCHEMICAL INDICATORS IN FABA BEAN FOR DROUGHT STRESS AS INFLUENCED BY SOME BIOFERTILIZERS AND BIOFOLIAR

El-Saber, M.M.[1], H.A. Sallam[1], R. El-Massry[2] and M.Z. Sitohy[2]

1. Desert Research Center, Biochemistry Unit, Cairo, Egypt.
2. Biochemistry Department, Fac., Agric., Zagazig University, Egypt.

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ABSTRACT: Two field experiments were carried out during 2005/2006 and 2006/2007 seasons at Agricultural Experimental Station of Desert Research Center (DRC) in Maryout region (Alexandria Governorate), to study effect of interactions between Biofertilizers (Biovit, Netrobin, Phosphorin) and biofoliar application (Biomagic "B") on biochemical components in faba bean (*Vicia faba* v.Nubaria- 1) under rainfed at Maryout conditions. The experiment included ten treatments, five biofertilizers (Control, Biovit, Nitrobin, Phosphorin and 1/2 Nitrobin + 1/2 Phosphorin) and biofoliar applications (Water as control and biomagic plus the previous biofertilizers treatments). Nitrogen and phosphorus were added at a rate of 30 Kg calcium superphosphate (15% P_2O_5) and 60 Kg ammonium nitrate (33.5%N) per feddan during seed bed preparation in sand clay loam in texture and calcareous soil in nature. The obtained results showed that the treatment of mixture "Biovit+ Biomagic" has the highest growth parameters, yield and yield components, than the control. Total carbohydrate and protein content in faba bean were significantly decreased with increase drought stress. The protein and carbohydrate contents were higher with mixture "Biovit + Biomagic" than the other treatments. Total soluble sugars, reducing sugars, proline, soluble protein and total amino acids content were significantly increased with increasing drought stress. Contents of K, Na, Ca and Mg were higher under drought stress with biofertilizer and biofoliar application "Biovit+Biomagic" than other treatments.

Key words: Faba bean, rainfed, biofertilizers, pigments, amino acids protein, carbohydrate, minerals, proline.

INTRODUCTION

Faba bean, *vicia faba* L. is one of the most important pulse crop cultivated in Egypt due to the richness of seed protein content. Therefore, there is need to increase its production by expansion through newly reclaimed areas. The sensitivity of this crop to drought affects its extension in marginal lands. In arid regions, water is becoming limited factor in crop production by limiting irrigation. Leport *et al.* (2006) investigated the effect of terminal drought on seed yield and its components in chick pea (*Cicer arietinum* L.). Early stress affected biomass and seed yield. Ashraf and Ibram (2005) concluded that under water stress in leguminous species, free amino acids, proline and glycine betaine were increased. Musallam *et al.* (2004 a and b) studied the yield, yield components and chemical composition of faba bean under rain-fed and irrigation conditions; the yield more than twice with irrigation. The highest carbohydrate and protein content were recorded under rainfed condition. El- Far (2001) studied the response of different cultivars of faba bean to drought. The results showed that irrigation at all stages resulted the highest yield and biomass. The highest protein content was found under drought. From another point of view, decreasing harmful effects of drought stress and improvement of the crop either in quantity or quality under these conditions was carried out by the applications of biofertilizers, i.e. *Azotobacter chrococcum, Bacillus megatherium, Bacillus rubtalis, Pseudomonas floresence, Bradirhizobium japanicum* as (Biovit*), Azotobacter chrococcum, Asospirillum brasilense* as (Nitrobin), *Bacillus megatherium* as (Phosphorin). Biofertilizer application improves plant growth, fruit yield and chemical composition, as compared with the untreated plants (Abdalla *et al.,* 2001, on pepper plants and Abdel-Mouty *et al.,* 2001 on potato). Application of N.P.K with biofertilizer resulted in the best growth, total yield and fruit characters (Ali, 2001).

This study aimed to identify biochemical indicators in faba bean to drought stress by some biofertilizers and biofoliar applications.

MATERIALS AND METHODS

Two field experiments were carried out during 2005/2006 and 2006/2007 seasons at Agricultural Experimental Station of Desert Research Center (DRC) in

Maryout region (Alexandria Governorate),to study effect of interaction between biofertilizers (Biovit, Netrobin, Phosphorin) and biofoliar application (Biomagic) on biochemical component in faba bean (*Vicia faba L.*) under rainfed at Maryout conditions. The experiment included ten treatments, five biofertilizers (Control, Biovit, Nitrobin, Phosphorin and 1/2 Nitrobin + 1/2 Phosphorin) and biofoliar applications (Water as control and biomagic plus the previous biofertilizers treatments). Nitrogen and phosphorus were added at a rate of 30 Kg calcium superphosphate (15% P_2O_5) and 60 Kg ammonium nitrate (33.5%N) per feddan during seed bed preparation in sand clay loam in texture and calcareous soil in nature. with E.C. 0.78 ds/m, pH 7.91. The experiments in two seasons, were applied as dry sowing and one irrigation at sowing was added, then after, plants were left to grow under rainfall conditions. The amount of rainfall was 159.05 mm in first season and 141.89 mm in second season.

Plant Materials

The seeds of faba bean variety (Nubaria – 1) were obtained from the Agriculture Research Center, Ministry of Agriculture, Giza, Egypt.

Planting

Planting was carried out on 13th November during the both seasons at rate of 60 Kg seeds per feddan. The treatments were arranged on split plot design with three replcates. The plot area was 6m^2 (2 X 3m). Organic manure, calcium super phosphate (15% P_2O_5) fertilizers were added during soil preparation at rates of 20 m3 and 30 Kg P_2O_5 per feddan respectively and 60 Kg ammonium nitrate (33.5% N) per feddan during seed bed preparation. Potassium fertilizer was added as potassium sulfate (50% K_2O) at a rate of 100 kg/feddan after anthesis and during seeds filling. Seeds of faba bean were sowed manually in sand clay loam in texture and calcarious soil in nature.

Application of Treatments

Biofertilizer treatments

A- Control.

B- Biovit, It was a solution of bacterial activators contained (*Azotobacter chrococcum, Bacillus megatherium, Bacillus rubtalis, Pseudomonas floresence, Bradirhizobium japanicum*) this solution was mixed with the soil and seeds of faba bean before sowing at a rate of (1L/ 100 L water).

C- Nitrobin, contains (*Azotobacter chrococcum, Asospirillum brasilens*) It was mixed with seeds before sowing at a rate of 3 package/fed, weight of package 500g.

D- Phosphorin, contains (*Bacillus megatherium*) It was mixed with seeds before sowing at a rate of 3 package/fed, weight of package 500g.

E- Mixture (1/2Nitropin + 1/2 Phosphorin) all these biofertilizers were sprayed with water as control.

Foliar application

The biological product of "Biomagic" consists of:

1. Amino acids (1.90%) which includes arginine, cystine, glycine, histidine, isoleucine, lysine, phenyl alanine, therionine, tryptophan, tyrosine, and valine.
2. Vitamins (0.038%) which includes thiamine, biotine, choline, folic acid, niacin, pantothenic acid, pyridoxine and riboflavin.
3. Macro-elements (mg/l) which includes (11125 N, 550 P_2O_5 and 625 K_2O).
4. Micro-elements (mg/l) which includes 160 Fe, 124 Zn, 100 Mn, 45 Mg, 45 Cu, 12 Mo, 7 Cd and 4 Ni.

Biomagic was applied as plant spray at a rate of (7.5g/50 liter water + 100g sulfur) /experimental area. It was applied 6 times every 15 days after 30 dayes from sowing until 90 dayes.

Sampling

Three plant samples were taken randomly from each treatment during the experiment of each season as follows:

a- Two samples of fresh plants representing two growth stages were collected after 45 dayes (before branching stage) and 60 days (before flowering stage).

b- The third one, represented by seeds, was taken after harvesting.

Growth parameters including fresh and dry weights, plant height and number of tillers for the fresh plants were recorded. Fresh samples were tested for photosynthetic pigments content and free proline content. Then, dried till constant weight representing dry weight.

Dry samples were grounded to fine powder and tested for carbohydrates fractions (total carbohydrates, soluble sugars and reducing sugars), soluble protein, total amino acids content and mineral nutrients content of Na, K, Ca and Mg.

Chemical Analysis of Plant

Determination of photosynthetic pigments

Chlorophyll a, chlorophyll b and carotenoids were determined according to A.O.A.C (1990).

Determination of free proline

Free proline concentration was measured colorimetrically in the extraction of fresh materials according to Bates *et al.* (1973).

Determination of total carbohydrate

Total carbohydrates were determined according to Nelson's method mentioned by Malik and Singh, (1980).

Determination of total soluble sugars

The consentration of total soluble sugars, reducing and non-reducing sugars were determined according to Bernfeld, (1955) and Miller, (1959).

Determination of total protein

Total protein was determined through determination of total nitrogen using modified kjeldahl-boric acid method according to A.A.C.C., (1994).

Determination of soluble protein

Soluble protein was determined according to Lowry's method (Lowry *et al.*, 1951).

Determination of total amino acid

Amino acids composition was determined by amino acid analyzer apparatus model "Eppendorf LC3000"

Determination of Minerals

Potassium, calcium and sodium

Potassium, calcium and sodium concentrations were determined using flame photometer model Perkin-Elmer PFP7 according to Allen, (1974).

Magnesium

Magnesium concentration was determined using atomic absorption (Unican).

The obtained data were subjected to the analysis of variance procedure and means were compared using the L.S.D method at 5% level of significance according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Growth Parameters

Table 1 shows clearly that the highest values of plant hight, fresh and dry weights at the two stages (Branching and flowering) at the two seasons were recorded in plants treated with a mixture of Biomagic + Biovit, if compared with control and other treatments. These results are in agreement with Alian, (2005) who concluded that using the mixture of nitrogen fixing bacteria and phosphate dissolving bacteria combined with spraying the plant with Biomagic led to increments in plant growth. On pea plant, it was shown that inoculation of plants with biomagic increased plant height, fresh and dry weight comparatively with non-inoculated ones (Ismail, 2002). The results showed significant differences in growth parameters due to the variation in treatments.

Yield and Yield Components

Table 2 shows clearly that the highest values of plant hight, number of pods, seeds weight (ton/fed.) and straw weight (ton/fed.) combined at the two seasons (2005/2006 and 2006/2007) were recorded in treatment with mixture of Biomagic + Biovit. These results are coordinate with El-Etr *et al.* (2004) who reported that the highest values of pea and wheat yield were observed with compost inoculated with *Azotobacter chrococcum* in comparison to compost withought any inoculation. Also, Alian (2005) found that the highest values of globe artichoke yield components were significantly affected by fertilization plant with Biovit and spraying with Biomagic. Abd El-Azez (2007) found that tomato early, marketable and total yield were significantly increased by foliar application of Biomagic in two seasons compared with control.

Table 1. Effect of some biofertilizers and biofoliar applications on growth parameters of faba bean during 2005/2006 and 2006/2007 seasons under drought stress

Treatments		Branching stage			Flowering stage		
Foliar	Biofertilizers	Plant h. (cm)	Fresh w. (g)	Dry weight (g)	Plant h. (cm)	Fresh w. (g)	Dry weight (g)
Control	Control	32.0	20.4	3.55	41.3	45.6	9.90
	Biovit	48.6	45.9	7.17	64.0	89.8	15.0
	Nitrobin	44.3	41.2	6.20	55.7	81.6	14.3
	Phosphorin	43.5	37.6	5.14	54.7	72.3	13.5
	1/2Nitro.+1/2Phos.	42.1	35.9	4.96	54.2	70.6	11.7
Biomagic	Control	48.9	43.7	8.52	69.4	76.6	10.5
	Biovit	55.5	52.9	12.5	82.7	88.3	15.9
	Nitrobin	52.4	47.3	11.4	79.0	83.3	14.0
	Phosphorin	49.8	45.3	10.9	75.0	81.0	12.6
	1/2Nitro.+1/2Phos.	49.9	46.2	11.2	76.3	78.6	13.3
	L.S.D at 5%	1.2	1.15	0.56	1.28	1.2	0.71

Means followed by 5% level, of probability according to L.S.D % test.

Table 2. Effect of some biofertilizers and foliar applications on yield parameters of faba bean under drought stress

Treatments		Yield parameters			
Foliar	Biofertilizers	Plant. h. (cm)	No. pods	Seeds w. ton/fed	Straw w. ton/fed
Control	Control	63.7	14.6	0.77	1.16
	Biovit	80.5	35.0	1.32	2.96
	Nitrobin	78.3	32.0	1.26	2.21
	Phosphorin	76.3	30.6	1.23	2.18
	1/2Nitro.+1/2Phos.	77.0	30.3	1.21	2.15
Biomagic	Control	84.7	51.0	2.36	3.12
	Biovit	92.0	69.3	3.49	4.76
	Nitrobin	89.0	62.3	2.86	3.77
	Phosphorin	85.0	59.0	2.34	3.46
	1/2Nitro.+1/2Phos.	87.9	61.6	2.45	3.62
	L.S.D at 5%	1.3	1.94	0.25	0.31

Means followed by 5% level, of probability according to L.S.D % test.

Photosynthetic Pigments

Table 3 showed that the treatment mixture (Biovit + Biomagic) recorded the highest values of chlorophyll a, b and carotenoids compared with control. Pigments, i.e. chlorophyll a, b and caroteniods were decreased as drought stress increased according to Barry *et al.*, (1992) who found that chlorophyll is more sensitive to drought stress than carotenoids and consequently the ratio of total chlorophyll to carotenoids decreases with increasing drought severity. On the other hand biofertilizers are increasing pigments content according to El-Gamal, (1996) who found that on potato inoculation of plants with HALEX2 resulted in a significant increase in leaf chlorophyll content.

Metabolic Products

Total carbohydrates

Table 4 shows that treatment with a mixture of Bivit+Biomagic recorded the highest values in total carbohydrate. The data also showed that total carbohydrates were decreased with increasing drought stress. Abd El-Rahman *et al.* (1994) found that drought caused a reduction of total carbohydrate that may be due to decreased photosynthetic activity, resulting from lowered CO_2 diffusion due to stomatal closure, and/or lower chlorophyll content. Leport *et al.* (1999) and Ma *et al.* (2001) observed a reduction in the rate of leaf photosynthesis in chick pea under stress.

Total soluble sugars (reducing and non-reducing sugars)

Table 4 shows that treatment with a mixture of Bivit+Biomagic recorded the highest values in total soluble sugars, reducing and non-reducing sugars. Total soluble carbohydrates, were increased in plants as response to water stress. On the other hand biofertilized plants revealed higher values of these metabolic products than non fertilized plants. The results agreement with Salamah (1997) who showed that the contents of total soluble sugars reducing and non reducing sugars were increased with applications of biofertilizers as compared with control. Abd El-Azez (2007) reported that tomato fruit content of total soluble solids was increased by Biomagic as foliar application.

Table 3. Effect of some biofertilizers and foliar applications on photosynthetic pigments (mg/g fresh weight) at two stages of faba bean under drought stress

Foliar	Biofertilizers	Branching stage Chlo. a	Chlo. b	Chlo. a+b	Caroten	Flowering stage Chlo. a	Chlo. b	Chlo a+b	Caroten
Control	Control	0.633	0.237	0.87	0.173	0.78	0.35	1.12	0.26
	Biovit	0.836	0.407	1.24	0.307	1.21	0.58	1.79	0.48
	Nitrobin	0.799	0.361	1.16	0.283	1.19	0.56	1.75	0.44
	Phosphorin	0.759	0.347	1.11	0.253	1.13	0.54	1.67	0.42
	1/2Nitro.+1/2Ph.	0.756	0.342	1.1	0.248	1.13	0.53	1.66	0.41
Biomagic	Control	0.936	0.581	1.52	0.313	1.24	0.59	1.82	0.46
	Biovit	1.17	0.712	1.88	0.489	1.56	0.9	2.46	0.65
	Nitrobin	0.996	0.688	1.68	0.451	1.49	0.86	2.35	0.62
	Phosphorin	0.975	0.656	1.63	0.439	1.43	0.83	2.26	0.58
	1/2Nitro.+1/2Ph.	0.985	0.669	1.65	0.448	1.45	0.84	2.28	0.59
	L.S.D at 5%	0.005	0.003	0.008	0.005	0.01	0.006	0.015	0.006

Means followed by 5% level, of probability according to L.S.D % test.

Table 4. Effect of some biofertilizers and foliar applications on total carbohydrate, total soluble and non-soluble sugars concentrations (g% dry weight) at two stages of faba bean under drought stress

Foliar	Biofertilizers	Branching stage Total Carb.	Non S.C	Soluble carbohydrate T.S.S	R.S	Non R.S	Flowering stage Total Carb.	Non S.C	Soluble carbohydrate T.S.S	R.S	Non R.S
Control	Control	23.4	21.9	1.45	0.89	0.56	26.0	24.3	1.63	0.95	0.68
	Biovit	32.3	29.3	3.27	2.39	0.88	38.0	33.7	4.24	3.31	0.93
	Nitrobin	30.0	27.7	2.63	1.65	0.98	34.0	30.3	3.69	2.26	1.43
	Phosphorin	28.9	26.6	2.28	1.41	0.87	32.0	28.6	3.36	2.23	1.13
	1/2Nitro.+1/2Ph.	28.7	26.4	2.25	1.38	0.87	31.0	27.7	3.23	1.78	1.45
Biomagic	Control	30.3	27.4	2.85	1.89	0.96	36.0	32.9	3.41	2.09	1.32
	Biovit	40.3	34.9	5.40	3.93	1.47	46.0	38.6	7.74	4.82	2.92
	Nitrobin	38.3	33.6	4.63	3.33	1.3	43.0	37.1	5.89	4.36	1.53
	Phosphorin	35.6	31.6	3.95	2.9	1.05	40.0	35.3	4.69	3.51	1.18
	1/2Nitro.+1/2Ph.	36.9	32.7	4.23	3.18	1.05	42.0	37.3	4.87	3.62	1.25
	L.S.D at 5%	1.16	1.025	0.13	0.09	0.04	1.2	1.12	0.22	0.12	0.13

Means followed by 5% level, of probability according to L.S.D % test.

Non S.C = Non soluble carbohydrate
T.S.S. = Total soluble sugars
R.S. = Reducing sugars
Non. R.S. = Non reducing sugar

Protein and Proline Content

Table 5 shows that treatment with mixture Biovit + Biomagic recorded the highest values for total protein, soluble protein, and proline contents. Plants treated with the same treatment (Biomagic+ Biovit) recorded the highest values for protein content compared with control. On the other hand total soluble carbohydrates, total soluble amino acids, total soluble protein and proline were increased in plants as response to water stress. Protein represents the main component of beans. Protein content of the leaves of faba bean significantly decreased with increasing drought stress according to Irigoyen *et al.* (1992) who reported that a general decline in protein synthesis occurred under water stress. Biofertilized plants revealed higher values of these metabolic products than non fertilized plants. Kishore *et al.* (2005), Hsu *et al.* (2003) and Ozturk and Demir (2002) concluded that proline is known to occur widely in higher plants and normally accumulates in large quantities in response to environmental stress. In addition to its role as an osmolyte for osmotic adjustment, proline contributes to stabilizing subcellular structure (e.g. membranes and proteins) scavenging free radicals and buffering cellular redox potential under stress conditions. Certain metabolic processes are triggered in response to stress, which increase the net solute concentration in the cell, thereby helping the movement of water into the leaf resulting in increase in leaf turgor. Large number of compounds are synthesized, which play a key role in maintaining the osmotic equilibrium and in protection of membranes as well as macromolecules.

Minerals Content

Data in Table 6 showed that treatment with interaction (Biovit + Biomagic) recorded the highest values for Ca, Mg, Na and K at two stages in agreement with those results obtained by Vijaya and Srivasuki (2001) they stated that dual inoculcation with biofertilizers increased plant growth and nutrient uptake (P, Ca, Mg, Na, and K) of micropropagated teak plants. Ions are main importance to the water relation of leaf cells. For xerophytes, ions are important in the generation of low osmotic potential, although physical properties of the plant are also vital for drought tolerance. However, for mesophytes adapting to drought, the supply of ions from roots is limited (by diffusion through the

Table 5. Effect of some biofertilizers and foliar applications on total protein, soluble, non soluble protein (g/100g dry weight) and proline content in leaves of faba bean (μ mol/g fresh weight) under drought stress

Treatments		Branching stage				Flowering stage			
Foliar	Biofertilizers	Proline	Total protein	Soluble protein	Non Soluble p.	Proline	Total protein	Soluble protein	Non soluble p.
Control	Control	4.55	15.4	2.33	13.07	6.31	10.7	1.29	9.41
	Biovit	7.79	19.5	4.35	15.5	10.3	16.9	3.36	13.5
	Nitrobin	6.47	18.7	3.99	14.7	9.53	14.9	3.25	11.6
	Phosphorin	6.31	18.2	3.79	14.4	9.28	13.7	3.19	10.5
	1/2Nitro.+1/2Pho.	6.28	18	3.66	14.3	9.21	13.4	3.11	10.2
Biomagic	Control	8.72	19.2	4.55	14.6	10.8	14.7	3.22	11.8
	Biovit	10.9	23.9	6.21	17.9	14.6	18.8	5.7	13.1
	Nitrobin	10.3	21.3	5.81	15.9	13.3	17.75	4.6	13.5
	Phosphorin	9.46	20.3	5.37	14.9	12.7	17.2	4.11	13.09
	1/2Nitro.+1/2Pho.	10.2	20.7	5.55	15.5	12.9	17.4	4.26	13.14
	L.S.D %	0.16	0.5	0.13	0.37	0.19	0.47	0.19	0.35

Means followed by 5% level, of probability according to L.S.D % test.

Table 6. Effect of some biofertilizers and foliar applications on some minerals composition (g/100g dry weight) at two stages of faba bean under drought stress

Treatments		Branching stage				Flowering stage			
Foliar	Biofertilizers	Ca	Mg	Na	K	Ca	Mg	Na	K
Control	Control	1.28	2.13	1.14	1.79	1.12	1.03	0.76	1.13
	Biovit	2.79	3.33	1.66	3.49	2.36	2.77	1.37	3.23
	Nitrobin	2.26	3.19	1.51	3.38	1.64	2.64	1.36	3.13
	Phosphorin	2.15	3.13	1.46	3.32	1.50	2.47	1.33	3.1
	1/2Nitro.+1/2Phos.	2.12	3.11	1.42	3.30	1.30	2.53	1.29	3.07
Biomagic	Control	2.33	2.32	1.84	2.95	1.76	1.10	1.30	2.6
	Biovit	4.61	3.21	1.85	4.35	4.14	1.79	1.35	4.1
	Nitrobin	4.40	2.95	1.78	4.11	3.87	1.54	1.33	3.73
	Phosphorin	3.94	2.65	1.69	3.95	3.19	1.39	1.28	3.50
	1/2Nitro.+1/2Phos.	4.24	2.75	1.59	4.03	3.21	1.48	1.24	3.61
	L.S.D at 5%	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02

Means followed by 5% level, of probability according to L.S.D % test.

soil) and they have a relatively minor role in osmotic adjustment (Flowers and Yeo, 1986). Generally NPK contents were higher by biofertilizer treatment than non fertilized plants. Mahajan and Tuteja (2005) reported that K^+ is required for maintaining the osmotic balance and has a role in opening and closing of stomata. Also K^+ is an essential co-factor for many enzymes. In stressed plants large numbers of organic or inorganic ions were accumulated which provide resistance against drought (Hoekstra *et al.* 2001). Mahmoud and Mahmoud (1999) found that biofertilizer (*Azotobacter chroococcum* or *Bacillus megatherium*) treatments significantly increased leaf micronutrient (N, P, K, Mg, Ca and Fe) contents of peach seedlings. The significant effect of biofertilizers may be due to the effect of different strain groups and nutrient mobilizing microorganisms which help in availability of metals and their forms in the composted material and increased levels of extractable minerals (El-Kramany *et al.*, 2000).

Seed Metabolic Products

Carbohydrates and protein content

Commonly highest amounts of total carbohydrate, total soluble sugars (reducing and non reducing) and total crude protein contents (soluble and non soluble protein) were obtained in plants treated with biofertilizers compared with control. It means that the highest nutritional value of faba seeds under drought stress treated with biofertilizers and Biomagic as foliar application were recorded in treatmen with Biovit+Biomagic and these results were at the same trend in both seasons (Table 7). However, the previous investigations reported that bio-N, P –fertilizer improved the physical and chemical properties of the yield (Ranganathan and Selvaseclan, 1997 and Zahir *et al.*, 1997). Abdalla *et al.* (2001) and Abdel-Mouty *et al.* (2001) reported that bio-fertilizer application improves fruit yield and chemical composition, which were in agreement with the results.

Amino Acids Content

Sixteen amino acids were detected in seeds of faba bean. These amino acids were presented in Table 8 a and b. Amino acids were divide into essential amino acids, i.e. therionine, valine, methionine, leucine, isoleucine, phenyl alanine, lysine, histidine, arginine and non-essential amino acids i.e. glutamic acid, aspartic acid, glycine, tyrosine, proline, alanine and serine. It is clear that glutamic acid, aspartic acid, serine, proline, glycine, alanine therionine, arginine, lysine, leucine, isoleucine and phenyl alanine occurred in higher amounts in treated plants and control. Further than, glutamic and aspartic acids were appeared to be the dominating amino acid in yielded seeds of control and treated plants. All amino acids were increased in all treatments as compared to control values; water stress caused remarkable increases significantly in all detected amino acids. The obtained results agree with Zayed and Zeid (1998) they found that contents of soluble proteins, amino acids and proline were increased under drought stress. The accumulation of such organic solutes is increasing the cytoplasmic osmoregulation and thus, increases plant tolerance. Table 8 a and b showed that the treatment mixture (Biomagic + Biovit) was recorded the highest values for total amino acids under drought stress compared with control and other treatments. The effect of biofertilizers may be due to the effect of different strain groups such as nitrogen fixers and nutrient mobilizing of microorganisms according to El-Kramany *et al.* (2000).

Table 7. Effect of some biofertilizers and foliar applications on total protein, soluble and non soluble protein, total carbohydrate, total soluble sugars, reducing and non reducing sugars (g/100g dry weight) on seeds of faba bean under drought stress

Treatments		Seeds Quality							
Foliar	Biofertilizers	Total Prot.	Soluble Prot.	Non S.P.	Total Carb.	Non Soluble Carb.	Soluble carbohydrate T.S.S	R.S.	Non R.S
Control	Control	11.22	1.16	10.06	39.7	38.47	1.23	0.79	0.44
	Biovit	18.23	3.33	14.9	46.4	43.31	3.09	1.83	1.26
	Nitrobin	17.42	3.22	14.2	44.3	41.97	2.33	1.50	0.83
	Phosphorin	16.76	3.16	13.6	43.5	41.2	2.3	1.32	0.98
	1/2Nitro.+1/2Phos.	16.40	3.09	13.31	43.2	40.97	2.23	1.30	0.93
Biomagic	Control	19.00	3.20	15.80	51.3	48.65	2.65	1.78	0.87
	Biovit	22.9	4.40	18.5	58.3	53.61	4.69	2.88	1.81
	Nitrobin	21.0	4.20	16.8	55.3	50.89	4.41	2.63	1.78
	Phosphorin	19.3	3.90	15.4	53.3	49.19	4.11	2.47	1.64
	1/2Nitro.+1/2Phos.	19.8	3.90	15.9	54.4	50.09	4.31	2.56	1.75
	L.S.D at 5%	0.37	0.16	0.32	0.9	0.69	0.17	0.05	0.02

Means followed by 5% level, of probability according to L.S.D % test.

Prot. = Protein S.P. = Soluble Protein Carb. = Carbohydrate

Table 8 a. Effect of biofertilizers and foliar applications on total amino acids, (essential amino acids "mg/g dry weight") in seeds of faba bean under drought stress.

Treatments		Essential amino acids								
Foliar	Biofertilizers	Therionine	Valine	Methionine	Isoleucine	Leucine	Phenyl alanine	Histidine	Lysine	Arginine
Control	Control	1.25	1.21	0.25	1.27	1.18	0.77	0.57	1.1	1.78
	Biovit	2.31	2.05	0.51	2.05	3.05	2.21	1.99	2.14	4.52
	Nitrobin	2.12	1.71	0.42	1.96	2.97	2.09	1.75	1.96	4.02
	Phosphorin	1.94	1.65	0.4	1.91	2.62	1.78	1.36	1.91	3.68
	1/2Nitro.+1/2Phos.	1.86	1.97	0.39	1.77	2.35	1.74	1.29	1.9	3.9
Biomagic	Control	2.44	2.39	0.76	2.7	2.97	1.68	2.07	2.13	3.31
	Biovit	3.31	2.83	0.89	3.12	3.31	2.83	2.82	3.32	6.25
	Nitrobin	3.23	2.73	0.82	2.89	3.23	2.74	2.76	3.23	6.02
	Phosphorin	3.09	2.65	0.77	2.83	3.03	2.63	2.53	3.12	5.87
	1/2Nitro.+1/2Phos.	3.12	2.69	0.79	2.96	3.16	2.68	2.64	3.16	5.95

Table 8 b. Effect of biofertilizers and foliar applications on total amino acids (non-essential amino acids, "mg/g dry weight") in seeds of faba bean under drought stress

Treatments		Non-essential amino acids						
Foliar	Biofertilizer	Aspartic acid	Serine	Glutamic acid	Proline	Glycine	Alanine	Tyrosine
Control	Control	2.07	1.12	3.43	1.17	1.15	1.08	0.43
	Biovit	4.91	2.28	5.4	2.06	2.44	2.13	1.41
	Nitrobin	4.66	2.19	5.02	1.98	2.31	2.09	1.34
	Phosphorin	4.45	2.14	4.66	1.74	2.21	2.05	1.25
	1/2Nitro.+1/2Phos.	4.25	2	4.52	1.72	2.18	1.98	1.21
Biomagic	Control	4.19	2.05	4.85	2.11	2.64	2.33	1.38
	Biovit	6.63	3.34	6.65	3.33	3.25	2.89	2.14
	Nitrobin	6.23	3.2	6.38	3.2	3.05	2.79	2.07
	Phosphorin	5.87	2.91	6.2	3.09	2.86	2.7	1.96
	1/2Nitro.+1/2Phos.	6	3.12	6.32	3.12	2.91	2.75	2

Conclusion

It could be concluded that biofertilizers: (Biovit, Nitrobin and Phosphorin) and Biomagic as biofoliar application stimulated plant growth and yield and induced drought tolerance by enhancing the accumulation of certain metabolites i.e. sugars,amino acids, proline and protein. On the light of the obtained results, it can be recommended that, using the combined treatments of Biomagic at a rate of 7.5g/l, 100g sulfur plus Biovit may be recommended to improve growth and chemical composition of faba bean under drought stress.

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الدلائل البيوكيميائية لمقاومة الجفاف فى الفول البلدى باستخدام بعض الأسمدة الحيوية والأسمدة الحيوية الورقية

محمود محمد محمد الصابر[1]– حسنى ابو العز سلام[1]
رجـب المصـــرى[2] – محمــود زكى سطوحى[2]

١ – مركز بحوث الصحراء – قسم الاصول الوراثية النباتية– وحدة الكيمياء الحيوية – المطرية – القاهرة – مصر.

٢ – قسم الكيمياء الحيوية – كلية الزراعة – جامعة الزقازيق– مصر.

أجريت تجربتين حقليتين خلال موسمى ٢٠٠٥/٢٠٠٦ و ٢٠٠٦/٢٠٠٧ بمحطة بحوث مريوط بالإسكندرية التابعة لمركز بحوث الصحراء وذلك لدراسة الدلائل البيوكيميائية فى الفول البلدى تحت الظروف المطرية بمريوط باستخدام بعض الأسمدة الحيوية ممثلة فى (البيوفيت، النتروبين والفوسفورين) والبيوماجيك كسماد رش على النباتات وتاثيرها على صفات النمو والمحصول وبعض المكونات البيوكيميائية وجودة البذور فى الفول البلدى (نوبارية – ١) النامية تحت الظروف المطرية والاراضى الكلسية. وكانت نسبة المطر فى الموسمين ١٥٩,٠٥ و ١٤١,٨٩ مم مطر على الترتيب. ويمكن تلخيص النتائج كما يلى:

١– وجد أن للإجهاد المائى تأثير سلبى واضح على القياسات الفسيولوجية (طول النبات، الوزن الرطب والوزن الجاف) عند مرحلتى النمو (التفريع والتزهير) وقد أظهرت معاملات التسميد الحيوى والتسميد الورقى بالبيوماجيك ارتفاع معنوى لقيم تلك القياسات مقارنة بالكنترول. وسجلت المعاملة بالبيوفيت والبيوماجيك أعلى القيم للقياسات الفسيولوجية.

٢– ظهرت فروق معنوية فى المحصول ومكوناته بين المعاملات والكنترول وسجلت المعاملة بالبيوفيت والبيوماجيك أعلى قيم لطول النبات وعدد الفروع وعدد القرون فى النبات وإنتاج البذور ومحصول القش من الفدان.

٣– وجد أن الإجهاد المائى يؤدى الى نقص فى المحتوى الكلوروفيللى والكاروتينى وادى استخدام التسميد الحيوى والبيوملجيك إلى حث النمو الخضرى وزيادة ملحوظة فى

المحتوى الكلوروفيللى والكاروتينى. وسجلت المعاملة بالبيوفيت والبيوماجيك أعلى قيم لكلوروفيل أ ، ب والكاروتينات.

٤- قلت الكربوهيدرات الكلية مع زيادة الإجهاد المائى بالنسبة للكنترول مقارنة بالمعاملات. وسجلت المعاملة بالبيوفيت والبيوماجيك أعلى قيمة لمحتوى الكربوهيدرات الكلية.

٥- زادت السكريات الذائبة الكلية المختزلة والغير مختزلة مع زيادة الإجهاد المائى. وسجلت المعاملة بالبيوفيت والبيوماجيك أعلى قيمة لمحتوى السكريات الذائبة الكلية المختزلة والغير مختزلة مقارنة بالكنترول.

٦- انخفض محتوى البروتين مع زيادة الإجهاد المائى بينما زادت البروتينات الذائبة تحت نفس الظروف وسجلت كل معاملات التسميد الحيوى والبيوماجيك زيادة معنوية فى محتوى البروتين والبروتينات الذائبة فضلا عن معاملة البيوفيت والبيوماجيك التى سجلت أعلى قيمة للبروتين والبروتينات الذائبة مقارنة بالكنترول والمعاملات الاخرى.

٧- ازداد محتوى البرولين معنويا نتيجة لزيادة الإجهاد المائى وسجلت المعاملة بالبيوفيت والبيوماجيك أعلى محتوى للبرولين تحت ظروف الإجهاد المائى.

٨- زاد محتوى العناصر المعدنية (الصوديوم، البوتاسيم، الكالسيوم والماغنسيوم) وذلك بزيادة الإجهاد المائى وسجلت المعاملة بالبيوفيت والبيوماجيك أعلى محتوى من العناصر المعدنية تحت ظروف الإجهاد المائى.

٩- اظهر التحليل الكيميائى للبذور إلى زيادة صفات القيمة الغذائية للبذور ممثلة فى تحسن محتوى البروتين والكربوهيدرات والسكرات الذائبة الكلية والبروتين الذائب والأحماض الامينية الكلية. وقد سجلت معاملة البيوفيت والبيوماجيك أعلى قيمة لتلك المكونات البيوكيميائية تحت ظروف الإجهاد المائى.

١٠- أدى استخدام التسميد الحيوى إلى زيادة عملية التمثيل الضوئى وبالتالى زيادة كلا من الكربوهيدرات الذائبة والغير ذائبة والبروتين الذائب والغير ذائب والأحماض الامينية وكذلك العناصر المعدنية وسجلت المعاملة بالبيوفيت والبيوماجيك أعلى القيم من تلك المكونات.