EFFECT OF CHEMICAL AND BIO-FERTILIZERS ON THE GROWTH AND ACTIVE INGREDIENTS OF MAJORANA HORTENSIS PLANT

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ABSTRACT

The experiment was carried out in the experimental farm of El-KanaterResearch Station, Horticulture Research Institute, Kalubia Governorate, Egypt. Cultivation of seedling carried out in two seasons 2011-2012/2012-2013to study the effect ofN.P.K. fertilizers and boifertilizer on Majorana Plant. This work was designed in order to investigate the possibility of reducing the need for NPK chemical fertilization as well as improving plant productivity by using bacterial biofertilization as an alternative. The plants of control treatment received only the full recommended rate of NPK chemical fertilization as ammonium sulphate, calcium superphosphate and potassium sulphate. For the other treatments, a single inoculum or mixture of different inoculum combinations of *Azotobacterchroococcum* and *Azospirillumlipoferum* were used in combination with NPK chemical fertilizer as quarter or half dose of the full recommended rate. The experiment was complete random parts to study the effect of nitrogen fixing bacteria application (*Azospirillumlipoferum* and *Azotobacterchroococcum*).

The results revealed that the application of biological fertilizers plays a remarkable role in improving yield quality and quantity in Marjoram and can be viewed as a suitable replacement for chemical fertilizers.

Keywords: Chemical fertilization, Bio-fertilization, *Majoranahortensis*

INTRODUCTION

Recently, medicinal and aromatic plants play a major role in agriculture and industry. They are validating drug safety as raw substances used in manufacturing of pharmaceuticals. Some of their components are the nucleus to the chemical biosynthesis for some important drugs such as cortisone, sex hormones, plasma substitute and others. Also, aromatic plants are used in manufacturing of cosmetics, beverages, flavoring agent, etc.

It is very important to produce chemical free, environment friendly medicinal and aromatic herbs for drugs extraction as well as medicines and cosmetics manufacturing as a main substance for human disease healing and health care. Inorganic fertilizers applied to agricultural crops have a great beneficial potential to maximize yields, that can contribute also to environmental pollution (air, water, soil), when applied in too high quantities, at the wrong time or within inappropriate application techniques. Increasing use of fertilizers in agriculture deteriorate environment and cause harmful impacts on living beings due to insufficient uptake of these fertilizers by plants results, fertilizers reaches into water surfaces causes eutrophication in water subsurface and affect living beings including growth inhabiting microorganism. The excess use of chemical fertilizers in agriculture are costly and also have various adverse effects on soils, i.e. depletes water holding capacity, soil fertility and disparity in soil nutrients. The optimal amount and modern management practice guaranty high yield and quality products and minimize possible negative effects. It was felt from a long time to develop

some low cost effective and eco-friendly fertilizers which work without disturbing nature (Deepali and Gangwar, 2010).

Biofertilizers are very important to produce medicinal and aromatic plants for drugs extraction and manufacturing as a main substance for human disease healing and health care. Producing such drugs has to be clean, having no or the least chemical residues of any harmful kinds. Additionally, biofertilizers are substitution of chemical fertilizers for healthy and cheap production (SubbaRao, 1981). The effect of biofertilization on the growth and productivity of medicinal plant**s** was applied by Hassan *et al*. (2010) on khella; Hassan (2009) on roselle; Harb*et al*. (2011) on black cumin using chemical fertilizers combined with biofertilzers resulted in higher values of volatile oil yield/plant and per fed.

The plant chosen in this investigation is marjoram *Majoranahortensis*, L. Fam. Lamiaceae (mint family). Marjoram is a popular herb from Europe. It is indigenous to Mediterranean countries and was known to the ancient Egyptians, Greeks and Romans (Tainter and Grenis. 1993).

Majoranahortensis is cultivated as culinary herbs and garden plants as well it is valued as a medicinal plant for improving antiseptic, antispasmodic, carminative, stimulant, and expectorant and nerve tonic rheumatic habits, stimulates. Moreover, the blood circulation, nerve, muscle pain, muscle rheumatism arthritis, flu, cold, bronchitis, stucked cough, asthma, hiccups, slow digestion, bad appetite, menstruation problems, blood pressure, worm infections, cramps, mould infections (El-Ghorab*et al.*, 2004). Essential oil is very strong and very pleasant fragrance, the highest essential oil percentage is found in the leaves, whereas only traces are found in flowers and stalks

(Guenther, 1974). Major components of the volatile oil are monoterpenoids; a-pinenebetapinene, sabinene, myrcene, a-terpinene, y-terpinene, paracymene, terinolene, a-phellandrene, betaphellandrene. Sesquiterpenoids: beta-caryphyllene, a-humulene. Monoterpenols: linalool, terpine-1-ol-4, terpine-1-ol-3, a-terpineol, cisthuyanol-4, trans-thuyanol-4. Terpenic esters: linalyl-acetate 0.1-3% terpenyl-acetate ,geranyl-acetate,phenolmethyl-ethers; trans-anethol(Kumar *et al*., 2011).

The objective of the study was the judicious of NPK chemical fertilization by investigating the effect of inoculation with bacterial cultures of nitrogen fixing bacteria *Azospirillumlipoferum* and *Azotobacterchroococcum* as biofertilization, alone or combined, plus full, half or quarter dose of chemical NPK fertilizers on vegetative growth, active constituents and chemical composition of marjoram (*Majoranahortensis*, L.) plants.

MATERIALS AND METHODS

Location of experiment: This study was carried out at the experimental field of theHorticulture Research Station at Al Qanater-Al Khairya, Agriculture Research Center (ARC), for two successive seasons (2011/2012 and 2012/2013).To study the effect of mineral and biological fertilization on the growth and active ingredients of *Majoranahortensis* plant.

Bacteria used: Active strains of *Azotobacterchroococcum* and *Azospirillumlipoferum* were provided from Unit of Biofertilizers, Faculty of Agriculture, Ain Shams Univ., Shoubra El-Kheima, Egypt.

Seeds and soil: The marjoram seeds were kindly provided from theHorticulture Research Station at Al Qanater-Al Khairya, Agriculture Research Center (ARC)(Barely Island Farm)Farmer Gezera Al-Shaeer

Table (1): Physical and chemical analysis of the soil used for growing marjoram plant.

Physical analysis	Sand %		55.2
	Silt %		26.3
	Clay %		18.5
	Soil texture		Sandy loam
Chemical analysis	Electrical conductivity (dSm^{-1})		2.10
	pH		7.5
	Soluble anions (meq/L)	CO_3^{--}	…..
		HCO_3^-	3.75
		Cl^-	6.5
		SO_4^{--}	15.05
	Soluble cations (meq/L)	Ca^{++}	14.4
		Mg^{++}	5.3
		Na^+	4.25
		K^+	1.35

Experimental procedure: Seeds of *Majoranahortensis* plants had been sown in outdoor nursery beds with a sandy soil.

Ammonium nitrate (33.5% N), calcium superphosphate (15.5% P_2O_5) and potassium sulphate (48% K_2O) were used for NPK fertilization, respectively. The inorganic were used at two rates:

1- Full of the recommended field rate, i.e. 300, 200 and 100 kg/fed. Ammonium nitrate, calcium superphosphate and potassium sulphate equal (100, 31 and 48kg /fed.) of N, P_2O_5, K_2O respectively (as a control).

2- Half of the recommended field rate, i.e. 150, 100 and 50 kg /fed. equal (50, 15.5 and 24 kg /fed.) of N, P_2O_5, K_2O respectively.

3- Quarter of the recommended dose, i.e. 75, 50 and 25 kg /fed. equal (25, 7.75 and 17 kg /fed.) of N, P_2O_5, K_2O respectively.

Calcium superphosphate was added during soil preparation, while N and K were added into 3 equal doses as follows:

a)- 30 days after transplantation.

b)- 2 weeks after the first harvest.

c)- 2 weeks after the second harvest.

After 45 days, marjoram seedlings were transplanted in 30cm diameter plastic bags filled with 6 kg of clay soil (obtained from Al Qanater Research Station).

The plants received the following fertilization treatments

T_1-Uninoculated(Control) + full dose of NPK.

T_2-*Azotobacterchroococcum.*

T_3- *Azospirillumlipoferum*.

T_4- *Azotobacterchroococcum* + *Azospirillumlipoferum*

T_5- *Azotobacterchroococcum* +25% NPK

T_6- *Azotobacterchroococcum* +50% NPK

T_7-*Azospirillumlipoferum*+25% NPK

T_8-*Azospirillumlipoferum*+50% NPK

T_9- *Azotobacterchroococcum* + *Azospirillumlipoferum*+25% NPK

T_{10}- *Azotobacterchroococcum* + *Azospirillumlipoferum*+50% NPK

Inoculation was carried out by immersing the seedlings roots in cell suspension of either *Azotobacterchroococcum* or *Azospirillumlipoferum* (contained about 10^8 cells/ml) or their mixture for 30 minutes.

Layout of the experiment: The experiment was designed using the randomized complete blocks design. The experiment included 10 treatmentswith3 replicates, each consisting of 5 pots (bags) treatment.

Data recorded: The plants were harvested in 3 separated cuts /season (first week of May,first week of August and first week of November for both seasons) by cutting the vegetative parts of all the plants 5 cm above the soil surface .

Thefollowing measurements were recorded at each cut:

1- Vegetative growth parameters

- Plant height (cm).
- Number of branches /plant.
- Herb fresh weight (g/plant)
- Herb dry weight (g/plant)

The herb was dried at 70 °C until a constant weight was obtained, then the herb dry weight was recorded.

2- Essential oil

a)- Essential oil content (% of fresh weight) in the herb: The oil percentage was determined according to the British pharmacopeia (1963). Satisfactory results were obtained by distillation of 50 gm of fresh herb for 2.5-3.0 hours. The herb was placed in a flask of 1000ml capacity. An amount of water, weighing about 4-5 times as much as the plant material, was added. Aproper essential oil trap and condenser were attached to the flask and

enough water was added to fill the trap. The flask was placed on an electrically heated bath. The distillation continued for 2.5 – 3.0 hours until no further increase in the oil was observed. The oil was permitted to stand undisturbed so that a good separation from water could be obtained .

b)-Essential oil components: Samples taken from the oil obtained in the second cut of each season were analyzed using gas liquid chromatographically analysis, to determine their main constituents. The use of GLC in the quantitative determinations was performed using the methods described by Bunzen*et al.*(1969) and Hoftman (1967),which are based on peak area measurements. Briefly 0.3ml of the volatile oil was dissolved in 10 ml diethyl ether and 1µl was injected into a gas chromatograph (Hewlett Packard, 5890 Series 11) equipped with fused silica capillary column with a coating film of HP-20M carbowax (0.32 mm i.i and 25m long). Nitrogen flow rate at 30 ml/min, hydrogen flow rate of 30 ml/min, and air flow rate of 300 ml min with an initial temperature of 40 °C min final temperature of 120°C for 2 min, injection temperature of 150 °C and the flame ionization detector temperature was 170 °C, Chart speed was 120 sec cm Rang 32; The reference (authentic) materials were injected with the samples to be analyzed and the authentic samples were compared for the identification of the components of the oil from different treatments.

The area of each peak was first calculated by an automatic integrator. The areas were then summed. The total area of the peaks represented the whole sample. The percentage of each component was the ratio between its peak areas to the total peak area, multiplied by 100.

Statistical analysis of data: Data recorded on growth oil content and oil yield were statistically analyzed, and separation of means was performed using the Duncan test at the 5% level as described by Little and Hills (1978).

RESULTS AND DISCUSSION

Effect of differentmineral and bio-fertilizers treatments on plant height:

Data presented in Table (1) show that control plants were shorter in height than other treatments. Utilization of mix of *Azospirillumlipoferum* and *Azotobacterchroococcum*incombination with 50% of recommended NPK dose (T10) gave the tallest plant at first cut in both years. Moreover, second and third cuts showed decline in plant heights compared to first cut. *Azospirillumlipoferum* or combination of both strains showed significant increase in plant height. The maximum significant increase of plant height was 63.7 cm at the first cut of T10 treatment .T10 and T3 showed the tallest plant in the first and second cut respectively of 2011. However, third cut height under both strains in combination application in T8, T9, T10 gave the taller plants 40.7, 40.3 and 39.3 respectively. T4 and T10 gave tallest plant 49.3 and 52.0 cm at first cut of 2013.

However, in second and third cuts plants were shorter than first cut third cut showed similarity among treatments except control.

*Azotobacter i*s able to produce antifungal compounds that fight plant diseases and improve viability and germination of the plantlets and, as a result, improve the overall plant growth (Chen, 2006).

Table (1): Effect of different mineral and bio-fertilization treatments on plant height at different cuts of *Majoranahortensis*.

Treatments		Plant hieght (cm)					
		1st year 2011/ 2012			2nd year2012/ 2013		
		1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut
T1	Control	49.0e	40.7c	34.0cd	44.8def	30.0Bcd	27.3c
T2	*Azotobacter*	52.5d	39.7c	35.0bcd	44.6ef	26.7E	28.0 bc
T3	*Azospirillum*	53.3d	**46.0a**	**38.7ab**	47.6bcde	34.0A	30.3a
T4	*Azotobacter+Azspirillum*	52.0de	43.0b	37.3abc	**49.3ab**	28.3De	31.0a
T5	*Azotobacter* +¼ NPK	55.0cd	40.3c	32.0d	43.5f	30.3bcd	30.0ab
T6	*Azotobacter* +½ NPK	56.7c	40.0c	35.3bcd	45.3cdef	29.3cde	31.0a
T7	*Azospirillum*+¼ NPK	57.5bc	39.3c	**38.7ab**	48.0bcd	31.7abc	31.7a
T8	*Azospirillum*+½ NPK	57.0c	40.7c	40.7a	46.4bcdef	33.0Ab	30.0ab
T9	*Azotobacter+Azspirillum*+ ¼ NPK	60.5b	38.3c	40.3a	48.4bc	30.7bcd	32.3a
T10	*Azotobacter+Azspirillum*+ ½ NPK	63.7a	39.7c	39.3a	52.0a	29.7cde	30.7a

N= nitrogen, P=phosphours, K=potassium, ¼ =25% / ½=50%

Means with the same letter are not significantly different.

Effect of differentmineral and bio-fertilizers treatments on fresh weight:

Data presented in Table (2) show that fresh weights were positive increment in the second cut compared to with the first and reduction was observed in the third one. Alteration of mineral fertilization with biofertilizer showed significant advances in cultivation of *Majoranahortensis*. Fresh weight showed variability among treatments in both growing seasons and different cuts.

In both years and all cuts treatments showed significant difference than control. In which, reducing amount of N, P, K and use single or combined strains of *Azospirillumlipoferum* and *Azotobacterchroococcum* gave better result than control.

Reduction synthetic fertilizer to one quarter or half gives better results than non-fertilized control or odd use of biofertilizer. *Azotobacterchroococcum* with reduced amount of chemical fertilizer gives better results than *Azospirillumlipoferum* or in combination together. Overall difference between using *Azotobacterchroococcum* combined with synthetic fertilizer gave 10-55% than control and showing better tendency by 10% than use of *Azospirillumlipoferum*. However, use of both strains combined did not improve plant fresh weight.T6 has increased fresh weigh significant in all cuts of first year of 2011. T6 and T7 showed the fresh weight in the first cut 46.6 and 48.2 respectively. However, T9 treatments includeboth strains of biofertilizer showed significant increase in the second cutof 2013 in second year.

T7 demonstrated significant affect on fresh weight of third cut in the first year gives better perform. First and second cutsgave better fresh weight in 2013 compared for what obtained in the first year.

However, second and third cut of the first year showed similar fresh weight over all fresh weight was higher in the first year compared to second year.

Biofertilizers are microbial inoculates used for application to either seed or soil for increasing soil fertility with the objective of increasing the number of such microorganisms and to accelerate certain microbial processes in the rhizosphere of inoculated plants or soil. Such microbiological processes can change unavailable forms of nutrients into available ones that can be easily assimilated by plants, and then increased herb fresh weight of marjoram (SubbaRao, 1993).

Table (2): Effect of different mineral and bio-fertilization treatments on fresh weight at different cuts of *Majoranahortensis*.

Treatments		Fresh weight (g/plant)						Total production of fresh herb	
		1st year 2011/2012			2nd year2012/2013				
		1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut	1st year	2nd year
T1	Control	31.0E	60.5cd	54.0F	34.4e	64.2e	32.2F	145.5e	130.8e
T2	*Azotobacter*	34.7D	59.3d	56.0Ef	41.8d	72.1cd	36.0ef	150.0d	149.9d
T3	*Azospirillum*	39.4C	66.3ab	61.7Bcd	42.3cd	75.2c	41.4cd	167.4c	158.9cd
T4	*Azotobacter+Azspirillum*	40.7Bc	59.3d	64.3Abc	44.4cd	74.1cd	45.7Abc	164.3bc	164.2cd
T5	*Azotobacter* +¼ NPK	39.4C	58.3d	60.0Cde	43.5cd	70.7d	40.5de	157.7c	154.7cd
T6	*Azotobacter +½ NPK*	46.6A	68.3a	68.0A	46.9b	75.3c	50.2A	182.9a	172.4a
T7	*Azospirillum*+¼ NPK	48.2A	66.7ab	63.3Bc	49.5a	72.5cd	46.4ab	178.2a	168.4b
T8	*Azospirillum*+½ NPK	38.7C	68.3a	57.3def	42.0d	86.6a	37.9de	164.3c	166.5d
T9	*Azotobacter+Azspirillum*+¼ NPK	39.8C	60.7cd	64.0abc	43.8cd	79.3b	41.3cd	164.5c	164.4cd
T10	*Azotobacter+Azspirillum*+½ NPK	42.9B	63.3bc	65.0ab	44.8bc	89.9a	42.7bcd	171.2b	177.4a

N= nitrogen, P=phosphours, K=potassium, ¼ =25% / ½=50%

Means with the same letter are not significantly different.

Effect of differentmineral and bio-fertilizers treatments on dry weight:

Results recorded in Table (3) reveal that for cut age of dry weight of the first year was higher than second year was third cut and first cut showed the highest % DW in first and second year respectively.

In first cut of both years non significant differs or slight difference among treatment was observed.

In 2013 use of combined strains gave higher % of dry matter maybe due to regulation of water absorption compiled to slight application of strains.

It could be concluded that the increment in plant dry weight may be attributed to the increase in both plant height, number of branches/plant and plant fresh weight. These results agreed with those obtained by Abo- El-Ala (2002), Kandeel and Sharaf (2003), Mahfouz (2003) and Abo- (2008) on marjoram. They reported that,the highest values of plant height, number of branches, herb fresh and dry weights were recorded for the treatment of biofertilizer in comparison to the other treatments (without biofertilizers) plants.

Table(3): Effect of different mineral and bio-fertilization treatments on percentage of dry weight at different cuts of *Majoranahortensis*.

Treatments		% of dry weight					
		1st year 2011/2012			2nd year2012/ 2013		
		1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut
T1	**Control**	**24.9Ab**	**23.8bc**	**27.9bc**	**27.4a**	**18.8d**	**16.0e**
T2	***Azotobacter***	**24.7Ab**	**26.6ab**	**27.0bcd**	**25.3a**	**21.0cd**	**18.0de**
T3	***Azospirillum***	**26.9A**	**27.7a**	**30.3ab**	**26.3a**	**23.6bc**	**18.0de**
T4	***Azotobacter +Azspirillum***	**26.1Ab**	**25.7abc**	**29.7ab**	**23.6a**	**23.5bc**	**20.0cd**
T5	***Azotobacter* +¼ NPK**	**23.7B**	**24.7bc**	**27.1bcd**	**24.0a**	**19.9d**	**19.3cd**
T6	***Azotobacter* +½ NPK**	**24.7Ab**	**26.5ab**	**33.4a**	**27.0a**	**19.9d**	**22.0abc**
T7	***Azospirillum*+¼ NPK**	**25.9Ab**	**27.5a**	**28.5bc**	**26.6a**	**19.2d**	**20.7bcd**
T8	***Azospirillum*+½ NPK**	**23.8B**	**24.3bc**	**29.3b**	**25.1a**	**23.7bc**	**23.0ab**
T9	***Azotobacter +Azspirillum*+¼ NPK**	**25.5Ab**	**25.9ab**	**25.3cd**	**28.0a**	**26.8Ab**	**24.0a**
T10	***Azotobacter +Azspirillum*+½ NPK**	**26.7A**	**23.1c**	**23.5d**	**26.1a**	**27.5A**	**24.0a**

N= nitrogen, P=phosphours, K=potassium, ¼ =25% , ½=50%

Means with the same letter are not significantly different.

Effect of differentmineral and bio-fertilizers treatments on oil percentage

Data presented in Table (4) indicate that the use of biofertilizer stimulate accumulation of oil contents than application of synthetic fertilizers. First & second cut showed the highest accusation of oil in first and second years. However, first cut of the first year showed the highest accumulation among different cuts. T6 showed 0.87% accumulation, while control treatment gave 0.54%. Moreover T6 showed stable tendency at different cuts in both years,which reveal good synergy between lowdose of NPK and*Azotobacter-Azospirillum*on accumulation of oil.Kandeel and Sharaf (2003) on marjoram plants, stated that, the highest oilpercentage and oil yield/ ha were obtained with plantsinoculated pre-sowing with three bacterial partners(biological fertilizers) and half of the recommended fieldrate of the inorganic N, P and K fertilization.

Table(4): Effect of different mineral and bio-fertilization treatments on oil percentage at different cuts of *Majoranahortensis*.

Treatments		Oil percentage (%)					
		1st year2011/2012			2nd year2012/2013		
		1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut
T1	Control	0.54f	0.55d	0.36a	0.58bcd	0.56c	0.36Bc
T2	*Azotobacter*	0.55f	0.56d	0.33ab	0.62ab	0.53c	0.33Cdef
T3	*Azospirillum*	0.63e	0.63c	0.34ab	0.51e	0.66b	0.34cde
T4	*Azotobacter +Azspirillum*	0.67de	0.64c	0.31b	0.56cd	0.68b	0.31Ef
T5	*Azotobacter* +¼ NPK	0.78b	0.72ab	0.33ab	0.56cd	0.75a	0.31def
T6	*Azotobacter* +½ NPK	0.87a	0.75a	0.36a	0.62ab	0.77a	0.39Ab
T7	*Azospirillum*+¼ NPK	0.74bc	0.68bc	0.35a	0.61ab	0.74a	0.34cde
T8	*Azospirillum*+½ NPK	0.64e	0.64c	0.34a	0.55d	0.65b	0.35Cd
T9	*Azotobacter +Azspirillum*+¼ NPK	0.66de	0.66c	0.36a	0.64a	0.66b	0.41A
T10	*Azotobacter +Azspirillum*+½ NPK	0.71cd	0.64c	0.31b	0.60abc	0.65b	0.30F

N= nitrogen, P=phosphours, K=potassium, ¼ =25%, ½=50%

Means with the same letter are not significantly different

Data presented in Table (4) show that N, P and K percentages in marjoram plant herb were considerably influenced by the inoculation with *A.chroococcum* and *Azospirillumlipoferum* or their mixture combined with NPK fertilizers. Gad (2001) reported that nitrogen, phosphorus, and potassium in leaves of *Foeniculumvulgare* and *Anethumgraveolens*were increased by applying biofertilizers.

Table (5): Effect of differentmineral and bio-fertilization treatments on percentage of total nitrogen, total phosphorus, total potassium, CHl (A), CHl (B) and carotenoids in 3rd cut from *Magoranahortensis*in season 2012/2013.

Treatments	N%	P%	K%	CH1(A)	CH1(B)	Carotenoids	Total.Ch
T1	1.840AB	0.2250 B	1.250 ABC	0.5300 BC	0.4400 C	0.9700 D	0.8400 D
T2	1.370B	0.2390 B	1.000 BCD	0.7400 ABC	0.6400 BC	1.370 BCD	0.9200 CD
T3	1.150B	0.2390B	0.8400 D	0.5800 ABC	0.5000 BC	0.8600 D	1.080 BCD
T4	1.280B	0.3670A	1.040 BCD	0.4400 C	0.4200 C	1.010 CD	0.8600 D
T5	1.140B	0.2800B	1.000 BCD	0.9100 ABC	0.8300ABC	1.730 BC	1.490 ABCD
T6	1.430B	0.2250B	1.500 A	1.160 AB	0.8100ABC	0.9900 D	1.970 ABC
T7	2.190A	0.2800B	1.300 AB	1.220 A	1.250 A	2.560 A	2.460 A
T8	1.500 AB	0.2800 B	0.9600 CD	1.140 AB	0.9100 AB	1.850 AB	2.040 AB
T9	1.120B	0.300AB	1.040 BCD	1.030 ABC	0.8300ABC	1.070 CD	1.860 ABCD
T10	1.290B	0.2570 B	1.000 BCD	0.9500 ABC	0.6600 BC	1.370 BCD	1.610 ABCD
LSD	0.7624	0.07741	0.3192	0.6500	0.4413	0.7303	1.050
	at alpha=0.05	at alpha= 0.05	At alpha= 0.05	at alpha=0.05	at alpha =0.05	at alpha=0.05	at alpha=0.05

N= nitrogen, P=phosphours, K=potassium, Chlorophyll (A), Chlorophyll (B)

Means with the same letter are not significantly different

Data presented in Table (5) show thatN, P and K percentages in marjoram plant herb were considerably influenced by the inoculation with *A.chroococcum* and *Azospirillumlipoferum* or their mixture combined with NPK fertilizers.Gad (2001) reported that nitrogen, phosphorus, and potassium

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تأثير التسميد الكيماوي والحيوي علي النمو والمحتوي الكيمائي لنبات البردقوش

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المستخلص

أجريت هذه التجربة فى مزرعة جزيرة الشعير فى مركز البحوث الزراعية بالقناطر الخيرية (القليوبية)

خلال عامى ٢٠١٢/٢٠١١ – ٢٠١٣/٢٠١٢ تم زرع الشتلات لدراسة مدى تأثير التسميد الكيماوى NPK والحيوى على النمو والمحتوى الكيماوى لنبات البردقوش.

وكان الهدف من الدراسة هو معرفة تأثير التسميد الكيماوى والحيوى على نبات البردقوش . أقيمت هذه التجربة فى صورة قطاعات كاملة العشوائية لدراسة تأثير نوعين من البكتريا هما أزتوبكتر وازوسيريلليم لمصادر متنوعة من التسميد وكبدائل لتقليل التلوث الزراعى.

كان تقييم التجربة فى وضع معاملة بدون إضافات و(تعتبر كنترول) وكذلك معاملات بإضافة ¼ و ½ الكمية NPKومعاملات بإضافة تسميد حيوى ازتوبكتر وازوسيريللم.

وكانت النتيجة: أدى التسميد الحيوى الى إستخدامة كبديل التسميد النتروجين المعدنى بكلا منهما أوقع وجود خليط منهما إلى تحسين كمية العشب الاخضر وكذلك نسبة المواد الفعالة وخفض نسبة النترات والنتريت مما يسمح باستهلاك البردقوش دون مشاكل صحية.