Australian Journal of Basic and Applied Sciences, 1(4): 657-666, 2007
ISSN 1991-8178

Improvement of Growth and Seed Yield Quality of *Vicia faba* L. Plants as Affected by Application of Some Bioregulators

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Abstract: Growth improvement, yield parameters and its components, photosynthetic pigments, mineral ions contents as well as the seed yield quality (represented by total carbohydrate and protein contents) of *Vicia faba L.* plants were studied in a field experiment during two successive growth seasons under the influence of some bioregulators (GA_3, IAA, benzyl adenine at the rate of 100 ppm or growth retardant ancymidol at the rate of 100 ppm). Generally, application of all the used treatments led to significant changes in the following items: plant height, average number of leaves, leaf area per plant and the dry weight of the shoot in both seasons. Application of benzyl adenine, IAA or ancymidol caused reduction in the flower abscission percentage and then producing the highest number of pod setting during the two seasons. All the used treatments of bioregulators caused marked changes in the seed yield and its components per plant (pod length, number of pods / plant, number and weight of seeds per pod as well as weight of 100 seeds). Photosynthetic pigments and mineral ions (Ca, K, and Mg) contents were gradually increased with plant age up to 90 DAS due to application of the bioregulators. All the used bioregulators caused significant increase in the protein and total carbohydrate percentage of the produced seeds resulted from the treated plants. The highest values of protein (25.46 %) and carbohydrate (59.94 %) were obtained from the application of benzyl adenine at the first season.

Keywords:

INTRODUCTION

Faba bean *(Vicia faba L.)* is one of the most important winter crops of high nutritive value in the world as well as in Egypt. Mature seeds of faba bean are a good sources of protein (about 25% in dried seeds), starch, cellulose, vitamin C and minerals (Hamilton, 2005). Therefore, they have an increasing importance for human and animal food in the future.

High yield, smaller seeds, less anti-nutritional factors, high adaptation ability to modern agriculture will make this plant more attractive for farmers, feed and food manufactures (Duc, 1997).

Although faba bean are consumed less in western countries, it is one of the main source of protein and energy for much in Africa, Asia and Latin America. It is a good alternative to expensive meat and fish protein. The longevity of storage life, ease of transportation and their low coast are attractive points for farmers.

Faba bean are consumed as fresh faba bean bods, seeds, conservative faba bean and as a dried seeds. Moreover, they have been used as a drug kidney stones, liver malfunctioning and eye diseases. At the same time they are used for animal food, broken seeds are mixed into animal diet and the vegetative parts of the plants are used as the animal fodder (Akcin, 1988).

Plant growth regulators are known to influence growth and development at very low concentrations but inhibit plant growth and development at high concentrations (Jules *et al.* 1981). Several researches have shown the stimulatory effects of growth regulators on the vegetative growth and yield of plants. Gibberellic acid has been used to stimulate stem and petiole extension in rhubarb, celery and water cress (Thomas 1976). Treatment of radish and onion seeds with auxin or a mixture of gibberellic acid (GA_3) and kinetin have been found to increase the germination of the seeds (Thomas 1976). Monthly foliar spraying of geranium *(Pelergonium graveolens)* resulted in increased plant height and herb production (Mohammed *et al.* 1983). Application of gibberellic acid, 4-chloroindole and 6-benzyl amino-purine on to the standard petal and calyx of *Vicia faba* var. major before or after tripping was found to significantly enhance pod set (Rylott and Smith 1990). Likewise, spraying of *Vicia faba* cv. Troy reproductive structure with indole-3-acetic acid, gibberellic acid or 6-benzylaminopurine resulted in increased pod number (Clifford *et al.* 1992).

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Ancymidol is a synthetic pyrimidine used as a growth retardant, its activity analogues of uniconazole i.e. inhibit the biosynthesis of gibberellins at their primary mode of action and induce the production of ethylene and abscisic acid (Hazebroek and Coolbaugh 1990). Chung Jaedong *et al*., (1999) indicated that foliar application of ancymidol improved the growth and productivity of *Bletilla striata* plants. In this concern Bekheta, (2000) found that application of growth retardant uniconazole improvemed growth and yield of faba bean plants grown under salinity stress.

In Egypt the balance between the production and the consumption of faba bean represented about 60 % of the national demands. For this reason efforts should be directed towards increasing and improving the faba bean yield, in order to fill the gap between production and consumption. Therefore, increasing the plant productivity is one of the main targets in Egyptian agricultural policy, this could be achieved through fertilization and /or growth regulators treatments including promoters and retardants.

Aim of the Work:

For the economical value of *Vicia faba* plants the present investigation was under taken as a trail to improve and increase its growth and yield by using some safe bioregulators as a foliar spray.

MATERIALS AND METHODS

Two field experiments were carried out during two successive growth seasons (2005/2006 and 2006/2007) at the Experimental Farm, Faculty of Agriculture, Menofyia University. The seeds of *Vicia faba L*. Giza 2 were obtained from the Legumes Crops Research Centre, Ministry of Agriculture Egypt and selected for uniformity in size and colour. The area of each experimental plot was 16.8 m^2, including seven rows 4 meters long and 60 cm apart. The seeds were sown on 10^{th} and 14^{th} of November in both seasons respectively in hills 20 cm apart on one side of the ridge. Twenty two days after sowing the plants were thinned to two plants / hill, i.e 70000 plant/fad. The preceding crop was maize in both seasons. Nitrogen fertilizer (in the form of urea 46.5 %) was applied at the rate of 15 kg N / fad before the first irrigation.

The plants were sprayed twice at 35 and 50 days after sowing with freshly prepared solutions of Gibberellic acid (GA_3), Indole acetic acid (IAA), Benzyl adenine (BA) or with the growth retardant ancymidol at the rate of 100 ppm using 1.5 and 2.5 litter of solution respectively for each experimental plot.

In each plot the external two rows were left as a border. The remaining five rows were divided into two sections, the first section included two rows for recorded plant growth and flowering characteristics, while the second section included three rows for estimating yield and its components. Physical and chemical properties of experimental soil are presented in Table (1).

Table 1: Physical and chemical properties of the top experimental soil during 2005/ 2006) seasons.

1-Physical properties

Properties / Seasons	Fine sand %	Coarse sand %	Silt %	Clay %	Texture class
2004/2005	22.90	12.99	29.80	33.40	Clay loam
2005/2006	24.70	7.80	35.00	35.10	Clay loam

2-Chemical properties

properties / Seasons	pH	E.C mmohs/cm	O.M. %	$CaCO_3$ %	Soluble Cations (meq/l)				Soluble anions (meq/l)			
					Ca^{++}	Mg^{++}	Na^{++}	K^+	Co_3	HCO_3	Cl	So_4
2004/2005	7.8	0.44	2.09	1.47	1.60	1.01	1.38	0.24	--	0.10	1.27	1.00
2005/2006	7.9	0.40	1.77	1.78	1.84	0.91	1.49	0.18	--	0.09	1.36	1.08

3- Macro and micro nutrients available

Elements / Seasons	Micro nutrients (ppm)						Macro nutrients (ppm)		
	Fe	Zn	Mn	Cu	Mo	B	N	P	K
2004/2005	2.73	0.90	5.12	1.29	0.14	0.05		7.44	211.40
2005/2006	3.12	1.10	5.36	2.05	0.19	0.07		6.54	300.20

Sampling:

Three samples (12 guarded plants for each) were collected at random from each plot at 60, 75 and 90 days after sowing and each sample were divided into three sections as follows:-

First Section:

The plants in this section were used for recorded and calculated the growth and yield parameters.

Second Section:

The new leaves of the plants were used for determination of photosynthetic pigments

Third Section:

In this section the roots of the plants were removed and the shoots were weighted dried in an electric oven at 70 C^0 till constant weight, ground to fine powder by means of an electric mill and kept until required for chemical analysis mineral ions content.

Vegetative Growth Parameters:

In each sample of the three collected samples the plants were collected at random and used for recording and calculating the growth and yield parameters. e.g. plant height (cm), number of branches/plant, number of leaves/plant, number of pods/plant (90 days after sowing), leaf area / plant (cm^2), stem dry weight /plant (g), leaves dry weight / plant (g), pods dry weight (g) and total dry weight / plant (g).

Reproductive Parameters:

During blooming stage five plants were marked at random in each plot in the field. The following characters were recorded per marked plant (included main stem and lateral branches). Flowers number and pods settings were counted during flowering stage with three days intervals beginning at blooming of the first flower until the end of the blooming stage, then the flowering and poding curves were done.

Yield and its Components:

For each experimental plot at harvest stage from three inner rows the following characters were recorded:-

- Number of pods / plant
- Pod length (cm)
- Seeds number / pod
- Seeds weight / pod
- Weight of 100 seeds (g)
- Seed yield / plant (g)
- Seed yield / fad (ton)
- Straw yield / fad (ton)
- Biological yield / fad (ton)
- Harvest index (%)

Chemical Analysis:

Estimation of Photosynthetic Pigments:

The photosynthetic pigments (chlorophyll a, chlorophyll b and carotenoids) were estimated by the spectrophotometic method recommended by Metzner *et al,* (1965). A known fresh weight (0.5 g) of the new leaves was homogenized in 85 % acetone for 5 minutes. The homogenate was centrifuged and the supernatant was made up to volume with 85 % acetone. The extraction was measured against a blank of pure 85 % aqueous acetone at 3 wave lengths of 452.5, 644 and 663 nm using Spekol spectro colorimeter VEB carl-Zeiss. Taking into consideration the dilution made, it was possible to determine the concentration of the pigment fraction (chlorophyll a, chlorophyll, b and carotenoids) as ug / ml using the following equations:-

- Chlorophyll a = 10.3 E 663 – 0.918 E 644 = ug/ml
- Chlorophyll b = 19.7 E 644 – 3.870 E 663 = ug/ml
- Carotenoids = 4.2 E 452.5 – 0.0264 Chl.a + 0.426 Chl b = ug/ml

Where E equal optical density at the given wave length

Mineral Ions Content:

Fine dry powder of plant material was digested according to Koch and Mac-Meekin (1924), dissolved in distilled water and completed to a definite volume, filtered through Whatman No.1 filter paper and the filtrate was kept in tightly screwed brown bottles until required.

Calcium and Potassium contents of the acid digest were estimated photometrically using a flame photometer (with the propreit filter) according to Brown and Lilliand (1946).

A series of separate standard solutions of calcium and potassium were prepared and estimated on the flame photometer for standard solutions and the samples were recorded. The percent of Ca and / or K was estimated from the equation:-

$$\text{Ca or K } (\%) = \frac{\text{conc. (ppm)}}{\text{wt. of sample (g) x10}}$$

conc. as ppm = reading of sample (optical density) x slope of corresponding standard curve.

Determination of magnesium element in acid digest solution of the samples was carried by the aid of atomic absorption spectrophotometer according to Carpena *et al.*(1990) and its percentage was calculated from the equation:

$$\text{Mg } (\%) = \frac{\text{conc. (ppm)}}{\text{wt. of sample (g) x10}}$$

where conc. ppm = reading (optical density) x slope of standard curve

Protein Content of the Seeds:

Total nitrogen percentage of *Vicia faba* seeds was extracted and determined by micro- Kjeldahl method as described by A.O.A.C. (1975). While the percentage of protein in the seeds was calculated by multiplying total --N by factor 6.25.

Seeds Total Carbohydrates:

Total carbohydrate percentage in *Vicia faba* seeds was determined using the method described by Dubois *et al.* (1956).

V- Statistical analysis

The data were statistically analyzed according to the methods described by Snedecor and Cochran (1982). Duncan,s multiple range test (Duncan 1955) was used to compare between the means treatments. The mean values within each column followed by same letters are not significantly different at 5 % level of probability.

RESULTS AND DISCUSSIONS

Vegetative Growth Parameters:

Data of the measured vegetative growth parameters of *Vicia faba* plants in relation to the applied bioregulators are presented in Table (2). Generally, application of bioregulators led to significant changes in the plant height in both seasons. The highest values were obtained from the application of GA_3 or IAA as compared with those obtained from the control and other treatments. On the other hand, application of ancymidol in both seasons caused reduction in the plant height as compared with the control plants.

The obvious promoting effect of GA_3 and IAA on faba bean plant height is quite expected. Marschner (1986) indicated that application of GA_3 and / or IAA on higher plants caused elongation in the primary cells in the young tissues and growth centers. In this respect, other investigators reported that faba bean plant height was increased due to foliar application of GA_3 or IAA as recorded by Shalaby and Ahmed (1994) and Abdel-Fattah (1997). In addition, Bekheta (2004) reported that foliar application of GA_3 on wheat plants caused increase in plant height. In the present work the reduction in plant height due to application of growth retardant ancymidol might be attributed to the interference of ancymidol in the gibberellin biosynthesis through preventing oxidation of ent-kaurene to ent-kaurenoic acid which led to inhibition of gibberellin biosynthesis (Chung Jaedong *et al*., 1999 using ancymidol; Bekheta and Ramadan, 2005 using uniconazole and Mahgoub *et al*,2006 using paclobutrazole).

Regarding the average number of branches/ plant the data showed that foliar application of bean plants with different bioregulators led to positive effect at all the studied growth stages. The highest numbers of branches / plant (3.75 and 4.00) were obtained from the application of benzyl adenine at 90 DAS for the first and the second seasons respectively. The differences in the number of branches/ plant due to application of benzyl adenine, ancymidol or IAA were not significant at all the studied growth stages during two growth seasons. These results are supported by Michael and Beringer (1980) who reported that cytokinins play an important role for increasing the number of lateral buds as well as the number of branches / plant. Moreover,

Table 2: Vegetative growth parameters of faba bean plants as treated by some bioregulators during two successive growth seasons.

Characters	treatments	1st season (2004/2005) Age (day after sowing) 60	75	90	2ed season (2005/2006) 60	75	90
Plantheight (cm)	0.0	62.91 b	78.45 b	98.53 a	57.53 b	70.95 b	92.20 b
	GA_3	68.62 a	90.53 a	100.03a	67.45 b	88.45 b	100.71a
	IAA	63.87 b	83.67ab	99.70 a	61.34 b	84.12ab	99.45a
	BA	63.45 b	83.51ab	99.03 a	61.23 b	82.87 b	97.45a
	Ancy.	60.21 b	87.12 b	93.37 a	56.33 b	79.51 b	90.20 b
No.of branches / plant	0.0	2.92 a	3.00 c	3.08 b	3.00 b	3.08 b	3.50 c
	GA_3	3.17 a	3.25 bc	3.33 ab	3.17ab	3.42 b	3.75bc
	IAA	3.08 a	3.42 ab	3.58 ab	3.08ab	3.17ab	3.83bc
	BA	3.17 a	3.67 a	4.25 a	3.50 a	3.75 a	4.50 a
	Ancy.	3.17 a	3.42 ab	3.50 ab	3.25ab	3.50ab	4.00 b
No. of leaves / plant	0.0	29.42b	33.92c	41.50a	26.25 b	36.00 c	43.83b
	GA_3	31.83ab	42.42ab	44..58a	30.50ab	42.75ab	52.00b
	IAA	30.75ab	36.92bc	46.33a	30.25ab	42.50abc	50.75a
	BA	34.75a	45.08a	50.33a	33.75a	46.00a	54.75a
	Ancy.	30.00ab	42.67ab	48.50a	28.25 b	39.67bc	60.00a
Leaf area /plant (cm^2)	0.0	851.22b	1346.33c	1614.93b	906.14b	1223.25c	1558.91c
	GA_3	934.92b	1448.89bc	2050.22a	966.47ab	1435.82bc	1805.53bc
	IAA	1032.93ab	1645.50ab	2027.12a	1125.74a	1523.75b	2003.70ab
	BA	1161.20a	1876.36a	2232.32a	1149.25a	1882.15a	2192.73a
	Ancy.	1140.04a	1688.41ab	2225.33a	985.98ab	1677.70ab	2169.88a
Stem dry wt. / plant (g)	0.0	5.49 b	9.57 c	13.23 b	5.62 c	7.96 b	14.52 b
	GA_3	5.87 b	10.96bc	17.92 ab	6.46 bc	9.13 b	18.45 a
	IAA	6.41 ab	12.67ab	18.53 ab	6.64 bc	9.31 b	19.63 a
	BA	8.20 a	14.13 a	19.17 a	8.30 a	12.57 a	20.13 a
	Ancy.	6.09ab	9.83 bc	18.18 ab	17.08 ab	8.44 b	19.11a
Leaves dry wt./ plant (g)	0.0	3.38 b	6.11 c	7.67 b	4.98 a	6.41 d	8.84 c
	GA_3	4.35 ab	8.96 ab	9.98ab	6.29 a	8.01 c	10.23 b
	IAA	4.17ab	8.02 bc	8.84 b	5.44 a	8.66 bc	10.80 b
	BA	5.17a	11.16 a	12.07 a	6.22 a	10.67 a	12.44 a
	Ancy.	3.70ab	9.24 ab	11.99 a	5.36 a	9.52 b	12.30 a
Total dry wt./ plant (g)	0.0	8.77 b	15.58 b	24.25 b	10.51b	14.27 b	25.46 c
	GA_3	10.03 b	19.82 b	33.05a	12.56ab	17.04 b	32.33 b
	IAA	10.48 b	20.68 ab	31.27a	11.97b	17.88 b	33.69ab
	BA	13.27 a	25.29a	37.79a	14.42a	23. 15 a	36.77a
	Ancy.	9.69 b	18.97b	34.93a	12.34ab	17.87 b	34.70ab

GA_3= gibberellic acid BA= benzyl adenine Ancy.= ancymidol IAA= Indole acetic acid

the ability of CCC and / or kinetin counteract the apical dominance either by arresting the active growth of main shoot meristem or through the differentiation of vascular tissue which contribute for increasing the number of lateral branches (Schiling, 1985). In this concern, many investigators indicated that the number of branches / faba bean plant were increased due to application of growth regulators (e.g. Shalaby, 1995 using kinetin; Etman *et al.,*1991 using CCC; Shalaby and Ahmad , 1994 using IAA , Rashad and Ahmad, 1996 using GA_3; Bekheta, 2000 using uniconazole and Mahgoub *et al.,*2006 using paclobutrazole).

It can be noticed generally from the data recorded in Table (2) that the highest values of the number of leaves / plant (49.83 and 54.25) were obtained by application of benzyl adenine at 90 days age. The superiority of these results due to application of growth regulators especially benzyl adenine might be attributed to the increased in the average number of branches and /or plant height. These results are in accordance with other researchers who found that application of kinetin , GA_{3} , uniconazole on faba bean increased the number of leaves / plant (El- Beheidi *et al.,*1991; Shalaby and Abdel Halim 1995; Abel- Fattah, 1997 ; Bekheta, 2000; El –Kady,2002 and Mahgoub *et al.,*2006).

Data recorded in table (2) showed that spraying faba bean plants with bioregulators caused significant increase in leaf area / plant at all the studied growth stages in both seasons. It can be noticed from the above mentioned results that application of bioregulators benzyl adenine, IAA or GA_3 were more effective in the leaf area per plant than ancymidol in both seasons at all the studied growth stages. The present results may be attributed to stimulative influence of these bioregulators on cell extension and /or on cell division while the ancymidol had an inhibition effect on cell extension. These finding are similar to those reported by other researchers (Bekheta, 2000 and El- Kady 2002) who found that application of growth retardant uniconazole on *Vicia faba* and wheat plants caused reduction in the leaf area / plant. In addition Bekheta (2004) reported that application of GA_3 and / or growth retardant paclobutrazole on wheat plant caused stimulation and inhibition respectively in the leaf area of wheat plant.

Regarding the effect of bioregulators on the total dry weight of the shoot system (including stem, leaves and pods). The data recorded in Table (2) show that all the applied bioregulators led to significant increase in the total dry weight of shoot system at all the studied growth stages in both two seasons. The highest values 19.07 and 20.03 g / plant were obtained from the application of benzyl adenine at the 3rd stage (90 DAS) during the two successive growth seasons. These increments might be attributed to the positive effects of bioregulators on plant height, number of branches, leaf area as well as the number of pods per plant. These results are in agreement with those obtained by many investigators using different bioregulators on various plants (El-Beeheidi *et al.,* 1991 El-Quesni *et al.,*1992 using CCC on faba bean; Shalaby and Ahmad, 1994 IAA on the lentil; Shalaby and Abdel-Hamid 1995 kinetin and GA_3 on faba bean; Bekheta, 2000 and El- Kady 2002 uniconazole on faba bean and wheat plants respectively; Bekheta, 2004 and Mahgoub *et al.,* 2006) paclobutrazole on wheat and *Calendula officinalis* L. respectively.

Photo Synthetic Pigments:

The data recoded in Table (3) show that spraying bean plants with all the used bioregulators caused significant increase in the photosynthetic pigments content (chlorophyll a , chlorophyll b, chl. "a + b" and carotenoids) in the leaves of faba bean plants collected at all the studied growth stages. Generally, all the tested photosynthetic pigments contents were gradually increased with age up to 90 DAS due to application of all the used bioregulators.

Table 3: Photosynthetic pigments of faba bean plants as treated by some bioregulators during two successive growth seasons.

Characters	treatments	1st season (2004/2005)			2ed season (2005/2006)		
		Age (day after sowing)					
		60	75	90	60	75	90
Chlorophyll "a"	0.0	2.37 b	5.80 c	7.50 b	2.49 b	5.73 b	6.61 c
	GA_3	2.44 b	6.40 bc	8.43ab	2.52 b	6.60 b	8.51 b
	IAA	2.79 b	6.94 b	9.05ab	2.62 b	6.77 b	8.58ab
	BA	2.56 b	6.24 bc	7.79 ab	2.62 b	6.30 b	8.48 b
	Ancy.	2.49 a	8.90 a	9.36 a	3.69 a	8.98 a	9.65 a
Chlorophyll "b"	0.0	1.18 c	1.85 a	2.30 b	1.20 c	1.66 b	2.22 d
	GA_3	1.25 bc	2.41 a	2.80 ab	1.31 abc	2.52ab	2.69b
	IAA	1.33 ab	2.47 a	2.84 ab	1.32ab	2.69 a	3.03 b
	BA	1.27 bc	1.91 a	2.74 ab	1.28 bc	2.01 ab	2.66 c
	Ancy.	1.38 a	2.70 a	3.69a	1.42	2.79a	3.59 a
Chlorophyll "a + b"	0.0	3.55 b	7.65 b	9.79 b	3.68 b	7.39 a	8.83 c
	GA_3	3.69 b	8.81 ab	11.23 b	3.83 b	9.12 bc	11.20b
	IAA	4.13 b	9.41 ab	11.89ab	3.89 b	9.45 b	11.61 b
	BA	3.83 b	8.15 ab	10.53ab	3.90 b	8.30 cd	11.14b
	Ancy.	4.87 a	11.59 a	13.05a	5.11 a	11.76b	13.24a
Carotenoids	0.0	1.58 b	2.27 a	3.26 b	1.48 b	2.19 b	3.14 c
	GA_3	1.76 ab	3.27 a	3.95ab	1.73 a	2.92 a	3.69 b
	IAA	1.87 ab	3.36 a	4.48 a	1.76 a	2.99 a	3.14ab
	BA	1.79 ab	2.64 a	3.92ab	1.65 ab	2.35 b	3.61 b
	Ancy.	1.92 a	3.48 a	4.39 a	1.85 a	3.19 a	3.97 a

GA_3= gibberellic acid BA= benzyl adenine Ancy.= ancymidol IAA= Indole acetic acid

The data revealed that foliar application of growth retardant ancymidol on faba bean was more effective (caused significant increase) on the content of photosynthetic pigments than other treatments at all the studied growth stages in both seasons. The increase in chlorophyll content of ancymidol treated plants could be referred to hormonal effects as it has been noted earlier that ancymidol stimulate chlorophyll biosynthesis through acceleration of chloroplasts differentiation and stimulating photosynthetic enzymes (Chung Jaedong *et al*., 1999)

The present results are in agreement with those obtained by many investigators (Reddy *et al.,*1990; Hodges *et al.,*1991; Xu and Taylor 1992, Bekheta 2004 and Bekheta *et al.,* 2006) They reported that the increase in chlorophyll content caused by treating with growth regulators can be relatively well explained by the preferred inhibition of cell extension by growth regulator. Due to inhibition of cell extension there are more cells per leaf blade and per fresh matter. Thus even at constant chlorophyll content / cell, chlorophyll content / leaf blade or / fresh matter would be increased.

Mineral Ions Content:

Data in Table (4) show that foliar application of *Vicia faba* plants with different bioregulators at all the used levels led to obvious increase in the endogenous content of mineral ions (Ca, K and Mg). The highest

Table 4: Effect of spraying *Vicia faba* plants with some bioregulators on the mineral ions content of the shoot system as mg/g dry wt. (during two successive growth seasons).

Characters / Treatments	K^+	Ca^+	Mg^+	K^+	Ca^+	Mg^+
	First season (2004/2005)			Second season (2004/2005)		
0.0	46.90	12.01	10.03	42.99	10.00	9.45
GA_3	47.00	12.47	10.36	43.09	10.60	9.49
IAA	47.16	12.59	10.59	43.81	11.00	9.86
BA	48.60	13.09	11.03	43.90	11.45	10.22
Ancy.	49.44	13.80	11.29	44.44	12.99	11.01

GA_3= gibberellic acid BA= benzyl adenine Ancy.= ancymidol IAA= Indole acetic acid

values were obtained from the application of growth retardant ancymidol in the samples collected in both two seasons compared to the control. These results are in agreement with the findings of kuchenbuch & Jung (1986) and Bekheta (2000) as they reported that treating maize and faba bean plants with triazole (BAS 11OW) and uniconazole led to increase in the uptake of N, P, Ca, Mg and K and hence their accumulation in the plants were observed.

Seeds Chemical Composition:

It is obvious from the data recorded in Table (5) that the seeds produced from the plants treated with bioregulators had significant increase in both protein and total carbohydrates percentages as compared to those obtained from the untreated plants. The seeds produced from the plants treated with benzyl adenine possessed the highest values of protein and total carbohydrate percentage (25.66 & 25,60 and 60.14 & 59.43) during the two seasons respectively. It can be suggested here that application of growth regulators especially benzyl adenine encourages the absorption of nitrogen from the soil and /or activated the photosynthetic process through their influence on some enzymatic action. The activation of these processes might cause the increase in protein accumulation and carbohydrate percentage in the seeds (El-Beheidi *et al.* 1991). Similar results were obtained by El- Etr, (2000) and Bardisi, 2004. They found that application of kinetin on soybean and pea plants respectively caused increase in the total content of the seed protein and the percentage of seeds carbohydrate.

Table 5: Protein and total carbohydrate contents of the seeds produced from faba bean plants treated with some bioregulators (during two successive growth seasons).

Treatments	1st season (2004/2005)		2ed season (2005/2006)	
	Protein (%)	Total carbohydrate (%)	Protein (%)	Total carbohydrate (%)
0.0	22.16 c	53.09 d	21.86 c	53.26 d
GA_3	24.44 ab	58.27 b	24.57 ab	57.71 b
IAA	23.17 bc	55.73 c	23.01 bc	55.69 c
BA	25.46 a	59.94 a	25.40 a	59.23 a
Ancy.	24.19 ab	56.81 c	24.28 ab	56.01 c

Flowers and Pods Abscission and Pods Setting:

Generally, data in Table (6) indicate that foliar application of bioregulators led to significant changes in the number of flowers and setting pods / plant during the two successive flowering seasons. It is clear that application of GA_3, Benzyl adenine and ancymidol augmented the number of flowers / plant as compared to the control plant. There is no significant differences in the number of flowers / plant between the treatments in the 1st season. On the other hand, application of IAA caused slight decease in the number of flowers / plant as compared to the untreated plants.

Table 6: Influence of spraying *Vicia faba L.*plants with some bioregulators on the number of flowers/plant, number of setting pods/plant and abscission percentage (during two successive growth seasons).

Treatments	Number of		Abscission (%)		
	Flowers / plant	Setting pods / plant	Flowers	Setting pods	Total
			First season (2004/2005)		
0.0	180.83 ab	58.42 b	64.95 ab	53.00 a	83.14 a
GA_3	192.80 a	58.67 b	66.86 a	48.61 b	82.65 ab
IAA	175.17 b	59.92 ab	63.00 ab	48.85 b	81.53 c
BA	189.92 a	69.75 a	62.61 b	48.73 b	80.13 c
Ancy.	191.75 a	64.83 ab	63.50 ab	46.20 b	81.13 ab
			Second season (2005/2006)		
0.0	159.25 c	53.75 b	69.00 a	60.83 a	86.78 a
GA_3	173.83 a	62.60 ab	67. 55 a	57.56 b	84.68 ab
IAA	158.00 c	66.80 ab	60.44 b	56.50 b	81.01 c
BA	170.00 b	72.75 a	58.82 b	57.18 b	80.60 c
Ancy.	172.42 ab	69.90 a	61.51 b	56.23 b	81.47 bc

GA_3= gibberellic acid BA= benzyl adenine Ancy.= ancymidol IAA= Indole acetic acid

Concerning to abscission percentage of flowers / plant the data revealed that application of benzyl adenine, IAA or ancymidol led to reduction in flower abscission percentage during the two seasons. The lowest numbers of flower abscission percentage (62.61 and 56.82 %) were obtained from the application of benzyl adenine during the two seasons. On the other hand, spraying the plants with GA_3 led to increase in the number of flowers obtained per plant compared to the plants untreated plants or treated with other bioregulators. In this respect El-Behiedi *et al.,* (1991); Rashad and Ahmad, (1996) and Bekheta (2000) all found that using different growth regulators on faba bean plants caused increase in the number of flowers per plant.

Regarding the number of pods setting, its clear from the data that there is a considerable variations between all the used treatments in both seasons. Application of benzyl adenine, ancymidol or IAA produced the highest number of pods setting in a descending order relative to GA_3 and control.

It is interesting to note that all the used growth regulators caused most significant reduction in the percentage of pods abscission less than the control in both seasons. It could be concluded from the above mentioned results that there is a positive relation between abscission percentage of pods and all the under studied bioregulators (i.e. led to increase in the number of setting pods / plant). In this concern Rabie *et al.,* (1991) ; El-Behedi *et al.,* (1991) and Bekheta (2000) stated that application of different bioregulators on faba bean plants caused reduction in the pod abscission percentage. They indicated that the reduction in pods abscission percentage per plant due to application of exogenous bioregulators might be attributed to the balance in the levels of endogenous hormone.

Table 7: Effect of spraying faba bean plants with some bioregulators on yield and its components (during two successive growth seasons).

Characters -------------- Treatments	Pod length (cm)	No. of pods/ plant	No. of seeds/ plant	Wt. of 100 seeds (g)	Seeds wt./pod (g)	Seed yield/ plant	Seed yield/fad (ton)	Straw yield/fad (ton)	Bio. yield/fad (ton)	Harvest index (%)
				First season (2004/2005)						
0.0	7.18b	26.16b	3.00b	68.35b	2.18b	57.84b	2.35b	3.81b	6.10bc	35.36b
GA_3	8.97a	28.89b	3.47a	69.19b	2.43a	85.28b	2.64ab	4.04b	6.48bc	38.60b
IAA	8.92a	30.43b	3.43a	75.32ab	2.44a	59.00b	2.97a	4.27a	6.98b	40.60b
BA	8.72a	34.44a	3.59a	80.10a	2.50a	63.61a	3.02a	5.01a	7.78a	36.77b
Ancy.	8.48a	33.61a	3.33a	76.77ab	2.47a	62.29a	2.99a	3.35b	6.09c	47.14a
				Second season (2005/2006)						
0.0	7.43b	21.79c	3.17b	68.00b	2.21b	52.68b	2.27b	3.81c	5.83b	36.45b
GA_3	9.32a	27.92b	3.59a	72.98ab	2.47a	56.20ab	2.51ab	4.04bc	6.30ab	37.60b
IAA	8.72a	30.58ab	3.57a	74.18ab	2.50a	57.29ab	2.62a	4.23ab	6.60a	37.58b
BA	8.62a	33.00a	3.62a	77.70a	2.54a	59.84a	2.75a	4.43a	6.93a	37.73b
Ancy.	8.53a	31.99a	3.51a	76.70a	2.53a	60.39a	2.73a	3.88c	6.36ab	40.85b

Yield and its Components:

Yield and its component consider the main target of the present investigation. So the data recorded in the Table (7) show that spraying faba bean plants with all the used bioregulators caused a marked effect on the seed yield / plant and its components (pod length, number of pods / plant, number of seeds / pod , seed weight / pod and weight of 100 seeds) in comparison to the untreated plants. The highest values of pod length (9.42 and 9.82 cm) were obtained from the application of GA_3 in the 1^{-st} and the 2^{ed} season respectively. The differences between treatments did not reach to the level of significance in both seasons. Similar results were obtained by Abd-El Fattah *et al.,* (1997) who found that pod length of faba bean was increased by foliar application of GA_3 at 50 ppm. Bekheta (2000) reported that using uniconazole on *Vicia faba* caused increase in the pod length.

Regarding the number of pods / plant , the highest numbers were obtained from the application of benzyl adenine or ancymidol compared to that resulted from IAA or GA_3 treatments in descending order. In the present work the increase in the number of pods / plant might be attributed to the increase in the number of branches / plant and / or the reduction in the abscission percentage as mentioned previously in Table (2). In agreement with these results, increase in the number of pods / plant has been recorded by many investigators after treatments with different growth regulators e.g. kinetin (El-Behedi *et al.* 1991; CCC El- Quesni *et al.* 1992; IAA Shalaby and Ahmad 1994; GA_3 Abd- El Fatah 1997 and uniconazole Bekheta 2000).

The data in the same table demonstrate that the seed weight / pod , the two main components (seeds number / pod and the weight of 100 seeds) as well as the seed yield / plant were increased by all the used growth regulators in comparison to the control in both seasons. The highest values in the number and weight of seeds per pod as well as the weight of 100 seeds were obtained from the foliar application of benzyl adenine in compression with other treatments. It can be noticed from these results that there is no any significant difference among all the used treatments in the two seasons.

The response of seed yield per fad under the influence of all the used growth regulators is shown in Table (7). The data show that application of all the used bioregulators led to increase in seed yield / fad in the two successive season as compared to the control plants. The increment in the average values of the two seasons were statically significant under the influences of benzyl adenine, ancymidol or IAA which recorded 27.83, 26.63 and 23.42 % respectively over the control. The only exception was resulted from the application of GA_3 which recorded non significant increase (12.84 %) in the average values of the two seasons.

As present in Table (7), straw and biological yield per fad were increased by the application of all the used growth regulators compared to the untreated plants in the two seasons. The highest values of straw and biological yield / fad were obtained by using benzyl adenine in both seasons followed by IAA,GA_3 and ancymidol in a descending order. In the present work benzyl adenine or IAA increased straw yield / fad through their effects on the number of branches / plant and on the total dry weight / plant (Table 2).

Harvest index was increased due to spraying the plants with bioregulators as compared to the untreated plants in both seasons as shown in table (7). It is obvious from the data that spraying the plants with ancymidol gave the highest value of harvest index compared with other treatments. One possible explanation is more amount of dry matter was re-translocation from temporary sinks (stem and other non seeds tissue) to major sinks (seed) enhanced by growth retardant ancymidol. In this respect several investigators reported that foliar application of different growth retardants on different plants caused increase in the values of harvest index; El-Gazzar *et al.,* (1993) using CCC on sorghum; Bekheta (2000) using uniconazole on faba bean; El-Kady (2002) using uniconazole on wheat and Bekheta (2004) using paclobutrazole on wheat.

The increase in the yield recorded in this investigation could be a reflection of the effect of bioregulators on growth and development, it might be due to: a) marked increase in the number of branches / plant (table 2) which gave a chance to the plant to carry more flowers, pods and hence more seeds b) marked increase in the photosynthetic pigments content (table 3), which could lead to increase in photosynthesis, resulting in greater transfer of assimilates to the seeds and causing increase in their weight (Table 7).

The previous mentioned reasons could act to increase the number and weight of pods as well as the seeds harvested from the treated plants.

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