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INFLUENCE OF SOME FERTILIZERS AND BORON FOLIAR SPRAY ON IMPROVING GROWTH AND OIL PRODUCTIVITY OF DRAGONHEAD (*Dracocephalum moldavica* L.) PLANT.

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ABSTRACT

Two field experiments were conducted to evaluate the effect of organic (compost 10 m^3/fed.) and bio (nitrobein + phosphorein) fertilizers when used with half or full doses of chemical fertilizer in presence of boron foliar spray at 0.0, 50 and 100 ppm on some growth parameters, photosynthetic pigments, minerals and some bioconstituents, endogenous phytohormones and oil yield of dragonhead (*Dracocephalum moldavica* L.) plants during 2011/2012 and 2012/2013 seasons. Also, interaction effects between boron and the applied fertilizer treatments on growth, chemical composition and oil productivity were studied as well. The results showed that, the applied treatments of fertilizers and boron as well as their combinations significantly increased most growth parameters i.e. plant height, number of branches and leaves/plant, fresh and dry weight of leaves (g)/plant and flowers fresh weight(g)/plant. Also, photosynthetic pigments i.e. chlorophyll a, b and carotenoids, minerals i.e. N, P, K, Fe, Zn and B uptake, and some bioconstituents as total carbohydrates, sugars and free amino acids content in leaves. Also, oil yield in leaves and flowers gave the maximum values when plants treated with organic and bio fertilizers in presence of foliar application with boron at 100 ppm as compared with those of individual application or untreated ones. Moreover, organic and bio fertilizers and in presence of boron at 100 ppm treatments increased endogenous phytohormones i.e. auxin, gibberellin and cytokinin contents, but they decreased abscisic acid values in dragonhead shoots during 2012/2013 season. Furthermore, organic and bio fertilizers and in presence of boron at 100 ppm treatments decreased the activity of antioxidant enzymes i.e. peroxidase, catalase and superoxide dismutase contents in dragonhead leaves during 2012/2013 season.

Thereby, it could be recommended that foliar application with boron at 100 ppm in the presence of half dose of chemical fertilizer+10m^3compost/fed.+ bio fertilizer could be used to improve growth and oil productivity of dragonhead plant.

Keywords: Dragonhead, chemical, bio and organic fertilization, boron, growth, oil productivity, and chemical composition.

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INTRODUCTION

Medicinal and aromatic plants use by 80% of global population for their medicinal therapeutic effects as reported by WHO (2008). Many of these plants synthesize substances that are useful to the maintenance of health in humans and other animals. These include aromatic substances, most of which are phenols or their oxygen-substituted derivatives such as tannins. Others contain alkaloids, glycosides, saponins and many secondary metabolites (Naguib, 2011)

Dragonhead (*Dracocephalum moldavica L.*) plants belong to Family Labiatae. Also, it is recently introduced to Egypt during the last two decades. It is a hardy plant native to regions from Eastern Europe to Siberia. The plant is widely used in folk medicine as a pain killer and in kidney complains. It is an easy and carefree plant best massed in sunny or partly shaded areas on well drained soil (Ismail, 2007). On the other hand, the plants are easy to grow and require special horticultural practices. Dragonhead is used as painkiller for treatments of kidney complains, against toothache and colds as well as anti-rheumatism. Also, dragonhead plant is very attractive to honey bees and this may reduce their mortality when subjected to pesticide contaminated ground cover. The seeds of dragonhead have astringent, carminative and tonic properties. They are used as a demulcent in the treatment of fevers. Furthermore, the plant is astringent, tonic and vulnerary and has antitumor properties (Dastmalchi *et al*., 2007). Recently, unconventional efforts are used to minimize the amounts of chemical fertilizers which applied to medicinal and aromatic plants in order to reduce production cost and environmental pollution without reduction of yield. Therefore, the trend now is using the bio and organic fertilizers.

Bio-fertilizers are reasonably safer to the environment than chemical fertilizers and play an important role in decreasing the use of chemical fertilizers. Consequently, it causes a reduction in environmental pollution. Bio fertilizers are microbial inoculants consisting of living cells of micro-organism like bacteria, algae and fungi alone or combination which may help in increasing crop productivity. Bio fertilizers can influence plant growth directly through the production of phytohormones such as gibberellins, cytokinins and IAA that act as growth regulators and indirectly through nitrogen fixation and production of bio-control agents against soil-borne phytopathogens and consequently increase formation of metabolites which encourage the plant vegetative growth and enhance the meristematic activity of tissues to produce more growth (Glick, 2003 and Ahmed and Kibret, 2014). The effect of bio-fertilizers on vegetative growth, yield and oil productivity in several studied was revealed by Badran and Safwat (2004) on fennel. Ismail (2007) on dragonhead plants, Amran (2013) on *Pelargonium graveolens* plants and El-Khyat (2013) on *Rosmarinus officinalis*.

Organic fertilizers are obtained from animal sources such as animal manure or plant sources like green manure. Continuous usage of inorganic fertilizer affects soil structure. Hence, organic manures can serve as alternative to mineral fertilizers for improving soil structure (Shahram and Ordookhani, 2011) and microbial biomass (Suresh *et al.* 2004). The addition of organic fertilizers to agricultural soils has beneficial effects on crop development and yields by improving soil physical and biological properties (Zheljazkov and Warman, 2004). Organic and bio fertilizers in comparison of the chemical fertilizers have lower nutrient content and are slow release but they are as effective as chemical fertilizers over longer periods of use (Naguib, 2011 and Mohamed *et al*., 2012). In this respect, Amran (2013) show that organic fertilizers enhanced vegetative growth parameters and essential oil productivity of *Pelargonium graveolens.*

Boron (B) is one of the important micronutrients, which has basic role in stabilizing certain constituents of cell walls structure and function and activity of plasma membrane, enhancement of cell division, tissue differentiation. Thus, boron could be directly associated with cell growth (Goldbach *et al.,* 1990). Also, boron has been involved in metabolism of nucleic acid, carbohydrate, protein, auxin and phenol. Moreover, boron has been role in sugar translocation, nucleic acids synthesis and pollen tube growth. Also, Boron plays a key role in higher plants by facilitating the short- and long-distance transport of sugar via the formation of borate- sugar complexes. However, such a proposal is unacceptable because, the prevalent sugar transport in the phloem forms only weak complexes with boron, and in the mechanisms of phloem loading of sucrose boron is not involved (Marschner, 1997, Goldbach and Wimmer, 2007 and Ganie *et al.,* 2013). Besides, more than 90% of the boron is found in cell walls. Its functions are also related to cell wall synthesis, lignifications and maintenance of cell wall structure (Hansch and Mendel, 2009). In addition, Ganie *et al.* (2013) reported that application of boron increase net photosynthetic rate which may be attributed to the increase in chlorophylls content of leaves. Furthermore, application of boron increased the activity of catalase and glutathione reductase, which act as antioxidants thus saving the electron transport mechanism of plant from getting oxidized by free radicals like superoxide radicals, singlet oxygen radicals (Wojcik *et al.,* 2008). Many investigators reported that stimulating effect of boron as a foliar spray on growth and flowering of different plants. In this concern, Gomaa and Mady (2008) found that boron foliar spray at 75 ppm increased growth parameter and oil productivity of chamomile plants.

The target of this work was to evaluate the benefits of supplementing organic and bio fertilizers with chemical fertilizer in presence of boron on growth and essential oil productivity of dragonhead plants and to minimize consuming of chemical fertilizers.

MATERIALS AND METHODS

Two field experiments were carried out at the Experimental Farm and in the Laboratory of Horticulture Department Faculty of Agriculture at Moshtohor, Benha Univ., during 2011/2012 and 2012/2013 seasons to study the effect of some fertilizer treatments (chemical, organic and bio-fertilizers) and boron spray as well as their combinations on vegetative growth, essential oil productivity and some chemical constituents of dragonhead (*Dracocephalum moldavica* L.) plants. Dragonhead seeds were obtained from Floriculture Farm, Horticulture Department, Faculty of Agriculture, Benha Univ. Seeds were sown in clay loam soils on 15^{th} October in both seasons in plots (1x1 m) containing two rows (50 cm. in between) every row contains two hills (50 cm. apart) and 45 days later, the plants were thinned, leaving only one seedling/hill.

Physical and chemical characters of the used soil are shown in Tables (a) and (b), Physical analysis was estimated according to Jackson (1973) whereas, chemical analysis was determined according to Black *et al*. (1982).

Table (a): Physical analysis of the experimental soil:

Parameters	**Unit**	**Seasons**	
		2011/2012	**2012/2013**
Coarse sand	%	5.08	4.90
Fine sand	%	15.98	16.35
Silt	%	26.38	27.12
Clay	%	52.56	51.63
Textural class	------	Clay loam	Clay loam

Table (b): Chemical analysis of the experimental soil.

Parameters	**unit**	**seasons**	
		2011/2012	**2012/2013**
$CaCo_3$	%	1.02	1.12
Organic matter	%	2.14	2.02
Available nitrogen	%	0.99	0.96
Available phosphorus	%	0.31	0.34
Available potassium	%	0.73	0.82
E.C	$dS.m^{-1}$	1.14	1.01
pH	----------	7.58	7.64

Bio-fertilizer treatment:

Dragonhead seeds were inoculated with a mixture of nitrobein + phosphorein contained efficient strains of nitrogen fixing bacteria namely, *Azotobacter chroococcum* + phosphate dissolving bacteria (*Bacillus megaterium* var phosphaticum) which supplied by the Department of Microbiology, Agric. Res. Center, Giza was used in this study as biological activators. The strains were characterized by a good ability to infect its specific host plant and by its high efficiency in N-fixation and phosphate solublizing. Seeds of dragonhead plants were washed with water and air-dried, thereafter the seeds were soaked in cell suspension of the mixture of nitrobein and phosphorein (1ml contains 10^8 viable cell) for 30 min. Gum arabic (16 %) was added as an adhesive agent prior to soaking. The inoculated seeds were air dried at room temperature for one hour before sowing. Another two applications were applied (1kg/fed) as an aqueous solution, the first one was applied just before irrigation after 60 days from sowing date, whereas the second one was done after 90 days from sowing date to increase the power ability of bacteria.

Organic fertilizer treatment:

Organic fertilizer i.e. compost containing plant sources and cattle manure at the rate of 10 m^3/fed., was thoroughly mixed with the soil before planting, the chemical properties of the tested compost are presented in Table (c).

Table (c): Chemical properties of the used compost:

Parameters	Ec $dS.m^{-1}$ (1:5)	pH (1:5)	Total C %	Total N %	Total P %	Total K %	Total Fe (ppm)	Total Zn (ppm)	C:N ratio
Reading	2.94	6.73	23.14	1.28	0.69	1.59	1425	384	18:1

Chemical fertilizer treatment:

The plants were fertilized with full chemical fertilizer dose as a recommended dose (Ismail, 2007); where ammonium nitrate (33.5% N) was added at the rate of 100Kg N/fed., calcium superphosphate (15.5 % P_2O_5) was added at the rate of 150 Kg and potassium sulphate (48.5 % K_2O) at the rate of 50 Kg /fed. The amount of N and K fertilizers were divided into four equal portions as side dressing at 55, 70, 85 and 100 days after sowing date of both seasons. However, the amount of P-fertilizer was added to the soil before seed sowing during soil preparation.

Boron treatments:

Boric acid (17% boron) was used as a source of boron. In each season, the foliage was sprayed four times during the growth period with boron at concentrations of 0.0, 50 and 100 ppm at 85, 100, 115 and 130 days after sowing date of both seasons. A surfactant (Tween 20) at a concentration of 0.01% was added to all tested solutions including the control..

Experiment layout:

This experiment was set up in a split plot design with three replicates. The main plot was employed by five fertilization treatments i.e. control (without fertilizer), full chemical fertilizer dose, 50% full chemical fertilizer dose + bio fertilizer, 50% full chemical fertilizer dose + organic fertilizer and 50% full chemical fertilizer dose + bio fertilizer + organic fertilizer. Whereas, the sub plot was devoted to three boron sprays i.e. control (tap water), 50 and 100 ppm.

Sampling and collecting data:

At the flowering stage i.e. 150 days after sowing (15^{th} March), morphological characteristics, photosynthetic pigments, chemical composition, endogenous phytohormones and antioxidant enzymes activity were estimated as following: Morphological characteristics i.e. plant height (cm), number of branches and leaves/plant, fresh and dry weights of leaves (g)/plant and fresh weight of flowers(g)/plant.

Photosynthetic pigments: chlorophyll a, b and carotenoids were calorimetrically determined in leaves of dragonhead according to the method described by Inskeep and Bloom (1985) and calculated as mg/g fresh weight. The essential oil was determined in the dragonhead leaves and flowers of each treatment was extracted by hydro-distillation according to Guenther (1961). The essential oil percentages in the leaves and flowers and oil yield /fed. were calculated for every treatment. The GLC analysis of the oil was carried out using Gas chromatograph, (Hewlett packard GC. Model 5890) equipped with a flame ionization detector (FID). A fused silica capillary (HP-5), (30 m length x 0.53 mm internal diameter (i.d.) x 0.88 um film thickness), was used for the separation in the GC. The following are the operating conditions of GC instrument: Injector and detector temperature were 250 and 270 ^{o}C , initial oven temperature, 50 ^{o} C for 2 min., raised at 6 ^{o} C per min, and then hold at 150 ^{o} C for 5 min,. then raised at 5 ^{o} C per min. then hold at 190 ^{o} C the carrier gas was nitrogen at 4 ml per min., and hydrogen, and air were used for the combination at 30 and 300 ml per min., respectively. The identification of the different constituents was achieved by comparing their retention times with those of the authentic samples.

Total nitrogen, phosphorus and potassium were determined in dragonhead leaves at the flowering stage i.e., 150 days after sowing (15th March), according the methods described by Horneck and Miller (1998), Sandell (1950) and Horneck and Hanson,(1998) respectively. Total carbohydrates, total sugars and total free amino acids were determined in dragonhead leaves at the flowering stage i.e., 150 days after sowing (15th March) according to Dubios *et al.*, (1956), Thomas and Dutcher, (1924) and Rosed, (1957), respectively. Also, Fe, Zn, and B were determined in dragonhead leaves at the same time by atomic absorption as described by Chapman and Paratt (1961).

Endogenous phytohormones

Endogenous phytohormones were quantitatively determined in dragonhead shoots at the of flowering stage i.e., 150 days after sowing in the second season using High- Performance Liquid Chromatography (HPLC) according to Koshioka *et al.* (1983) for auxin (IAA), gibberellins and abscisic acid (ABA), while cytokinins were determined according to Nicander *et al.* (1993).

Assay of enzymes activities

Assay of catalase, peroxidase and superoxide dismutase and their activities were determined in dragonhead leaves at the of flowering stage i.e., 150 days after sowing in the second season according to the methods described by Cao *et al.* (2005) and calculated according to the method of Kong *et al.* (1999).

Statistical analysis:

The obtained data in both seasons of study were subjected to analysis of variance as a factorial experiment in split plot design. L.S.D. method was used to differentiate between means according to Snedecor and Cochran (1989).

RESULTS AND DISCUSSION

Growth parameters:

The growth parameters of dragonhead plants as plant height, number of branches and leaf per plant, fresh and dry weights of leaves per plant and fresh weight of flowers per plant were significantly increased by all fertilizer application treatments or with boron foliar application at 50 and 100 ppm during the two seasons as shown in Tables (1&2). The interaction effect between fertilizers application and boron foliar application at 50 &100 ppm gave the highest values of growth parameters during the two growing seasons as compared with either individual foliar application or control plants.

T1

T2

Maximum stimulatory effect was excited in plants those treated by fertilizer (chemical, bio and organic) and boron foliar application at 100 ppm during the two seasons. However, the tallest plant (98.23 and 94.92 cm), the heaviest fresh (301.4 and 316.9 g) and dry (33.12 and 37.28 g) weights of leaves/plant were scored by the combined treatment between full chemical fertilizer dose (F_2) and foliar spray with boron at 100 ppm, followed by the combined treatment between 50% chemical fertilizer+ bio+ organic (F_5) and boron at 100 ppm , whereas the highest number of branches (19.24 and 18.16) and leaves (649.4 and 666.2) per plant were recorded by the treatment of(F_5) supported with boron at 100 ppm, followed by the treatment of F_2 enriched with boron at 100 ppm in the first and second seasons, respectively. With regard to the stimulatory effect of bio and organic fertilizer application and boron foliar application on different estimated characteristics of dragonhead growth it could be attributed to the effect of this components upon the endogenous phytohormones specially the growth promoters i.e. auxins, gibberellins and cytokinins content. The effect of organic and bio-fertilizer (nitrobein and phosphorein) on root morphology and development, uptake of nitrogen, phosphorous and other minerals and hormone supply to plants have been suggested as factors are responsible for growth responses (Abou El-Ghait *et al*., 2012, Gendy *et al*., 2013 and Youssef and Mady, 2014). The obtained results were confirmed by Dobbelaere *et al.* (2003) and Gendy *et al.* (2013) they reported that bio-fertilizer can promote plant growth directly through fixation of nitrogen, facilitation of mineral uptake, solubilization of phosphorus, production of siderophores that solubilize and sequester iron, production of phytohormones, or reduction in soil levels of ethylene. Moreover, Amran (2013) and El Khyat (2013) revealed that bio and organic fertilizers improved plant height, number of branches and fresh and dry weights of leaves/plant as compared with chemical fertilizer treatment of *Pelargonium graveolens* and *Rosmarinus officinalis*, respectively. On the other hand, Rao and Vidyasagar (1981a) reported that foliar application of boron increased plant height, stem girth, dry matter accumulation, total seed number per head of sunflower plant. Gomaa and Mady (2008) mentioned that foliar application of boron at 75 ppm increased the plant height, number of branches and fresh and dry weights of herb of chammomile plants. Also, Vishwakarma *et al.* (2008) revealed that in groundnut maximum plant height, number of branches were recorded with application of borax as a soil application. Moreover, more than 90% of the boron is found in cell walls. Its functions are also related to cell wall synthesis, lignifications and maintenance of cell wall structure (Hansch and Mendel, 2009).

Photosynthetic pigments:

Data in Table (3) indicate that different photosynthetic pigments as chlorophyll a, b and carotenoids were positively responded to the different fertilizer treatments or with boron foliar application at 50 and 100 ppm on dragonhead leaves during the two assigned seasons. Also, the interaction between fertilizers application and boron foliar application at 50&100 ppm gave the highest values in this respect, comparing with the control plants. Moreover, increase of chlorophylls and carotenoids content may be enhanced photosynthesis efficiency and that is a good explain to the increasing of growth parameters. In this respect, Abou-Aly and Gomaa (2002), Abou-Aly and Mady (2009), Hellal *et al.* (2011), Abou El-Ghait *et al*., (2012) and Gendy *et al*., (2013) stated that mixed bio fertilizers and organic fertilizers increased both leaf chlorophyll a, b and carotenoids concentration more than control. On the other hand, Fathy (1995) found that foliar application of boron increased chlorophyll and nutrients content in tomato plants. Also, Gomaa and Mady (2008) on chammomile plants found that boron foliar application increased photosynthetic pigments as chlorophyll a, b and carotenoids. Moreover, Ahmed and Azeem (2011) reported that foliar application of boron was the most effective in enhancing the chlorophyll content which may have resulted in increased photosynthetic rate. Thurzo *et al.* (2010) observed an increase in the photosynthetic pigment contents like chlorophylls and carotenoids by foliar application of boron in sweet cherry at full bloom. Furthermore, Ganie *et al.* (2013) reported that application of boron increase net photosynthetic rate which may be attributed to the increase in chlorophylls content of leaves. The enhancing effect of bio and organic fertilizer with boron treatment on chlorophyll content could be attributed to the favorable effect of these treatments to increase biosynthesis of chlorophylls through improving the absorption of N and Fe ions which are involved in chloroplast formation, which might be expected as a reason for chlorophyll increases in dragonhead leaves (Marschner, 1997).

Minerals and some bioconstituents:

With regard to the minerals, N, P, K, Fe, Zn and B uptake in dragonhead leaves, data in Table (4&5) clearly indicate that different fertilizer application treatments or with boron foliar application at 50 and 100 ppm were significantly increased N, P, K, Fe, Zn and B uptake on dragonhead leaves compared with those of control plants in both seasons in most cases. Also, it could be noticed that fertilizer (chemical, bio and organic) and boron at 100 ppm as foliar application treatment was superior in this respect, during the two seasons. Gendy *et al.* (2012) found that application biofertilizers increased N, P and K in leaves content of roselle plants. Abou-Aly and Mady (2009) stated that mixed biofertilizers increased N, P and K in leaves content of wheat compared with control plants. Mohamed *et al.*(2012) revealed that application of bio and organic fertilizers increased leaf N, P and K contents of *Stevia rebudiana* plant. Moreover, Rao and Vidyasagar (1981b) reported that boron when foliar spray on foliage helped to increase the mineral composition of leaves, stems and petioles during different growth stages of sunflower. They also noticed that foliar spray of boron influenced the absorption and preferential translocation of mineral elements into different parts of the plant. Also, Ghourab (2000) mentioned that boron foliar spray is associated with enhancement of vegetative growth and increases of N, P and K concentrations and contents in the leaves of sugar beet plants.

T3

T4

T5

Concerning total carbohydrates, total sugars and total free amino acids, different fertilizer treatments or with boron foliar application at 50 and 100 ppm gave the best values of total carbohydrates, total sugars and total free amino acids in leaves of dragonhead plants during the two seasons (Table, 6) . Also, it could be noticed that fertilizer (chemical, bio and organic) and boron at 100 ppm as foliar application treatment gave the highest values in this respect, comparing with the control plants. Moreover, high content of total sugars and some bioconstituents as a direct result for high rates of photosynthesis with great efficiency. That was preceded with large photosynthetic area and high content of photosynthetic pigments (Table, 3). Abou-Aly *et al*.(2006) reported that application of bio fertilizer and foliar spray with boron increased total carbohydrates, total sugars and total free amino acid in leaves of squash plants. Moreover, Youssef and Mady (2014) reported that application of organic fertilizer increased total carbohydrates, total sugars and total free amino acid in leaves of roselle plants. Furthermore, boron plays an important role in maintaining plasma membrane integrity, possibly by linking glycoprotein and glycolipil components of plasma membrane bilayer through its ability to complex OH-containing polysaccharides or through its involvement in enzyme systems such as ATPases, or esterases, that become active on pollen hydration (Ganie *et al.*, 2013).

Oil parameters:

Data in Table (7) reveal that most applied treatments of fertilizers and boron as well as their combinations succeeded in increasing leaves and flowers oil percentages as well as total oil yield / fed. in both seasons. However, the highest leaves oil percentage (0.225 and 0.235) were recorded by the combined treatment between F_3 and boron at 100 ppm, the highest flowers oil percentage (0.321 and 0.312) were scored by F_4 treatment combined with boron at 100 ppm, whereas the highest total oil yield/fed. (14.97 and 15.30) were registered by the combined treatment between F_5 and boron at 100 ppm, in the first and second seasons, respectively. These results are in close agreement with those reported by Abd El-kader and Ghaly (2003) on coriander, Kandeel (2004) on *Ocimum basilicum*, Niakan *et al.* (2004) on *Mentha piperitea*, Gomaa and youssef (2007) on fennel, Badran *et al*., (2007) on cumin, Abou El-Ghait *et al.* (2012) on indian fennel, Asghar and Manijeh (2012) on *Silybum marianum*, Alireza (2012) on *Foeniculum vulgare* and Abd El- Wahab (2013) on *Origanum syriacum* var. *Sinaicum*. In addition, Amran (2013) and El-Khyat (2013) showed that bio and organic fertilizers in combination with half dose of chemical fertilizer increased oil yield per plant and per fed. of *Pelargonium graveolens* and *Rosmarinus officinalis,* respectively. On the other hand, Gomaa and Mady (2008) found that foliar application of boron increased oil yield of chammomile plants. Also, Majeed (2013) reported that foliar application of boron increased oil yield of *Anethum graveolens* plant.

T6

T7

With regard to volatile oil, data in Table (8) showed that Gas chromatograms analysis of the volatile oil of dragonhead herb revealed the presence of Eucalyptol, Nerol, Linalool, Geranial, Citral, Geranyl acetate and Caryophyllene in all treatments. However, the main component of dragonhead leaves volatile oil was Citral. However, the higest value of Citral (54.38%) was observed by the combined treatment between F_3 and boron at 100 ppm, followed by the combined treatment of F_4 and boron at 100 ppm treatment. In addition, most applied treatments of fertilizers and boron as well as their combinations increased total components of the volatile oil in comparison with untreated ones (control). These results are in accordance with the finding of Ismail (2007) on *Dracocephalum moldavica* plant and Gomaa and Mady (2008) on chammomile plants.

Endogenous phytohormones :

Endogenous phytohormones of dragonhead shoots as affected by different fertilizer treatments or with boron foliar application at 50 and 100 ppm are shown in Table (9). According to these results, all promoters (auxins, gibberellins and cytokinins) were improved by using the different fertilizers and boron treatments, yet abscisic acid was decreased. Also, it could be noticed that fertilizer (chemical, bio and organic) and boron at 100 ppm as foliar application gave the maximum values in auxins and cytokinins, while they gave the highest reduction of abscisic acid in shoots of dragonhead during 2012/ 2013 season. These data could also be of great influence upon different vegetative and reproductive growth. In addition, increasing cytokinins level on the account of auxin could be in favor of increasing the number of formed branches and leaves (Table, 1) and improvement of photosynthetic pigments content (Table,3) in dragonhead plants. Similar results were obtained by Gomaa and Mady (2008) on chammomile plants and Abou-Aly *et al*.(2006) reported that application of bio fertilizer and foliar spray with boron increased auxins, gibberellins and cytokinins while abscisic acid was decreased in shoots of squash plants.

Antioxidant enzymes activity:

Plants posses antioxidant system in the form of enzymes such as peroxidase (PX), catalase (CAT) and superoxide dismutase (SOD), these antioxidant enzymes are reported to increase under various environmental stress (Noctor and Foyer, 1998). In this respect, data in Table (10) clearly show that different applied treatments of fertilizer application or with boron foliar application at 50 and 100 ppm induced reductions in the peroxidase, catalase and superoxide dismutase actives as compared with control leaves of dragonhead during 2012/2013 season. These reductions in determined enzymatic antioxidant activity with different applied treatments might be due to their direct scavenging function against the toxic free radicals and their promotional effects on synthesis of internal protective antioxidants, i.e., total sugars, total free amino acids and carotenoids. Similar results were obtained by Youssef and Mady (2014) on roselle plants.

T8

T 9

T10

The obtained results of this study may be due to the role of fertilization and boron in growth and development of the plants; where the use of N-fixing bacteria (nitrobein) as a bio-fertilizer product containing nitrogen fixing bacteria, e.g. Azotobacter and Azospirillum was found to have not only the ability to fix nitrogen but also to release certain phytohormones of cytokinins, gibberellins and auxins which could enhance plant growth through absorption of nutrients and so on enhancing photosynthesis process (Hegde *et al.,* 1999) Microorganisms used as bio-fertilizers may affect the integrity of growing plants by one mechanism or more such as nitrogen fixation production of growth promoting substances or organic acids, enhancing nutrients uptake or protection against plant pathogens (Hawaka, 2000) Also, N-fixers synthesize stimulatory compounds such as, gibberellins, cytokinins and IAA. They act as growth regulators, which increased the surface area per unit of root length and were responsible for root hair branching with an eventual increase in the uptake of nutrients from the soil (Sperenat, 1990 and Dadarwal *et al.,* 1997). Besides, the use of Phosphate dissolving bacteria (phosophorein) as a bio-fertilizer product containing very active phoshphate dissolving bactcria has proved its efficiency in enhancing different aspects of growth and development of many plant species including medicinal and aromatic ones. Establishment of a strong root system is related to the level of available phosphate in the soil. Phosphate dissolvers or vesicular arbuscular mycorrhizae and silica bacteria are capable of converting tricalcium phosphate to monocalcium phosphate ready for plant nutrition. Phosphate also increased mineral uptake and water use efficiency (Hawaka, 2000). Moreover, when organic manures (compost) added as fertilizer, it led to decrease soil pH which in turn increasing solubility of nutrients for plant uptake, in some cases organic materials may act as low release fertilizer. Recently, on the way of sustainable agriculture with minimum effects, the use of organic manures (compost or chicken manure, ..etc) as natural soil amendments is recommended to replace the soluble chemical fertilizers. They improve the structure of weak-structured sandy soils and increase their water holding capacity. Also, they improve soil fertility, and stimulate root development, induce active biological conditions and enhancing activities of micro-organisms especially those involved in mineralization (Suresh *et al*., 2004). Furthermore, to interpret and evaluate the effect of chemical fertilization concerned in this study, on augmenting the different tested vegetative growth parameters, yield component parameters and chemical constituents of dragonhead plants, it is important to refer to the physiological roles of nitrogen, phosphorus and potassium in plant growth and development. Such three macronutrient elements are the common elements usually included in fertilizers**.** Plant supplement with these macronutrients in form of fertilizers is necessary because the soil is usually in deficient of them due to plant removal leaching or they are not readily available for plants. Therefore, such addition of well balanced NPK fertilization quantities insured production of high productivity and chemical constituents of dragonhead plants.

The role of NPK fertilization on promoting vegetative growth characters, enhancing yield component parameters and increasing growth, oil yield and as well as stimulating the chemical constituents content of dragonhead plants could be explained by recognizing their fundamental involvement in the very large number of enzymatic reaction that depend on NPK fertilization . NPK reflected directly on increasing the content of total carbohydrates, total sugars and total free amino acids as well as NPK % in the leaves were indirectly the cause for enhancing the augmenting of all other vegetative growth traits, oil yield and components of dragonhead plants (Cooke, 1982).

Consequently, it is preferable from the previous results that treating dragonhead plants with the combined treatment between half dose of chemical fertilizer+10m^3 compost/fed. + bio fertilizer and boron at 100 ppm for enhancing growth and oil productivity of this plant. Therefore, the present study strongly admit the use of such treatment to provide good and high exportation characteristics due to its safety role on human health.

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تأثير بعض الأسمدة والرش الورقي بالبورون علي تحسين النمو و إنتاجية الزيت في نبات رأس التنين.

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أجريت تجربتين حقليتين لتقييم تأثير الأسمدة العضوية (كمبوست بمعدل ١٠ متر مكعب للفدان) والأسمدة الحيوية (نترو بين و فوسفورين) عند استخدامها مع نصف جرعه السماد الكيماوي مقارنه بجرعة السماد الكيماوي الكاملة في وجود الرش الورقي بالبورون بتركيز(صفر ، ٥٠، ١٠٠ جزء في المليون) علي بعض صفات النمو وصبغات البناء الضوئي والمحتوي الكيماوي و الهرمونات الداخلية ومحصول الزيت لنبات رأس التنين خلال موسمي ٢٠١١/ ٢٠١٢ و ٢٠١٢/ ٢٠١٣ . وكذلك تم دراسة تأثير التفاعل بين الرش الورقي بالبورون ومعاملات التسميد علي النمو والمحتوي الكيماوي و الهرمونات الداخلية ومحصول الزيت لنبات رأس التنين.

أوضحت النتائج أن استخدام معامله نصف المعدل من التسميد الكيماوي والتسميد العضوي و الحيوي في وجود الرش بالبورون بتركيز ١٠٠ جزء في المليون قد سجلت أعلي القيم بالنسبة لطول النبات ،عدد الأوراق والأفرع للنبات والوزن الطازج و الجاف للأوراق للنبات والوزن الطازج للأزهار للنبات و النسبه المئويه للزيت في الأوراق و الأزهار/ نبات ، ومحصول الزيت الكلي للفدان. أيضا أظهرت النتائج أن نصف المعدل من التسميد الكيماوي والتسميد العضوي و الحيوي في وجود الرش بالبورون بتركيز ١٠٠ جزء في المليون أدي إلي زيادة محتوي الأوراق من صبغات البناء الضوئي وهي كلوروفيل أ،ب والكاروتينيدات ، ومحتوي الأوراق من النيتروجين و الفوسفور و البوتاسيوم والحديد والزنك والبورون الممتص ، ومحتوي الأوراق من الكربوهيدرات الكلية والسكريات الكلية والأحماض ألأمينيه الكلية لنبات رأس التنين خلال موسمي النمو. وكذلك أظهرت النتائج أن نصف المعدل من التسميد الكيماوي والتسميد العضوي و الحيوي في وجود الرش بالبورون بتركيز ١٠٠ جزء في المليون زيادة محتوي المجموع الخضري من الاوكسين و الجبر يللين والسيتوكينين وقله محتواه من حمض الابسيسيك خلال موسم النمو الثاني. و كذلك أظهرت النتائج أن المعاملة بنصف المعدل من التسميد الكيماوي والتسميد العضوي و الحيوي في وجود الرش الورقي بالبورون بتركيز ١٠٠ جزء في المليون إلي تقليل محتوي الأوراق من نشاط الأنزيمات (Peroxidase, Catalase and Superoxide dismutase)وذلك خلال موسم النمو الثاني.

ولقد أكدت هذه النتائج أن المعاملة بنصف المعدل من التسميد الكيماوي والتسميد العضوي و الحيوي في وجود الرش بالبورون بتركيز ١٠٠ جزء في المليون أدي إلي تحسين النمو وزيادة إنتاجية الزيت لنبات رأس التنين وتقليل الاسمدة الكيماوية.

قام بتحكيم البحث

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Table 1: Effect of some fertilizers and boron treatments on plant height and number of branches and leaves of dragonhead plants during 2011/2012 and 2012/2013 seasons.

Parameters		Plant height (cm)			Mean	Number of branches / plant			Mean	Number of leaves/plant			Mean
First season (2011/2012)													
Boron / Fertilization		control	Boron 50ppm	Boron 100ppm		control	Boron 50ppm	Boron 100ppm		control	Boron 50ppm	Boron 100ppm	
F_1 (control)		62.17	68.30	71.34	67.27	12.18	14.20	15.14	13.84	384.8	462.5	510.4	452.6
F_2 (chemical NPK)		82.46	89.61	98.23	90.10	14.93	16.14	17.13	16.07	581.5	576.1	625.2	561.3
F_3 (50%NPK+bio)		85.02	84.35	93.67	87.68	13.21	14.60	15.19	14.33	442.4	511.7	540.3	498.1
F_4 (50%NPK+organic)		80.42	82.46	91.82	84.90	13.46	14.72	14.38	14.19	455.6	529.2	518.0	500.9
F_5 (50%NPK+bio+organic)		81.36	86.71	96.42	88.16	15.86	16.87	19.24	17.32	584.6	621.3	649.4	618.4
Mean		78.29	82.29	90.30		13.93	15.31	16.22		489.8	540.2	568.7	
L.S.D at 0.05	Boron	6.89				1.17				48.14			
	Fertilization	8.89				1.51				62.10			
	Interaction	15.43				2.62				107.8			
Second season (2012/2013)													
F_1 (control)		59.37	65.91	69.28	64.85	11.26	13.92	14.87	13.35	363.9	472.6	518.1	451.5
F_2 (chemical NPK)		79.72	86.21	94.92	86.95	14.71	15.08	16.93	15.24	499.8	540.6	645.3	561.9
F_3 (50%NPK+bio)		76.43	82.30	91.04	83.26	14.63	14.92	15.31	15.57	497.2	504.6	545.5	513.1
F_4 (50%NPK+organic)		77.82	81.14	83.14	80.70	15.92	16.18	15.92	15.99	540.6	560.4	572.4	557.8
F_5 (50%NPK+bio+organic)		78.03	84.60	92.83	85.15	16.30	17.94	18.16	17.47	524.2	626.5	666.2	605.6

Mean		74.27	80.03	86.24		14.56	15.60	16.24		485.1	541.3	587.5	
L.S.D at 0.05	**Boron**	5.92				5.36				43.86			
	Fertilization	7.64				6.91				56.58			
	Interaction	11.85				12.01				98.25			

Chemical fertilization = 100 kg/fed. ammonium nitrate + 150 kg/fed. calcium super phosphate + 50 kg/fed. potassium sulphate, bio-fertilization: with a mixture of nitrobein + phosphorein and organic fertilization (compost at 10m^3/fed.).

Table 2 : Effect of some fertilizers and boron treatments on fresh and dry weights of leaves and fresh weight of flowers of dragonhead plants during 2011/2012 and 2012/2013 seasons.

First season (2011/2012)

Parameters	Fresh weight of leaves(g) / plant			Mean	Dry weight of leaves(g) / plant			Mean	Fresh weight of flowers(g)/ plant			Mean
Boron / Fertilization	control	Boron 50ppm	Boron 100ppm		control	Boron 50ppm	Boron 100ppm		control	Boron 50ppm	Boron 100ppm	
F_1 (control)	142.1	175.6	198.9	172.2	17.18	21.36	24.75	21.10	42.61	46.32	49.76	46.23
F_2 (chemical NPK)	258.8	270.7	301.4	277.0	28.46	29.73	33.12	30.44	64.80	71.43	75.44	70.56
F_3 (50%NPK+bio)	185.6	224.8	237.6	216.0	22.23	27.32	28.01	25.85	52.61	65.90	62.43	60.31
F_4 (50%NPK+organic)	195.6	238.1	243.5	225.7	21.45	28.56	28.67	26.23	61.73	58.76	62.60	61.03
F_5 (50%NPK+bio+organic)	251.1	267.3	293.7	270.7	30.11	28.23	32.42	30.25	68.72	74.85	79.82	74.46

Mean		206.6	235.3	255.0		23.89	27.64	29.39		58.09	63.45	66.01	
L.S.D at 0.05	**Boron**	28.34				2.57				5.14			
	fertilization	36.56				3.32				6.63			
	interaction	63.48				5.76				11.51			
Second season (2012/2013)													
F_1 (control)		123.4	165.2	186.5	158.4	14.76	19.83	22.32	18.97	47.14	51.25	48.92	49.10
F_2 (chemical NPK)		219.6	253.8	316.9	263.4	24.96	29.60	37.28	30.61	68.35	76.93	74.20	73.16
F_3 (50%NPK+bio)		203.1	227.7	246.1	225.6	23.95	27.00	28.78	26.58	54.92	58.46	63.17	58.85
F_4 (50%NPK+organic)		226.8	240.8	263.1	243.6	26.66	28.56	31.03	28.75	52.50	56.45	59.75	56.23
F_5 (50%NPK+bio+organic)		225.3	249.3	293.1	255.9	26.55	27.39	33.41	29.12	78.31	76.92	81.37	78.87
Mean		199.6	227.4	261.1		23.38	26.48	30.56		60.24	64.00	65.48	
L.S.D at 0.05	**Boron**	31.27				2.71				5.36			
	fertilization	40.34				3.50				6.91			
	interaction	70.04				6.07				12.01			

Chemical fertilization = 100 kg/fed. ammonium nitrate + 150 kg/fed. calcium super phosphate + 50 kg/fed. potassium sulphate, bio-fertilization: with a mixture of nitrobein + phosphorein and organic fertilization (compost at 10m^3/fed.).

Table 3: Effect of some fertilizers and boron treatments on photosynthetic pigments of dragonhead leaves during 2011/2012 and 2012/2013 seasons.

First season (2011/2012)												
Parameters	**Chlorophyll a (mg/g F.W)**			**Mean**	**Chlorophyll b (mg/g F.W)**			**Mean**	**Carotenoids (mg/g F.W)**			**Mean**
Boron / Fertilization	**control**	**Boron 50ppm**	**Boron 100ppm**		**control**	**Boron 50ppm**	**Boron 100ppm**		**control**	**Boron 50ppm**	**Boron 100ppm**	
F_1 (control)	0.432	0.477	0.483	0.464	0.238	0.315	0.338	0.297	0.213	0.234	0.286	0.244
F_2 (chemical NPK)	0.475	0.487	0.512	0.491	0.241	0.327	0.346	0.305	0.224	0.263	0.312	0.266
F_3 (50%NPK+bio)	0.479	0.522	0.534	0.512	0.254	0.335	0.358	0.316	0.240	0.275	0.324	0.280
F_4 (50%NPK+organic)	0.484	0.546	0.554	0.528	0.263	0.348	0.364	0.325	0.254	0.286	0.336	0.292
F_5 (50%NPK+bio+organic)	0.490	0.563	0.572	0.542	0.272	0.354	0.370	0.332	0.272	0.315	0.347	0.311

Mean		0.472	0.519	0.531		0.254	0.336	0.355		0.241	0.275	0.321	
L.S.D at 0.05	**Boron**	0.024				0.021				0.022			
	Fertilization	0.038				0.032				0.035			
	Interaction	0.058				0.047				0.052			
Second season (2012/2013)													
F_1 (control)		0.438	0.480	0.494	0.471	0.240	0.319	0.341	0.300	0.217	0.238	0.293	0.249
F_2 (chemical NPK)		0.479	0.489	0.522	0.497	0.246	0.332	0.349	0.309	0.231	0.273	0.318	0.274
F_3 (50%NPK+bio)		0.482	0.530	0.541	0.518	0.259	0.339	0.362	0.320	0.245	0.279	0.329	0.284
F_4 (50%NPK+organic)		0.487	0.552	0.563	0.534	0.270	0.352	0.369	0.330	0.262	0.294	0.340	0.299
F_5 (50%NPK+bio+organic)		0.496	0.569	0.582	0.549	0.286	0.357	0.377	0.340	0.276	0.322	0.352	0.317
Mean		0.476	0.524	0.540		0.260	0.340	0.360		0.246	0.281	0.326	
L.S.D at 0.05	**Boron**	0.029				0.027				0.028			
	Fertilization	0.042				0.039				0.040			
	Interaction	0.063				0.054				0.057			

Chemical fertilization = 100 kg/fed. ammonium nitrate + 150 kg/fed. calcium super phosphate + 50 kg/fed. potassium sulphate, bio-fertilization: with a mixture of nitrobein + phosphorein and organic fertilization (compost at 10m^3/fed.).

Table 4 : Effect of some fertilizers and boron treatments on N, P and K uptake (kg/fed.) of dragonhead leaves content during 2011/2012 and2012/2013 seasons.

First season (2011/2012)												
Parameters	**Leaf N uptake (kg/fed.)**			**Mean**	**Leaf P uptake (kg/fed.)**			**Mean**	**Leaf K uptake (kg/fed.)**			**Mean**
Boron / Fertilization	**control**	**Boron 50ppm**	**Boron 100ppm**		**control**	**Boron 50ppm**	**Boron 100ppm**		**control**	**Boron 50ppm**	**Boron 100ppm**	
F_1 (control)	4.62	5.74	7.07	5.81	0.520	0.754	0.790	0.688	3.46	4.67	5.82	4.65
F_2 (chemical NPK)	9.08	10.49	12.24	10.60	1.00	1.10	1.28	1.13	6.69	7.49	8.90	7.69
F_3 (50%NPK+bio)	6.35	8.72	8.47	7.85	0.672	0.964	0.941	0.859	4.86	7.34	7.06	6.42
F_4 (50%NPK+organic)	5.77	9.12	8.67	7.85	0.685	0.864	1.01	0.853	5.41	8.16	8.19	7.25
F_5 (50%NPK+bio+organic)	8.60	9.01	11.44	9.68	0.961	1.00	1.20	1.05	8.09	8.06	9.80	8.65

Mean		6.88	8.62	9.58		0.768	0.936	1.04		5.70	7.14	7.95	
L.S.D at 0.05	B**oron**	1.45				0.213				1.68			
	fertilization	1.87				0.275				2.17			
	interaction	3.25				0.477				3.67			
Second season (2012/2013)													
F_1 (control)		4.22	6.33	6.75	5.77	0.397	0.600	0.712	0.570	3.22	5.33	5.62	4.72
F_2 (chemical NPK)		7.96	10.94	14.40	11.10	0.797	1.04	1.38	1.07	6.71	7.46	10.65	8.27
F_3 (50%NPK+bio)		7.24	7.71	9.19	8.05	0.684	0.862	0.870	0.805	5.63	7.26	8.22	7.04
F_4 (50%NPK+organic)		7.17	8.64	9.90	8.57	0.851	0.864	0.990	0.902	6.72	7.68	7.82	7.41
F_5 (50%NPK+bio+organic)		8.47	8.74	12.35	9.85	0.803	0.966	1.18	0.983	6.69	8.28	10.66	8.54
Mean		7.01	8.47	10.52		0.706	0.866	1.03		5.79	7.20	8.59	
L.S.D at 0.05	B**oron**	1.27				0.204				1.74			
	fertilization	1.64				0.263				2.24			
	interaction	2.84				0.457				3.90			

Chemical fertilization = 100 kg/fed. ammonium nitrate + 150 kg/fed. calcium super phosphate + 50 kg/fed. potassium sulphate, bio-fertilization: with a mixture of nitrobein + phosphorein and organic fertilization (compost at 10m^3/fed.).

Table 5: Effect of some fertilizers and boron treatments on leaf Fe, Zn and B uptake (g/fed.) of dragonhead leaves during 2011/2012 and 2012/2013 seasons.

First season (2011/2012)												
Parameters	Leaf Fe uptake (g/fed.)			Mean	Leaf Zn uptake (g/fed.)			Mean	Leaf B uptake (g/fed.)			Mean
Boron / Fertilization	control	Boron 50ppm	Boron 100ppm		control	Boron 50ppm	Boron 100ppm		control	Boron 50ppm	Boron 100ppm	
F_1 (control)	178.9	236.8	328.5	248.1	60.61	82.54	104.0	82.4	17.3	26.9	32.1	25.5
F_2 (chemical NPK)	310.8	364.6	400.6	358.7	167.3	159.8	200.3	175.8	38.3	37.5	49.2	41.7
F_3 (50%NPK+bio)	239.0	362.6	343.5	315.0	85.9	110.2	122.3	106.1	26.2	32.4	31.4	30.0
F_4 (50%NPK+organic)	263.1	374.3	356.4	331.3	82.9	134.3	115.6	110.9	28.8	37.7	37.3	34.6
F_5 (50%NPK+bio+organic)	364.2	407.9	517.4	429.8	131.5	132.7	147.1	137.1	37.9	38.5	43.4	39.9

Mean		271.2	349.2	389.3		105.6	123.9	137.9		29.7	34.6	38.7	
L.S.D at 0.05	Boron	62.81				14.27				2.56			
	fertilization	81.02				18.41				3.30			
	interaction	140.69				31.96				5.74			
Second season (2012/2013)													
F_1 (control)		151.3	216.5	251.2	206.4	54.6	83.3	97.5	78.5	20.0	24.2	28.2	24.1
F_2 (chemical NPK)		310.3	353.1	450.9	371.4	134.2	174.0	205.4	171.2	37.7	41.3	47.0	42.0
F_3 (50%NPK+bio)		293.7	326.6	353.0	324.4	96.6	127.8	121.2	115.2	32.2	36.4	35.9	34.8
F_4 (50%NPK+organic)		340.4	345.5	396.2	360.7	98.5	92.7	108.6	99.9	35.9	40.5	44.2	40.2
F_5 (50%NPK+bio+organic)		397.0	395.7	499.5	430.7	102.4	113.6	184.5	133.5	35.7	41.2	44.8	40.5
Mean		298.5	327.5	390.2		97.3	118.3	143.4		32.3	36.7	40.0	
L.S.D at 0.05	Boron	39.36				17.19				3.90			
	fertilization	50.77				22.18				5.03			
	interaction	88.17				38.51				8.74			

Chemical fertilization = 100 kg/fed. ammonium nitrate + 150 kg/fed. calcium super phosphate + 50 kg/fed. potassium sulphate, bio-fertilization: with a mixture of nitrobein + phosphorein and organic fertilization (compost at 10m^3/fed.).

Table 6: Effect of some fertilizers and boron treatments on total carbohydrates, total sugars and total free amino acids of dragonhead plants during 2011/2012 and 2012/2013 seasons.

First season (2011/2012)												
Parameters	**Total carbohydrates (mg/g dry weight)**			**Mean**	**Total sugars (mg/g fresh weight)**			**Mean**	**Total free amino acids (mg/g fresh weight)**			**Mean**
Boron fertilization	**control**	**Boron 50ppm**	**Boron 100ppm**		**control**	**Boron 50ppm**	**Boron 100ppm**		**control**	**Boron 50ppm**	**Boron 100ppm**	
F_1 (control)	124.5	188.3	194.7	169.2	14.62	20.34	26.18	20.38	9.12	12.89	15.60	12.54
F_2 (chemical NPK)	135.8	195.4	198.9	176.7	16.83	23.72	27.90	22.82	9.84	13.65	17.38	13.62
F_3 (50%NPK+bio)	163.4	198.7	202.4	188.2	19.26	25.80	29.66	24.91	10.63	15.34	18.55	14.84
F_4 (50%NPK+organic)	182.6	204.5	214.7	200.6	20.10	27.50	30.25	25.95	11.48	16.90	19.75	16.04
F_5 (50%NPK+bio+organic)	192.7	209.3	217.6	206.5	22.45	28.75	32.78	27.99	12.65	17.55	20.16	16.79

Mean		159.8	199.2	205.7		18.65	25.22	29.35		10.74	15.27	18.29	
L.S.D at 0.05	Boron	18.14				1.13				1.02			
	fertilization	22.54				1.77				1.34			
	interaction	31.63				2.84				2.14			
Second season (2012/2013)													
F_1 (control)		126.7	190.7	197.4	171.6	15.38	21.24	26.67	21.10	9.22	12.94	15.77	12.64
F_2 (chemical NPK)		138.4	197.3	199.5	178.4	17.56	23.87	28.35	23.26	10.14	13.80	18.20	14.05
F_3 (50%NPK+bio)		166.2	196.4	204.6	189.1	18.67	26.30	29.85	24.94	10.85	15.48	18.76	15.03
F_4 (50%NPK+organic)		187.4	203.6	216.2	202.4	20.46	28.23	31.78	26.82	11.93	17.24	20.77	16.65
F_5 (50%NPK+bio+organic)		194.6	210.5	219.3	208.1	23.15	29.46	33.15	28.59	12.79	17.95	20.85	17.20
Mean		162.7	199.7	207.4		19.05	25.82	29.96		10.99	15.48	18.87	
L.S.D at 0.05	Boron	19.55				1.18				1.09			
	fertilization	24.32				1.85				1.52			
	interaction	32.45				2.94				2.30			

Chemical fertilization = 100 kg/fed. ammonium nitrate + 150 kg/fed. calcium super phosphate + 50 kg/fed. potassium sulphate, bio-fertilization: with a mixture of nitrobein + phosphorein and organic fertilization (compost at 10m^3/fed.).

Table 7: Effect of some fertilizers and boron treatments on leaves oil %, flowers oil % and total oil yield (l/fed.) of dragonhead plants during 2011/2012 and 2012/2013 seasons.

First season (2011/2012)												
Parameters	Leaves oil %			Mean	Flowers oil %			Mean	Total oil yield (l/fed.)			Mean
Boron / Fertilization	control	Boron 50ppm	Boron 100ppm		control	Boron 50ppm	Boron 100ppm		control	Boron 50ppm	Boron 100ppm	
F_1 (control)	0.126	0.145	0.132	0.134	0.186	0.214	0.237	0.212	3.34	5.95	6.39	5.56
F_2 (chemical NPK)	0.164	0.183	0.191	0.179	0.217	0.246	0.236	0.233	9.49	11.27	12.66	11.14
F_3 (50%NPK+bio)	0.186	0.214	0.225	0.208	0.250	0.239	0.245	0.245	8.81	10.73	11.55	10.36
F_4 (50%NPK+organic)	0.194	0.183	0.206	0.194	0.295	0.284	0.321	0.300	9.43	10.12	11.81	10.45
F_5 (50%NPK+bio+organic)	0.193	0.195	0.217	0.202	0.271	0.293	0.318	0.294	11.27	12.44	14.97	12.89

Mean		0.173	0.184	0.194		0.244	0.252	0.271		8.67	10.10	11.48	
L.S.D at 0.05	**boron**	0.015				0.013				1.68			
	fertilization	0.015				0.017				2.17			
	interaction	0.027				0.029				3.76			
Second season (2012/2013)													
F_1 (control)		0.106	0.124	0.136	0.122	0.156	0.218	0.230	0.201	3.44	5.32	6.15	4.97
F_2 (chemical NPK)		0.170	0.166	0.194	0.177	0.243	0.227	0.256	0.242	9.06	10.01	13.52	10.86
F_3 (50%NPK+bio)		0.193	0.183	0.235	0.204	0.208	0.235	0.247	0.230	8.50	9.31	12.34	10.05
F_4 (50%NPK+organic)		0.157	0.176	0.194	0.176	0.256	0.296	0.312	0.288	8.24	9.93	11.70	9.96
F_5 (50%NPK+bio+organic)		0.188	0.197	0.228	0.204	0.285	0.270	0.298	0.284	10.87	11.74	15.30	12.64
Mean		0.163	0.169	0.197		0.230	0.249	0.269		8.02	9.26	11.80	
L.S.D at 0.05	**boron**	0.023				0.019				1.39			
	fertilization	0.030				0.025				1.79			
	interaction	0.052				0.043				3.11			

Chemical fertilization = 100 kg/fed. ammonium nitrate + 150 kg/fed. calcium super phosphate + 50 kg/fed. potassium sulphate, bio-fertilization: with a mixture of nitrobein + phosphorein and organic fertilization (compost at 10m^3/fed.).

Table 8 : Effect of some fertilizers and boron treatments on the identified constituents of leaf´s volatile oil of dragonhead plant obtained from GLC analysis and calculated as relative percentages.

Boron treatments		Fertilization treatments	Components / Treatments	Eucalyptol	Nerol	Linalool	Geranial	Citral	Geranyl acetate	Caryophyllene	A compo
Boron treatments	0.0	Fertilization treatments	F_1 (control)	0.432	3.21	1.69	8.43	38.01	21.23	0.862	
			F_2 (chemical NPK)	0.561	4.16	0.943	9.12	43.80	18.24	0.624	
			F_3 (50%NPK+bio)	0.149	2.53	1.26	7.36	41.21	27.63	1.02	
			F_4 (50%NPK+organic)	0.312	6.28	2.17	8.14	35.21	29.24	0.921	
			F_5 (50%NPK+bio+organic)	0.462	4.21	1.82	11.12	32.64	26.32	0.432	
	50 ppm		F_1 (control)	0.623	2.93	1.32	9.32	35.21	21.63	0.320	
			F_2 (chemical NPK)	0.324	3.41	2.16	7.36	44.32	23.18	1.12	
			F_3 (50%NPK+bio)	0.765	4.26	1.82	4.92	46.02	25.72	0.741	
			F_4 (50%NPK+organic)	0.821	6.01	1.93	5.43	49.37	19.64	0.462	

	F_5 (50%NPK+bio+organic)	0.690	5.21	1.02	8.73	35.42	18.21	1.13
100 ppm	**F_1 (control)**	0.421	4.32	1.31	6.24	34.11	20.36	0.721
	F_2 (chemical NPK)	0.312	4.11	1.56	7.83	47.52	28.31	0.811
	F_3 (50%NPK+bio)	0.672	6.14	1.08	8.16	54.38	26.41	0.632
	F_4 (50%NPK+organic)	0.531	3.21	1.35	7.02	52.93	24.90	0.921
	F_5 (50%NPK+bio+organic)	0.672	5.21	1.40	6.40	37.51	23.42	0.826
Mean		0.517	4.35	1.52	7.71	43.23	23.63	0.770

Chemical fertilization = 100 kg/fed. ammonium nitrate + 150 kg/fed. calcium super phosphate + 50 kg/fed. potassium sulphate, bio-fertilization: with a mixture of nitrobein + phosphorein and organic fertilization (compost at 10m^3/fed.).

Table 9 : Effect of some fertilizers and boron treatments on endogenous phytohormones content of dragonhead shoots during 2012/2013 season.

Parameters	Promoters			Inhibitors
	Auxins (µg/g FW)	**Gibberellins** (µg/g FW)	**Cytokinins** (µg/g FW)	**Abscisic acid** (µg/g FW)

Treatments	control	boron 50ppm	boron 100ppm	control	boron 50ppm	boron 100ppm	control	boron 50ppm	boron 100ppm	control	boron 50ppm	boron 100ppm
F_1 (control)	13.35	14.13	14.94	17.21	18.35	18.58	10.14	10.87	11.63	1.87	1.74	1.52
F_2 (chemical NPK)	14.27	14.68	15.44	17.76	18.85	18.95	10.59	10.96	11.85	1.70	1.52	1.33
F_3 (50%NPK+bio)	14.80	15.20	15.89	17.54	19.23	19.27	10.75	11.30	12.18	1.63	1.48	1.24
F_4 (50%NPK+organic)	14.96	15.46	16.22	18.18	19.74	19.65	11.70	11.54	12.66	1.55	1.27	1.11
F_5 (50%NPK+bio+organic)	15.65	15.82	16.65	18.78	20.13	20.45	11.84	11.94	13.25	1.35	1.18	0.98

Chemical fertilization = 100 kg/fed. ammonium nitrate + 150 kg/fed. calcium super phosphate + 50 kg/fed. potassium sulphate, bio-fertilization: with a mixture of nitrobein + phosphorein and organic fertilization (compost at 10m^3/fed.).

Table 10 : Effect of boron and fertilization treatments on some anti-oxidant enzymatic activity contents of dragonhead leaves during 2012/2013 season.

Parameters / Treatments	Anti-oxidant enzymatic activity								
	Peroxidase (µg/g FW/h)			Catalase (µg/g FW/h)			Superoxide dismutase (µg/g FW/h)		
	control	Boron 50ppm	Boron 100ppm	control	Boron 50ppm	Boron 100ppm	control	Boron 50ppm	Boron 100ppm
F_1 (control)	94.60	83.55	75.80	83.24	75.43	65.74	122.25	111.32	95.75
F_2 (chemical NPK)	92.24	80.52	73.60	80.36	72.67	63.85	115.70	107.20	94.38
F_3 (50%NPK+bio)	87.15	77.64	71.84	79.55	69.64	60.33	112.30	102.44	88.65
F_4 (50%NPK+organic)	84.45	74.22	69.28	76.16	66.43	55.77	110.75	99.53	82.59
F_5 (50%NPK+bio+organic)	82.63	70.45	66.56	74.39	64.84	52.34	108.55	96.84	78.95

Chemical fertilization = 100 kg/fed. ammonium nitrate + 150 kg/fed. calcium super phosphate + 50 kg/fed. potassium sulphate,

bio-fertilization: with a mixture of nitrobein + phosphorein and organic fertilization (compost at 10m^3/fed.).