Spraying with Commercial Fertilizers beside Effects of the Bio-nitrogen and Different Levels of Mineral Nitrogen on Growth, Yield and Quality of Broccoli

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ABSTRACT---- ***The aim of this study was to analyse the effect of foliar application of amino magnical as commercial fertilizer beside the effect of bio-nitrogen and different mineral nitrogen on plant growth and yield of broccoli. Two field experiments were conducted at El- Nubaria, Beheira Governorate, Egypt during 2013/2014 and 2014/20015. Experimental design comprised three replicates. The bio-nitrogen treatments were used Microbin, Serialen and Azotobacter and different levels of mineral nitrogen. Amino-Magnical used as foliar application (100% N recommended dose + without spray of amino magnical; 50% N recommended dose + one spray; 50% N recommended dose + two sprays and 50% N recommended dose + three sprays). The results showed that the application of Microbin increases the vegetative growth expressed as plant height, leaves number as well as fresh and dry weight of leaves, stems, apical heads and total plant compared with Serialen and Azotobacter treatments. Higher values of the abovementioned characteristics were also obtained with 100% N recommended dose without foliar application or 50% N recommended dose + One spray of amino magnical. Lower values of vegetative growth were obtained with Serialen or the other fertilization treatments. Total yield of apical heads and their physical quality expressed as (diameter, height and fresh weight) and their chemical quality recorded higher values with Microbin treatment compared with Serialen and Azotobacter treatments. In addition, treatments 100% N recommended dose without foliar application or 50% N recommended dose + one spray of amino magnical recorded the highest values of total yield and quality of apical heads compared with the other fertilization treatments. With respect to the interaction, Microbin treatment plants receiving 100% N recommended dose or 50% N recommended dose + one spray of amino magnical recorded the higher values of the vegetative growth, total yield of apical heads and their quality. While, the other interaction treatments gave lower means of vegetative growth, total yield of apical heads and quality. The lowest values of vegetative growth, total yield of apical heads and their quality were obtained with Serialen and Azotobacter treatments receiving 50% N recommended dose + three sprays of amino magnical.***

Keywords--- Broccoli, commercial fertilizers, foliar application, bio-nitrogen fertilization

1. INTRODUCTION

Broccoli is an important vegetative crop in the world. Broccoli plant have a high nutritional value which includes proteins and vitamins for human, feed and for animals. This plant belongs to the family of cruciferous vegetables [12]. Broccoli is an Italian vegetable crop, cultivated in Italy in ancient roman times and about 1720 in England. While, broccoli was appeared in USA in 1806, but it was used as an important plant around 1923 [12]**.** Broccoli is planted in Egypt in small areas around Cairo and Alexandria [2]. However broccoli is very important plant as vegetables and it contains more vitamins and minerals, many researches were done to increase its cultivation areas. Broccoli has lots of nutrients and presents perfect commercial value. For the time being, the yield of broccoli will really increase because of its diversified uses and high nutrients [37].

Recently, the broccoli plant in Egypt was exposed to some problems such as cultivars, fertilization, low amounts of available nutrients and low organic matter content as well as poor hydrophilic, chemical and biological properties. The best means of maintaining soil fertility and productivity could be through periodic addition of organic manures such as poultry manure.

Nonetheless, the application of bio-fertilization increased the plant growth of broccoli. Many researches on such an effect obtained showed that the used of bio-nitrogen improves the plant growth and that of yield reported in [24]; [13]; [25]; [40]; [41]; [3] and [4].

Due to nutrition importance and economic significance, it is very important to improve new technique methods for increasing the crop production. Thus, the application of the nutrients as sparing is one of these new methods that are considered to be more effective on plant growth. In addition, the application of nitrogen sources is very important on broccoli and the foliar fertilization. This supports essential role in respiration, metabolism activation of the enzymes, photosynthesis, chloroplast formation, chlorophyll synthesis and natural hormone biosynthesis. [34]; [11]; [33]; [32]; [5]; [6]; [22].

The importance of amino acids in essential nutrients is well Known as a means to increase yield and overall quality of crops. The amino acids content many nutrients as nitrogen, calcium, magnesium and boron so the application of amino acids increased the plant growth and yield. These results showed by [15]; [16] and [19].

Foliar fertilization of some commercial fertilizers was very important method to increase the plant growth and yield highly used in order to increase the mineral fertilizers quantities [19]. The objective of the present work was determine to spray amino magnical which is a commercial fertilizer which compound containing with amino acids, Mg and calcium on broccoli plants in order to increase their vegetative growth, head yield and quality as well as to save mineral fertilizers. Other study obtained that foliar spray by Amifol K (containing amino acids, K and calcium) as a minor nutritional fertilizer gained the best plant growth, yield and quality of broccoli heads [19].

However, root is common to be first part of plant that adsorbed nutrients from soils, but nutrients availability might be limited then affects fertilizer efficiency. Thus, it is better to use foliar application than extend nutrients for plant. There is some information of the foliar fertilization. [34]**.** This study was contacted to response the vegetative growth, heads yield and heads quality of two broccoli cultivars to sparing amino magnical under different mineral and bio- fertilization treatments. The aim of this work was to study the effect of bio-nitrogen fertilization with different levels of mineral nitrogen plus Amino-Magnical as a foliar application on growth, yield and quality of broccoli.

2. MATERIALS AND METHODS

Two field experiments were carried out on broccoli *(Brassica oleraceae L.* var. *italica* cv. Centauro, Family *Cruciferae*) in an area of newly reclaimed soil at El-Nuberia, Beheira Governorate, Egypt, during the two successive winter seasons of 2013/2014 and 2014/2015.

Treatments were as follows:-

1- Nitrogen bio-fertilizer: Three bio-fertilizers were evaluated: i) Microbin, ii) Serialen and iii) Azotobacter.

2- Mineral nitrogen fertilization doses: N was applied in the following treatments:i) 100 % N recommended dose without spray, ii) 50 % N recommended dose + one spray of amino magnical, iii) 50 % N recommended dose + two sprays of amino magnical and 50 % N recommended dose + three sprays of amino magnical.

Table (1): Physical and chemical properties of the experimental soil during the two seasons of 2013/2014 and 2014/2015.

A. Physical properties

Season	Sand %	Clay %	Silt %	Texture
2013/2014	55.85	3.45	40.70	Sandy
2014/2015	56.72	3.72	39.56	Sandy

B. Chemical properties

Season	E.C. dSm^{-1}	pH	Meq./L							
			Cations				Anions			
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{-}	HCO_3^{-}	Cl^{-1}	$SO_4^{=}$
2013/2014	2.18	7.81	8.61	4.80	4.64	1.59	Nil	1.40	1.80	17.40
2014/2015	1.26	7.76	7.60	2.20	3.79	0.91	Nil	1.40	1.60	12.20

Soil samples were collected at random before planting from the top layer (0-30 cm depth) for physical and chemical analysis. Soil analysis is presented in Table (1). Soil physical properties were analyzed using the procedures described by **[9]** for particle size distribution and soil texture, while soil chemical analysis was measured according to the procedures described by [21].

Seeds of broccoli cv. Centauro were imported from Takii Seed Company in Japan. Seeds were sown in the nursery in foam trays filled with a mixture of peat moss and vermiculite (1:1 volume) on the first of August in 2013 and 2014 seasons. Seedlings were transplanted in the open field at 45 days age.

Ditches of 50 cm width and 30 cm depth were built in the locations of irrigation lines. Organic fertilizer (compost) and calcium super phosphate were added through the ditches before transplanting and ditches were covered by soil. Drip irrigation lines were spread over the ditches. Mineral fertilizer was added using ammonium nitrate (33.5 % N) as a source of nitrogen at a rate of 100 N unit in four different combinations with foliar application of amino magnical, calcium super phosphate (15.5 % P_2O_5) as a source of phosphorus at a rate of 60 P_2O_5 units/fed and potassium sulphate (48 % K_2O) as a source of potassium at a rate of 40 K_2O units/fed. The quantities of the chemical fertilizers were splinted into two equal doses (21 and 42 days after transplanting) beside plants. Seedlings were transplanted on one side of each row in 75 cm width and 50 cm apart. Each plot included three rows, plot area was 10.5 m^2.

Experimental design: A split plot design with four replicates was followed. Bio-fertilizer treatments were located in the main plots, whereas treatments of mineral fertilization with foliar fertilization were assigned in the sub-plots. Statistical analysis of variance was followed according to [36].

Data recorded:

I) Vegetative growth characters: A random sample of five plants was collected from each experimental treatment 60 days after transplanting and the following data were recorded during the two seasons.

1) Plant height.
2) Leaves number per plant.
3) Leaves fresh weight.
4) Stems fresh weight.
5) Apical head fresh weight.
6) Total plant fresh weight.
7) Leaves dry weight.
8) Stems dry weight.
9) Apical head dry weight.
10) Total plant dry weight.

II) Apical heads yield and Physical quality: All broccoli heads of each plot were harvested at vegetative mature stage in order to record the following data:-

1) -Apical heads yield (ton/ fed): Total main yield of the apical heads.
2) - Mean apical head diameter (cm).
3) - Mean apical Head height (cm).
4) -Mean apical head weight (g/ plant).

III) Chemical composition:

A. Nutritional value: The following analyses were done in the apical spear at maturing stage:

1) -Total soluble solids (T.S.S.) was determined by a hand refractometer, according to the method described by [8].

2) -Ascorbic acid (vitamin C) was determined as mg/100g fresh weight using 2, 4, 6-di-chlorophenol-indophenol method described in [7].

B. Chemical contents: The percentages of nitrogen, phosphorus and potassium in the acid digested samples of dry leaves and heads were determined as follows:

1) - Nitrogen determination (N): Total nitrogen percentage was determined using Nesslar method according to the procedure described by [23].

2) - Phosphorus determination (P): Phosphorus percentage was determined colorimetric-ally according to the method described by **[**38]**.**

3) - Potassium determination (K): Potassium percentage was determined using Flame Photometer according to [10].

3. RESULTS AND DISCUSSION

I) - Vegetative growth characteristics

A. Effect of nitrogen bio-fertilizers: Data in Table (3) showed that the response of plant growth to the application of nitrogen bio-fertilizers. Results showed that the vegetative growth was increased by bio-fertilization. Data in the same

Table showed that the application of Microbin was increased the vegetative growth of broccoli plants compared with other treatments. In comparison with Serialen and azotobacter, Microbin treatment plants were increased in the tall with denser leaves, higher values of spear height and diameters as well as higher values of fresh and dry weight of leaves, stems, spears and total plant. The increasing of plant due to microbial flora which happened by the application of bio-fertilization.These increases in vegetative growth also may be due to the enhancing role of micro-organisms on solubilizing of the soil nutrients and increasing its content in the soli solution. Also, the application of Mycorrhizal increases the root system volume which in turn causes more absorbing surfaces more water and increasing the nutrients absorption.

Table (2) :Effect of the interaction of nitrogen bio- fertiliters and mineral nitrogen doses on total bacterial count (TC), 2013/2014 and 2014/2015 Azotobacter, phosphate, potassium, fungal and actinomysets (CFU gram dry soil) after 60 days from transplanting.

Bio-fertilizers	Mineral nitrogen fertilizer + Amino magnical	T.C x 10^5	T.F x 10^3	Act x 10^3	Azot.x 10^4	Mek.x 10^4	Cerr.x 10^4
Microbin	100% N recommended doses + without spray	275.00	20.00	27.00	42.00	37.00	32.00
	50% N recommended doses+ One spray	260.00	24.00	19.00	41.00	34.00	30.00
	50% N recommended doses + Two sprays	275.00	20.00	27.00	42.00	37.00	32.00
	50% N recommended doses + Three sprays	276.00	29.00	23.00	40.00	39.00	38.00
Mean		**271.50**	**23.25**	**24.00**	**41.25**	**36.75**	**33.00**
Serialen	100% N recommended doses + without spray	270.00	22.00	25.00	41.00	40.00	33.00
	50% N recommended doses + One spray	259.00	22.00	20.00	37.00	33.00	32.00
	50% N recommended doses + Two sprays	270.00	22.00	25.00	41.00	40.00	33.00
	50% N recommended doses + Three sprays	273.00	27.00	25.00	41.00	41.00	40.00
Mean		**268.00**	**23.25**	**23.75**	**40.00**	**38.50**	**34.50**
Azotobacter	100% N recommended doses + without spray	273.00	27.00	21.00	40.00	35.00	37.00
	50% N recommended doses + One spray	252.00	20.00	22.00	39.00	35.00	35.00
	50% N recommended doses + Two sprays	273.00	27.00	21.00	39.00	35.00	41.00
	50% N recommended doses + Three sprays	275.00	28.00	24.00	42.00	40.00	39.00
	Mean	**268.25**	**25.50**	**22.00**	**40.00**	**36.25**	**38.00**

In addition, the fertilization with micro-organisms secrete many growth promoters such as GA3, IAA and cytokinins which reflected enhancement in vegetative growth.

These results which Many reported that the bio-fertilization increased growth of broccoli plants and other cruciferous vegetables crops are harmony with **[**11] on broccoli**;** [35] on cauliflower; Similar results were recorded by **[**39] on broccoli since they reported that the plant growth response of broccoli to 12 different treatments of bio-fertilizers (*Azotobacter* and *Azospirillum*) and N level (100, 125 and 150 kg/ha). Data in the same Table show that the treatment of *Azotobacter* + *Azospirillum* with 150 kg/ha was significantly superior over the recommended fertilizer rate alone. [25] demonstrated that the effect of bio-fertilizers namely *Azospirillum sp.* and *Azotobacter sp.*, applied at 5 and 10%, on the growth and yield of sprouting broccoli gave the maximum values of vegetative growth in plants supplied with 5% *Azotobacter sp*. In addition, [41**]** on broccoli reported that inoculated plants with bio-fertilizer showed higher vegetative growth parameters as (plant height; leaves number; branches number as well as fresh and dry weight of leaves and stems) than the untreated plants. In addition, [28] found that inoculation of bacteria (Bio-N) singly or in combination with chemical fertilizers positively affected growth characters of potato plants. These results may be attributed to the increased of activity and efficiency of bacteria in reduction of soil pH by secreting organic acids i.e. acetic, prop-ionic, fumaric and succinic, and consequently more solubility and availability of nutrients for plants. Furthermore, bio-fertilizers can caused a positive effect on plant growth through the enhanced levels of phytohormones (GA_3, IAA and cytokinins) that modulated by ACC deaminase enzyme, N_2-fixation, and the reduction in root membrane potential. The noticeable increases of growth traits of broccoli plants by the increase in the applied bio-fertilizer dose may be confirmed by the progressively increase in the nutritional elements in the tested soil and in plants. Our results indicated that, bio-N is beneficial for sustainable agriculture and human healthy nutrition as a partial alternative to mineral-N fertilizer.

B. Effect of mineral nitrogen doses: Data in Table (4) show that the effect of mineral nitrogen doses on plant growth as plant height, leaves number and fresh and dry weight of leaves, stems, apical heads and total plant were statistically increased by fertilization treatments. The highest value of vegetative growth parameters of broccoli plants were obtained by application the 100% N recommended dose or 50% N recommended dose + one foliar spray of amino magnical treatment without significant differences. Application of 50% N recommended dose + two foliar sprays of amino magnical lies in the second order. The lowest values of vegetative growth were obtained by the application of 50% N recommended dose + three foliar sprays of amino magnical. These results were similar and significant in the two seasons of the

experiment and its harmony with [19] who came to similar results. They reported that the highest values of vegetative growth expressed as plant height, leaves number as well as fresh and dry weight of leaves were obtained by foliar application of Amifol K because its content of amino acids and potassium which the Amino acids and potassium play a important role in the physiology of the plants. Amino acids are the basal components in protein synthesis. In addition, potassium molecule is the carrier of the photosynthetic products especially carbohydrates. So that they enhance protein and carbohydrates synthesis. [19] added that Amifol K foliar spray recorded the highest N, P and K percentages in broccoli leaves. In addition, leaves content of chlorophyll A and B were increased by Amifol K spray.

Other studies reported that the mineral fertilizer increase the plant growth as [41] and [30**].** It is clear that the application of nitrogen is an important method to protein and plays an important role in the cell enlargement and cell division and consequently on plant growth. Nitrogen also plays a great role in photosynthesis and in turn in the condensation of its products through plant tissues.

Consequently, the higher value of vegetative growth of broccoli plants, resulting by foliar application of amino magnical might be due to the easy absorption of foliar amino acids by plant leaves. In addition, its direct effect on protein, carbohydrates and N, P and K contents. In addition, chlorophyll A and B are the major light absorbing pigments of the plant leaves and play an important role in the metabolic activities in plant tissues, consequently, higher vegetative growth and economic yields with foliar fertilization.

Other results reported that, mineral fertilizer as foliar application of nutrients increase vegetative growth as **[**13]; [29] and [40] on broccoli**).**

C. Effect of the interaction: Data in Table (5) obtained that the interaction treatments significantly affected all growth parameters. These results were true and nearly similar in both seasons of the experiment. Generally, it could be summarized that, the highest values of vegetative growth of broccoli plants such as plant height, leaves number as well as fresh and dry weight of leaves, stems and apical heads were obtained by inoculation plants with Microbin when fertilized by 50% N recommended dose + one foliar spray of amino magnical. On the hand, the lowest values of the abovementioned parameters were obtained by plants inoculated with Azotobacter and receiving 50% NPK recommended dose + three foliar sprays of amino magnical. Other interaction treatments ranged in-between these two treatments. These results were similar and true in the two seasons of the experiment.

Table (3) :Effect of nitrogen bio-fertilizers on vegetative growth of broccoli plants during two seasons 2013/2014 and 2014/2015.

Nitrogen bio-fertilizers	Plant height (cm)	Leave No./ plant	Head Dia. (cm)	Head height (cm)	Fresh weight (gm / plant)				Dry weight (gm /plant)		
					Leaves	Stems	Heads	Total	Leaves	Stems	Heads
(2013/2014)											
Microbin	36.33	12.50	13.25	11.50	150.17	86.60	168.42	405.20	11.73	16.23	24.01
Serialen	31.92	11.75	13.00	11.25	128.56	71.54	152.66	352.77	11.64	14.17	21.65
Azotobacter	34.42	10.83	14.17	10.50	141.98	71.94	155.55	369.47	11.94	15.01	21.38
L.S.D at 0.05	1.38	0.61	0.68	N.S.	6.82	7.46	4.56	11.82	N.S.	0.68	0.52
(2014/2015)											
Microbin	38.92	14.00	14.75	12.25	164.92	93.19	183.92	442.03	12.48	17.64	24.72
Serialen	33.92	13.00	14.25	12.08	138.31	77.13	163.16	378.60	12.39	14.97	22.39
Azotobacter	36.25	11.83	16.17	11.25	156.73	80.69	169.88	407.30	12.69	16.19	21.64
L.S.D at 0.05	0.85	0.55	0.38	0.58	2.40	2.11	2.91	4.13	N.S.	0.74	0.38

Table (4) :Effect of N rates on vegetative growth of broccoli plants during two seasons 2013/2014 and 2014/2015.

Mineral fertlizer rates of NPK (unit/fed.) plus Amino magnical	Plant height (cm)	Leave No./ plant	Head Dia. (cm)	Hea height (cm)	Fresh weight (gm / plant)				Dry weight (gm /100 gm F*W*)		
					Leaves	Stems	Heads	Total	Leaves	Stems	Heads
(2013/2014)											
100% N recommended doses+ without spray	36.50	12.56	17.44	13.00	203.10	106.57	277.89	587.56	11.38	18.44	32.73
50% N recommended doses+ One spray	37.28	11.33	13.33	10.00	162.17	79.43	160.33	401.93	11.71	14.83	22.65
50% N recommended doses+ Two sprays	32.94	11.00	15.11	11.56	112.40	75.08	142.32	329.81	10.96	14.19	22.94
50% N recommended doses+ Three sprays	30.17	11.89	8.00	9.78	83.29	45.70	54.96	183.95	13.03	13.09	11.06
L.S.D at 0.05	1.72	0.67	0.50	0.71	4.73	4.46	4.77	8.96	0.39	0.51	0.50

Table (5) :Effect of interaction (Bio-nitrogen x Nitrogen doses) on vegetative growth of broccoli plants during two seasons 2013/2014 and 2014/2015.

Bio-fertilizers	Mineral fertlizer of N (unit/fed.) plus Amino magnical	Plant height (cm)	Leave No./ plant	Head Dia. (cm)	Head height (cm)	Fresh weight (gm / plant)				Dry weight (gm /100 gm F*W*)		
						Leaves	Stems	Spears	Total	Leaves	Stems	Heads
						(2013/2014)						
Microbin	**100% N recommended doses+ without spray**	39.17	12.67	17.00	13.67	201.79	121.38	289.57	612.74	11.44	20.93	34.64
	50% N recommended doses+ One spray	37.17	12.33	14.67	11.33	189.54	103.00	208.31	500.85	11.59	18.17	27.14
	50% N recommended doses+ Two sprays	33.83	11.67	13.33	11.67	101.50	70.03	124.25	295.78	11.52	13.31	23.07
	50% N recommended doses+ Three sprays	35.17	13.33	8.00	9.33	107.87	52.00	51.57	211.44	12.36	12.50	11.20
Serialen	**100% N recommended doses+ without spray**	33.67	12.33	15.00	12.33	168.99	85.59	242.02	496.61	11.64	15.90	29.42
	50% N recommended doses+ One spray	34.67	10.67	11.00	9.33	130.83	73.81	124.33	328.97	12.46	15.09	18.59
	50% N recommended doses+ Two sprays	33.00	11.33	16.33	11.33	125.72	80.19	161.44	367.34	10.30	13.56	23.56
	50% N recommended doses+ Three sprays	26.33	12.67	9.67	12.00	88.72	46.59	82.84	218.15	12.14	12.14	15.02
Azotobacter	**100% N recommended doses+ without spray**	36.67	12.67	20.33	13.00	238.50	112.75	302.08	653.33	11.05	18.51	34.14
	50% N recommended doses+ One spray	40.00	11.00	14.33	9.33	166.14	61.48	148.35	375.97	11.07	11.23	22.23
	50% N recommended doses+ Two sprays	32.00	10.00	15.67	11.67	109.99	75.03	141.28	326.30	11.05	15.70	22.20
	50% N recommended doses+ Three sprays	29.00	9.67	6.33	8.00	53.27	38.52	30.47	122.26	14.59	14.61	6.96
	L.S.D at 0.05	2.98	1.16	0.86	1.23	8.19	7.72	8.26	15.53	0.67	0.89	0.87
						(2014/2015)						
Microbin	**100% N recommended doses+ without spray**	42.00	14.17	18.50	14.42	216.54	127.13	305.07	648.74	12.19	22.21	35.55
	50% N recommended doses+ One spray	39.67	13.83	16.17	12.08	204.29	112.09	223.81	540.18	12.34	19.92	27.95
	50% N recommended doses+ Two sprays	36.33	13.17	14.83	12.42	116.25	75.78	139.75	331.78	12.27	14.62	23.42
	50% N recommended doses+ Three sprays	37.67	14.83	9.50	10.08	122.62	57.75	67.07	247.44	13.11	13.79	11.95
Serialen	**100% N recommended doses+ without spray**	35.67	13.58	16.67	13.08	178.74	91.34	252.52	522.61	12.39	16.75	29.92
	50% N recommended doses+ One spray	36.67	11.92	12.00	10.42	140.58	79.56	134.83	354.97	13.21	15.85	19.16
	50% N recommended doses+ Two sprays	35.00	12.58	17.33	12.08	135.47	85.94	171.94	393.34	11.05	14.34	24.76
	50% N recommended doses+ Three sprays	28.33	13.92	11.00	12.75	98.47	51.67	93.34	243.48	12.89	12.96	15.72
Azotobacter	**100% N recommended doses+ without spray**	38.00	13.67	22.33	13.75	253.25	121.50	318.91	693.66	11.80	19.71	34.37
	50% N recommended doses+ One spray	42.00	12.00	16.33	10.08	180.89	70.23	161.85	412.97	11.82	12.40	22.27
	50% N recommended doses+ Two sprays	34.00	11.00	17.67	12.42	124.74	83.78	154.78	363.30	11.80	16.87	22.83
	50% N recommended doses+ Three sprays	31.00	10.67	8.33	8.75	68.02	47.27	43.97	159.26	15.34	15.78	7.10
	L.S.D at 0.05	1.80	0.88	0.68	1.15	2.78	3.68	5.31	7.85	0.52	0.77	0.93

II. Total yield of apical heads:

A. Effect of nitrogen bio-fertilizers: Results in Table (6) and Figure (1) Showed that there were significant differences in the total main flower spears yield between bio-fertilizers treatments in the two seasons of this study. Total main spears yield of broccoli plants which inoculated by Microbin recorded higher values compared with plants inoculated by Azotobacter or Serialen. The application of bio-fertilization resulted in statistical increases in the total green yield of broccoli. These increase in the main head yield may be due to bio-fertilization might be due to its positive effect on the vegetative growth and increase the chemical content of broccoli plants such as N,P and K.

These increases in the total green yield due to Microbin amounted to 0.133 and 0.108 ton/fed which equals 9.4 and 7.6 %; 0.174 and 0.118 ton/fed which equals11.3 and 7.6 % over the Serialen and Azotobacter treatments in the two seasons, respectively. These findings were similar and true in both seasons of study. The increasing in head yield might be also to the increase in the soil microbial flora which happened by Microbin as the results in Table (2).

These results were in agreement with those obtained by **Manivannan and Singh (2004)**; **Wange and Kale (2004)** on broccoli.

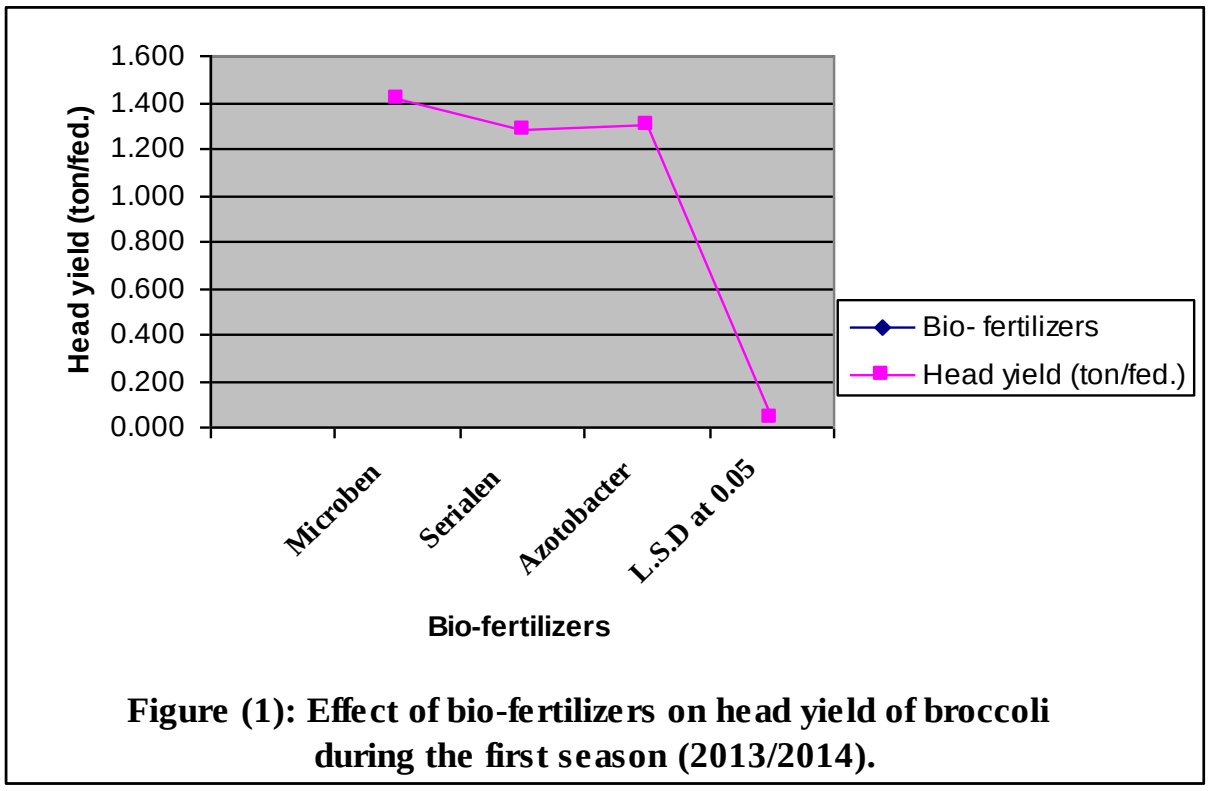

Figure (1): Effect of bio-fertilizers on head yield of broccoli during the first season (2013/2014).

B. Effect of mineral nitrogen doses: Data presented in Table (7) and Figure (2) indicated that total yield of apical heads was widely affected by fertilization treatments. The highest total yield of apical heads was obtained by the application of the 100% N recommended dose only or 50% N recommended dose + one spray of amino magnical. Treatment of 50% N recommended dose + two sprays of amino magnical lies in the second order with respect to the total yield. The lowest yield of apical heads was recorded by 50% N recommended dose + three sprays. These results were similar and statistical in the two seasons of the experiment. Application of 100% N recommended dose without spray recorded 1.872 and 1.882 increase in the total yield per feddan in the two seasons of the experiment which equal 80.2 and 76.7% in a comparison with 50% N recommended doses+ three sprays treatment. Application of 50% N recommended dose + one spray of amino magnical reflected an increase in the total yield amounted to 0.885 and 0.885 ton/ feddan which equal 65.7 and 65.7% in a comparison with 50% N recommended doses+ three sprays treatment in the two seasons, respectively. These results obtained that treatment of 50% N recommended dose + one spray can substitute 100% N recommended dose without spray. This treatment may save the costs of 50% of the recommended dose, their transport and application costs. These results indicated that the costs of fertilizing broccoli could be reduced by 50% by foliar application of one spray of amino magnical. This treatment might reduce fertilization costs of broccoli by 50%. Superiority of this treatment was the result of foliar application of one spray of amino magnical. These results might be due to the role of amino acids and K contents of amino magnical in substituting the decrease in N in the plant tissues.

These results may be reflect o that amino magnical which contains amino acids, Mg and calcium. The role of amino acids in essential quantities is well known as a means to increase yield and overall quality of crops [31]; [15] and [16]).

[19] found that using Amifol K as foliar spray to broccoli plants recorded higher yields of apical heads. Also the content of potassium nutrients as a mobile element play a great role as a carrier within the plant tissues. In addition K had a important role in carbohydrate synthesis besides its role as chlorophyll component. These characters introduce K for an important role in enhancing growth, photosynthesis, dry matter accumulation and in turn head yield of broccoli plants. Results also recommend one spray of amino magnical besides 50% of the recommended nitrogen dose.

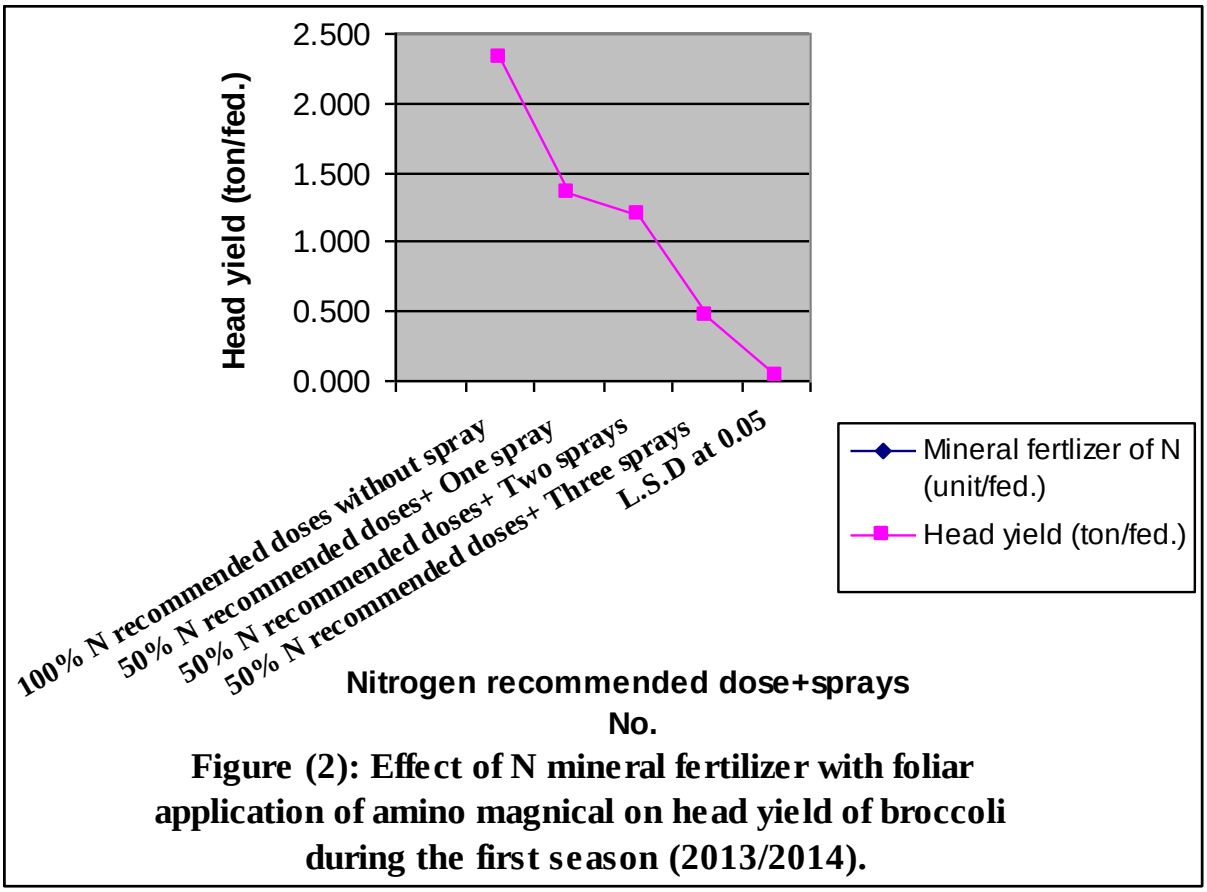

Figure (2): Effect of N mineral fertilizer with foliar application of amino magnical on head yield of broccoli during the first season (2013/2014).

C. Effect of the interaction: Data in Table (8) and Figure (3) show that the interaction of nitrogen bio-fertilization with mineral and foliar nitrogen fertilizer doses statistically affected apical heads yield of broccoli. Results obtained that the highest values of total yield of apical heads was obtained by Microbin treatment which receiving 100% N recommended dose without amino magnical spray. Total yield of Microbin treatment which receiving 50% N recommended dose + one spray of amino magnical lies in the second order. On the contrary, the lowest total yield was obtained by Azotobacter treatment which receiving 50% N recommended dose + three sprays of amino magnical. The other interaction treatments ranged in between these two interaction treatments. These results were similar and true in the two seasons of the experiment.

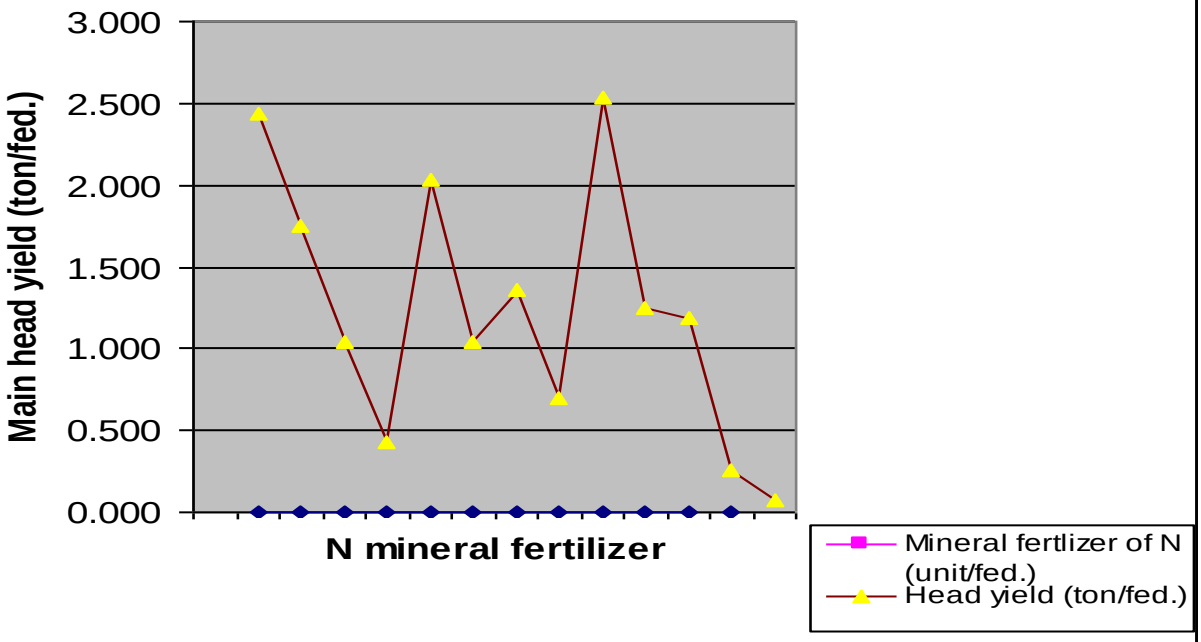

Figure (3): Effect of the interaction between bio-fertillizers and N mineral fertilizer on main head yield of broccoli during the first season (2013/2014).

Table (6) :Effect of bio-nitrogen on main flower spears yield and quality of broccoli during two seasons 2013/2014 and 2014/2015.

Nitrogen bio-fertilizers	Head yield (ton/fed.)	Physical quality			Chemical quality		Chemical content (Flower spears)		
		Weight (g)	Dia. (cm)	Height (cm)	T.S.S (%)	Vit.C (mg/ 100g F*W*)	N (%)	P(%)	K (%)
					(2013/2014)				
Microbin	1.415	168.42	13.83	11.50	11.57	93.84	3.15	0.38	2.76
Serialen	1.282	152.66	13.08	11.53	6.29	75.79	3.36	0.39	3.06
Azotobacter	1.307	155.55	14.11	10.50	9.16	84.28	3.34	0.41	3.09
L.S.D at 0.05	0.038	4.562	N.S.	0.645	0.526	1.534	0.130	N.S.	0.182
					(2014/2015)				
Microbin	1.545	183.92	15.33	10.30	12.78	92.67	3.10	0.44	3.31
Serialen	1.371	163.16	14.58	10.33	7.59	74.20	3.31	0.44	3.68
Azotobacter	1.427	169.88	15.53	9.30	10.46	83.70	3.29	0.47	3.62
L.S.D at 0.05	0.024	2.910	N.S.	0.411	0.200	0.448	0.065	N.S.	0.041

Table (7) :Effect of N rates on main flower spears yield and quality of broccoli during two seasons 2013/2014 and 2014/2015.

Mineral fertlizer of N (unit/fed.) plus Amino magical	Head yield (ton/fed.)	Physical quality			Chemical quality		Chemical content (Flower spears)		
		Weight (g)	Dia. (cm)	Height (cm)	T.S.S (%)	Vit.C (mg/ 100g F*W*)	N (%)	P(%)	K (%)
					(2013/2014)				
100% N recommended doses+ without spray	2.334	277.89	17.44	13.22	9.80	92.99	2.80	0.33	2.75
50% N recommended doses+ One spray	1.347	160.33	13.22	10.37	8.91	73.83	3.44	0.47	2.92
50% N recommended doses+ Two sprays	1.196	142.32	16.11	11.67	8.71	90.70	3.54	0.34	3.08
50% N recommended doses+ Three sprays	0.462	54.96	7.92	9.44	8.60	81.01	3.35	0.42	3.12
L.S.D at 0.05	0.040	4.768	1.198	1.044	0.292	1.635	0.099	0.060	0.233
					(2014/2015)				
100% N recommended doses+ without spray	2.454	292.17	18.94	12.02	11.10	91.71	2.75	0.39	3.36
50% N recommended doses+ One spray	1.457	173.50	14.61	9.28	10.21	72.66	3.39	0.54	3.42
50% N recommended doses+ Two sprays	1.306	155.49	17.61	10.36	10.01	89.76	3.49	0.40	3.69
50% N recommended doses+ Three sprays	0.572	68.13	9.42	8.24	9.79	79.96	3.30	0.46	3.68
L.S.D at 0.05	0.026	3.066	0.643	0.720	0.147	0.899	0.049	0.019	0.036

Table (8) :Effect of interaction (Cultivars x Nitrogen rates) on vegetative growth and main head yield of broccoli during two seasons 2013/2014 and 2014/2015.

Bio-fertilizers	Mineral fertlizer of N (unit/fed.) plus Amino magnical	Head yield (ton/fed.)	Physical quality			Chemical quality		Chemical content (Flower heads)		
			Weight (g)	Dia. (cm)	Height (cm)	T.S.S (%)	Vit.C (mg/ 100g F*W*)	N (%)	P(%)	K (%)
Microbin						**(2013/2014)**				
	100% N recommended doses+ without spray	2.432	289.57	18.00	13.33	12.13	102.90	2.16	0.19	1.96
	50% N recommended doses+ One spray	1.750	208.31	14.67	11.67	10.80	82.32	3.47	0.58	2.80
	50% N recommended doses+ Two sprays	1.044	124.25	14.67	11.67	11.40	98.00	3.57	0.37	2.99
	50% N recommended doses+ Three sprays	0.433	51.57	8.00	9.33	11.93	92.12	3.39	0.36	3.30
Serialen	100% N recommended doses+ without spray	2.033	242.02	15.67	13.00	7.20	82.32	3.06	0.35	3.01
	50% N recommended doses+ One spray	1.044	124.33	11.00	10.43	6.53	66.31	3.43	0.40	3.31
	50% N recommended doses+ Two sprays	1.356	161.44	17.00	11.67	5.90	81.67	3.66	0.37	3.12
	50% N recommended doses+ Three sprays	0.696	82.84	8.67	11.00	5.53	72.85	3.29	0.41	2.78
Azotobacter	100% N recommended doses+ without spray	2.537	302.08	18.67	13.33	10.07	93.75	3.18	0.43	3.28
	50% N recommended doses+ One spray	1.246	148.35	14.00	9.00	9.40	72.85	3.43	0.44	2.64
	50% N recommended doses+ Two sprays	1.187	141.28	16.67	11.67	8.83	92.45	3.38	0.27	3.14
	50% N recommended doses+ Three sprays	0.256	30.47	7.10	8.00	8.33	78.07	3.36	0.49	3.29
	L.S.D at 0.05	0.069	8.258	2.075	N.S.	0.506	2.832	0.171	0.104	0.403
Microbin						**(2014/2015)**				
	100% N recommended doses+ without spray	2.563	305.07	19.50	12.13	13.43	101.23	2.11	0.24	2.46
	50% N recommended doses+ One spray	1.880	223.81	16.17	10.47	12.10	81.32	3.42	0.67	3.30
	50% N recommended doses+ Two sprays	1.174	139.75	16.17	10.47	12.70	97.00	3.52	0.46	3.69
	50% N recommended doses+ Three sprays	0.563	67.07	9.50	8.13	12.90	91.12	3.34	0.38	3.80
Serialen	100% N recommended doses+ without spray	2.121	252.52	17.17	11.80	8.50	80.82	3.01	0.41	3.85
	50% N recommended doses+ One spray	1.133	134.83	12.50	9.57	7.83	64.15	3.38	0.45	3.81
	50% N recommended doses+ Two sprays	1.444	171.94	18.50	10.13	7.20	80.17	3.61	0.43	3.62
	50% N recommended doses+ Three sprays	0.784	93.34	10.17	9.80	6.83	71.68	3.24	0.47	3.44
Azotobacter	100% N recommended doses+ without spray	2.679	318.91	20.17	12.13	11.37	93.09	3.13	0.52	3.78
	50% N recommended doses+ One spray	1.360	161.85	15.17	7.80	10.70	72.51	3.38	0.49	3.14
	50% N recommended doses+ Two sprays	1.300	154.78	18.17	10.47	10.13	92.11	3.33	0.33	3.77
	50% N recommended doses+ Three sprays	0.369	43.97	8.60	6.80	9.63	77.07	3.31	0.55	3.79
	L.S.D at 0.05	0.045	5.310	1.113	1.248	0.254	1.558	0.085	0.033	0.063

III. Quality of apical heads:

A. Effect of nitrogen bio-fertilizers: Data in Table (6) Showed that there were significant differences in the physical and chemical quality of apical heads of broccoli between nitrogen bio-fertilizers treatments in the two seasons of this study. The highest values of heads physical quality, .i.e. weight, diameter and height were recorded by Microbin treatment and the lowest values were found by Serialen treatment. Also, Data presented in Table (6) indicated that application of Microbin increased the values of TSS and vitamin C in apical heads of broccoli compared with Azotobacter and Serialen treatments**.** These findings were similar and true in both seasons of this study. Enhancing head physical and chemical quality might be also referred to the higher products of photosynthesis and bio-synthesis resulting by the increase in the soil microbial flora which happened by bio-fertilization as the results in Table (2).

B. Effect of mineral nitrogen doses: Physical quality of apical heads of broccoli expressed as weight, diameter and height and chemical quality expressed as TSS and vitamin C were statistically affected by mineral nitrogen doses treatments (Table, 7). The highest values of physical and chemical quality were obtained by application of 100% N recommended doses without spray and 50% N recommended dose + one foliar spray of amino magnical treatment in the second order. Lower quality was obtained by 50% N recommended dose + three foliar sprays of amino magnical treatment.

C. Effect of the interaction: The physical quality of apical heads expressed as diameter, height and Mean fresh weight of apical head followed the same trend of the vegetative growth and total yield in relation to the interaction (Table, 8). The highest values of quality parameters were obtained by application of Microbin treatment which receiving 100% N recommended doses without spray of amino magnical treatment and the second treatment which receiving 50% N recommended dose + one foliar spray of amino magnical treatment. On the other hand, the lowest quality was obtained by plants inoculation by Azotobacter which receiving 50% N recommended dose + three foliar sprays of amino magnical. The other interaction treatments ranged in between these two treatments. These results were similar and true in the two seasons of the experiment.

IV- Chemical composition of broccoli heads:

A. Effect of nitrogen bio-fertilizers: Data presented in Table (6) demonstrated that, the N % in broccoli heads were significantly increased by inoculation plants by Serialen compared with other two treatments in both seasons. Moreover, the lowest values of N percentages were recorded by plants which inoculated by Microbin. The P % in broccoli heads was not significantly differed between nitrogen bio-fertilizers treatments. Data presented in Table (6) demonstrated that, the K % in broccoli heads were significantly increased by inoculation plants by Azotobacter compared with other two treatments in both seasons.

[17] and [18] reported that application of bio-fertilizer increased the ability to convert N_2 to NH_4 and thus make it available to plants and enhanced the concentration of N, P and K in onion. In addition, the mechanism by which bio-fertilization can exert a positive effect on plant growth can be through the synthesis of phytohormones, N_2 fixation, reduction in membrane potential of roots, synthesis of some enzymes (such as ACC deaminase) that modulate the level of plant hormones. Free living N-fixing bacteria such as *Azotobacter* and *Azospirillum* have the ability not only to fix nitrogen but also to release certain phytohormones, i.e. GA_3, IAA and cytokinins which could stimulate plant growth and increase the availability of nutrients for plant roots by the increase in their dissolutions. In addition, the increase in the capacity of photosynthesis process [20].

B. Effect of mineral nitrogen doses: Data in Table (7) show that there were significant differences in N, P and K percentages by using different mineral nitrogen doses treatments in the two seasons of this study. The highest N percentages in heads of broccoli was produced by 50% N recommended doses+ two spray of amino magnical treatment in the two seasons of this study. On the contrary, the lowest amount of N percentage in heads of broccoli was found by 100% mineral fertilizer without spray treatment in the two seasons. These results were in accordance with those reported by [1] and [14]).

Concerning to the superiority in elemental values in tissues of leaves and heads of broccoli by increasing the organic manure, may be attributed to high content of N, P and K. The high availability of macro and micro elements in organic manure are found in an enough quantity which required for a good plant growth, consequently higher yield and better quality. The results are accordance with those obtained by [2]. These results may be due to the role of N, P and K in plant tissues of broccoli, since, N plays major roles in the synthesis of structural proteins and other several macromolecules. In addition to its vital contribution in several biochemical processes in the plants [27].

The highest p percentages in heads of broccoli was produced by 50% N recommended doses+ one spray of amino magnical treatment in the two seasons of this study. On the contrary, the lowest amount of P percentage in heads of broccoli was found by 100% mineral fertilizer without spray treatment in the two seasons. However, phosphorus plays major role in protein synthesis and protoplasm formation. These may increase the proportion of protoplasm cell wall with the result of increased concentration of P in cells and increased cell size [26].

The highest K percentages in heads of broccoli was produced by 50% N recommended doses+ three sprays of amino magnical treatment in the two seasons of this study. On the contrary, the lowest amount of K percentage in heads of broccoli was found by 100% mineral fertilizer without spray treatment in the two seasons. Moreover, potassium plays an important role in the functions of enzymes needed for the vital processes.

C. Effect of interaction: Interaction of nitrogen bio-fertilizers with mineral nitrogen doses statistically affected on the N, P and K% in tissues of broccoli heads shown in Table (8). These results held well in the two seasons. Generally, it could be summarized that, the highest amount of N percentage in heads of broccoli recorded when inoculated broccoli plants by Serialen with 50% N recommended doses + Two sprays of amino magnical treatment and follow up the broccoli plants which inoculated by Microbin with 50% N recommended doses + Two sprays of amino magnical treatment in the second order.

Results in Table (8) show clearly that, the P percentage in heads of broccoli significant response to the interaction among nitrogen bio-fertilizers with mineral nitrogen doses during the two seasons. The highest value of P percentage in heads of broccoli was produced by broccoli plants which inoculated by Microbin and fertilized with 50% N recommended doses+ one spray of amino magnical treatment and follow up the broccoli plants which inoculated by Azotobacter and fertilized with 50% N recommended doses+ Three sprays.

The highest values of K percentage in heads of broccoli was produced by broccoli plants which inoculated by Serialen and fertilized by 50% N recommended doses + One spray of amino magnical and follow up the broccoli plants which inoculated by Microbin and fertilized with 50% N recommended doses+ Three sprays.

On the contrary, the lowest values of N, P and K percentages in broccoli heads recorded by plants which inoculated by Microbin and fertilized by 100% N recommended doses + without spray of amino magnical. These results were completely similar in both seasons.

4. CONCLUSION

Foliar fertilization could be used for saving fertilizers and reducing production costs. Foliar application of Amino magnical play an important role in the production of good crop and higher yield. The obtained results show that the vegetative growth, yield and quality of broccoli plants were enhanced by bio-nitrogen fertilizers. It is concluded that broccoli plants could be inoculated by Microbin and cultivated in a combined with 100% N recommended doses without spray of amino magnical treatment and follow up the treatment 50% N recommended dose + One application spray of amino magnical in the second order to improve growth and reduce use of mineral N fertilizer, producing high yield of broccoli heads with high quality.

5. ACKNOWLEDGMENT

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