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INFLUENCE OF IRRIGATION WITH MAGNETIZED WATER AND BIOFERTILIZERS APPLICATION ON THE GROWTH AND ESSENTIAL OIL CONTENT OF LEMON GRASS PLANTS

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ABSTRACT: *This investigation was carried out at the Experimental Farm of the Faculty of Agriculture, Menoufia University, during two successive seasons of 2010 and 2011. This study aimed to investigate the effect of irrigation with magnetic water on the growth and essential oil content of Cymbopogon citratus Stapf., fertilized with biofertilizers (Rhizobacterein or Biogene) in combinations with different levels of urea (46% N) fertilization (0, 100, 200 and 300 kg / fed).*
The obtained results showed that, watering lemon grass plants with magnetized water caused a considerable improvement in the measured growth and yield parameters as well as essential oil content, when it was fertilized with Biogene as biofertilizer besides using the highest urea fertilization level (300 kg / fed). Meanwhile, the irrigated plants with ordinary water without application of bio- or urea fertilization gave significantly the lowest values in this concern. In addition the mineral content (N, P and K%) in the leaves as well as the photosynthetic pigment (chlorophyll A + B) and total carbohydrate percentage in the herb followed the previously mentioned trend.

Key words: *Cymbopogon citratus*, biofertilization, magnetic water.

INTRODUCTION

Lemongrass (*Cymbopogon citratus* STAPFF) is an important aromatic plant. It belongs to the genus *Cymbopogon*, family *Gramineae*. Lemon grass plant is characterized by a powerful lemon like odder due to the presence of the compound citral as the main constituent in the volatile oil. The essential oil is extracted from the herb and used in various medicinal and aromatic industries, such as scenting soaps, perfumes and detergents as well as preparation of ionone compounds from citral. The ionone compounds serve as starting material for the synthesis of vitamin A (Neelam *et al*., 1993). Increasing the production of lemongrass could be achieved through modifications of agricultural practices and fertilization. One of the means of increasing plant productivity is studying the different plant spacing for optimizing the herb yield. Another way of improving plant productivity is plant nutrition, especially nitrogen fertilization.

The prductivity of medicinal and aromatic plants such as *Cymbopogon citratus* Stapf. is known to be influenced to a large extend by agricultural practices such as irrigation and nutrients supply. Several investigators pointed out that water and nutrient management are known to have a great important for raising the production potentially various medicinal and aromatic plant such as lemon grass.

Recently unconventional efforts are used to minimize the used amounts from chemical fertilizers which applied to medicinal and aromatic plants in order to reduce production costs and environmental pollution without reduction of the produced yield. Therefore, the trend now is to introduce nitrogen fixing gene through genetical engineering into the plant or inoculating the growing media with nitrogen fixing organisms.

Bio fertilizers are reasonably safer to the environment than chemical fertilizers and play an important role in decreasing the used chemical fertilizers. Consequently it causes reduction environmental pollution. Furthermore, several investigators pointed out that the application of bio fertilizers which contained N_2-fixing microorganisms enhanced plant growth not only through providing the plants with sufficient amounts from nitrogen but also through synthesizing stimulatory compounds such as gibberellins, cytokinins and IAA which act as growth regulators (Sperenat, 1990 and Dadarwal *et al*., 1997).

Several investigations studied the role of bio fertilizers containing symbiotic or non symbiotic nitrogen fixing bacteria in augmenting the vegetative growth characteristics, yield and yield components, essential oil production and / or chemical composition of the plant revealed by Badran and Safwat (2004) on *Foeniculum vulgare*, Mazrou (2008) on *Cymbopogon citratus* Stapf., Afify (2009) on *Ammi visnaga*, El-Leithy *et al*. (2011) on *Ricinus communis* and Mazrou, Ragia (2013) on *Carum carvi* L.

Furthermore, *Cymbopogon citratus* Stapf. plants as an semi aquatic plants this reflects the importance of water as an important limiting factor for growth and essential oil content of lemon grass plant. In the last few decades the influence of irrigation with magnetic water on the growth and active constituents of medicinal and aromatic plants was studied by some investigators such as Farooqi *et al*. (1999) mentioned that watering with magnetized water affected the biosynthesis and metabolic turnover of monoterpenes in mint represents a mechanism for recycling carbon and energy from foliar terpenes in to other metabolites. Also, Esfandiar *et al*. (2012) on *Foeniculum vulgare* L. found that magnetized water has different chemical and physical properties and actions associated with metabolic process in the plant and Mazrou, Ragia (2013) on *Carum carvi* L.

In this regard it could be noticed that the application of either bio and chemical fertilizers or irrigation with magnetic water play an important role in improving both quantitative and qualitative characteristics of medicinal and aromatic plants. Otherwise, the available studies about the effect of irrigation with magnetized water on the essential oil content and yield are still limited.

Therefore, the objective of our investigation will be dealing with studying the effect of bio and chemical fertilization on the growth and essential oil content of lemon grass under the environmental conditions of Experiment Farm of the Faculty of Agriculture, Menoufia university in Shibin El-Kom, Egypt.

MATERIALS AND METHODS

Two field experiments were conducted at the Experimental Farm of the Faculty of Agriculture, Menoufia, Univ. during two successive seasons of 2010 and 2011. This investigation aimed to study the effect of bio fertilization with some commercial bio fertilizers containing N_2-fixing bacterial strains, chemical N-fertilization as well as irrigation with magnetized water on the growth and essential oil content in *Cymbopogon citratus* Stapf. plants.

The experimental soil was a clay one and its physical and chemical properties are recorded in Tables (1 a and b) according to the method described by Jackson (1967).

Table (1). The physical and chemical properties of the experimental soil according to the methods described by Jakson (1967).

a) The physical properties of the experimental soil.

Clay %	Silt %	Fine sand %	Coarse sand %	Organic matter %	Water field capacity %	Texture grade
23.20	44.23	27.40	3.84	2.80	38.80	Clay loamy

b) The chemical analysis of the experimental soil.

Total P_2O_5 %	Total N %	Total $CaCO_3$ %	C.E.C mg/100 g	E.C min/hos/cm at 25°C	pH	Soluble ions mg/100g			
						Ca^{++}	Mg^{++}	Na^{+}	K^{+}
0.26	0.12	2.32	25.60	0.40	7.90	0.42	0.68	0.62	0.12

The experiments were arranged in a factorial as a completely randomized block design with three replicates of 2 × 2 m for each treatment.

The replicate included 4 rows (50 cm apart). The plants were transplanted at the Experimental Farm at a distance of 50 cm between the plants on 22nd of April in each growing seasons 2010 and 2011. Each row contained 4 plants and consequently each plot contained 16 plants.

During soil preparation, the recommended doses from calcium super phosphate of 150 kg/ fed (15.5% P_2O_5) and 100 kg/fed potassium sulphate (48% K_2O) were added in each growing season. Meanwhile, Nitrogen fertilization was used in the form of urea fertilizer (46% N) at levels of 0 (N_0), 100 (N_1), 200 (N_2) and 300 (N_3) kg / fed / season.

The aforementioned N-fertilization doses were added in three equal side dressings during the growing period. The first addition was after two weeks from transplanting meanwhile, the second and the third doses were added after two weeks from the first and the second cuts in the two growing seasons. The previously mentioned urea fertilization rates (N_0, N_1, N_2 and N_3) were added separately or in combinations with 400 g/fed from each of the following commercial bio fertilizers, Rhizobacterein (contained N_2-fixing bacterial strain of *Azotobacter chroococcum*) or Biogene (contained N_2-fixing bacterial strain of *Azotobacter chroococcum* and *Azospirillium lipoforum*). The used bio fertilizers were obtained from National Research Center, Giza, Egypt. The commercial bio fertilizers were added in two equal side dressings to the soil after one week from the first and the second applications of urea fertilization in the two experimental seasons. The treatments of bio- and urea fertilization could be arranged in treatments as follows:

1- Control without bio (B_0) or urea fertilization (N_0).
2- Bio fertilization with Rhizobacterein (B_1).
3- Bio fertilization with Biogene (B_2).
4- Urea fertilization at 100 kg/fed (N_1) without bio fertilization.
5- Bio fertilization with Rhizobacterein (B_1) + 100 kg/fed urea (N_1).
6- Bio fertilization with Biogene (B_2) +100 kg/fed urea (N_1).
7- Urea fertilization at 200 kg/fed (N_2) without bio fertilization.
8- Bio fertilization with Rhizobacterein (B_1) + 200 kg/fed urea (N_2).
9- Bio fertilization with Biogene (B_2) + 200 kg/fed urea (N_2).
10- Urea fertilization at 300 kg/fed (N_3) without bio fertilization.
11- Bio fertilization with Rhizobacterein (B_1) + 300 kg/fed urea (N_3).
12- Bio fertilization with Biogene (B_2) + 300 kg/fed urea (N_3).

The aforementioned treatments were irrigated with either magnetized water (M_1) which passed through magnetron tube of 2 inches diameter and 4000 Gaus strength (Amin and Kaseem, 2009) or non-magnetized water (M_0).

Harvesting:

During each experimental season the plants were cut three times. In each harvest the plants were cut leaving about 15 cm above the soil surface. The first cut was done on 9th of July, meanwhile the second and the third cuts were at end of September and at end of November in the two growing seasons.

For each cut the following data were recorded and statistically analyzed by using L.S.D according to Snedecor and Cochran (1980). The soil moisture level was kept at about 75% from its water holding capacity during the growing period.

Vegetative growth parameters:

1- Plant height in cm.
2- Number of tillers / plant.
3- Fresh weight of leaves / plant (g).
4- Fresh weight of herb in ton / fed.
5- Dry weight of leaves / plant (g).

The leaves were dried at 70°C for 72 hours and kept as powder for chemical analysis.

Furthermore, the following chemical constituents were determined.

1- Determination of the essential oil percentage in random samples obtained from the fresh herb of each treatment was carried out in each cut during the two experimental seasons according to the method described by British Pharmacopea (1963). The oil percentage (v/w) was calculated according to the following equation:

$$\text{Essential oil percentage} = \frac{\text{Observed oil in graduated tube in ml}}{\text{Weight of sample in g}} \times 100$$

2- The essential oil yield / plant (ml) and in liter per fed for the three cuts and for season was calculated.

3- In addition the following chemical constituents of the plant were determined in well dried herb at 70°C and fine powdered samples of herb obtained from each treatment:

- Total nitrogen percentage was determined by Kjeldahl's procedure (Bremmer, 1996).
- Phosphorus percentage was determined by using Spectophotometer (Richards, 1954).
- Potassium percentage was determined by using Flame photometer.

Photosynthetic pigments, chlorophyll (A), chlorophyll (B) and carotenoids content in fresh leaves were determined according to the method described by Wettstein (1957).

By using the following equations:

Chlorophyll(A) in mg/l= 9.784×E.662–0.99×E.664
Chlorophyll(B) in mg/l= 21.426×E.644–4.65×E.662
Carotenoids in mg/l= 4.695×E.440–0.226 (A + B)

Total carbohydrate:

The total carbohydrate percentage in the dried herb was determined according to Dubios *et al*. (1957).

RESULTS AND DISCUSSION

1. Vegetative growth:

1.1. Plant height:

The data in Table (2) indicate that the plant height of *Cymbopogon citratus*. stapff plants. was considerably increased as a result of irrigating the plants with magnetized water and the addition of bio and urea fertilization when compared with control plants irrigated with non-magnetized water and received neither bio nor urea fertilization in the three cuts in both growing seasons. The best results in this respect were obtained when the plants were irrigated with magnetized water and received the bio fertilizer (Biogene) plus the highest urea fertilization level (300 kg/fed) in each growing seasons. On the other hand, the shortest plants were produced by the control plants which were irrigated with ordinary water without addition of bio- or urea fertilization in the three cuts of the two growing seasons. For example the plant height in the second cut ranged between 75.9 and 171.0 cm in the first season, whereas in the second one it was between 85.5 and 146.7 cm for the treatments of M_0 +B_0 + N_0 and that of M_1 + B_2 + N_3, respectively.

The improvement in the plant height could be explained through the effective role of magnetic water which enhanced plant growth in the presence of the bio fertilizer and suitable N dose.

These results could be supported by the findings of Nasher (2008) on chick pea (*Cicer orientimum*), Ameen and Kassim (2009) on *Jerbera jamesonii* L. and Vashisth and Nagarjan (2010) on *Helianthus annus* L. Furthermore, these results are in harmony with those obtained by Kandeel *et al.* (2001) on *Foeniculum vulgare* plant, Mazrou (2008) on *Mentha piperita* L., Badran *et al.* (2009) on *Nigella sativa* L., Abido *et al.* (2011) on *Mentha spicata* L. plants, who assured the previously obtained results.

1.2. Number of tillers per plant:

The data in Table (3) clearly show that the produced number of tillers / plant of *Cymbopogon citratus* stapff plants. were markedly improved as a result of watering the plants with magnetized water besides the application of bio- and urea fertilization during the two experimental seasons. The treatment irrigation with magnetized water and using Biogene as bio fertilizer plus the highest urea fertilization level (300 kg /N/fed) realized the highest number of tiller / plant if compared with the other interaction treatments and the control (M_0, B_0 and N_0) in the three cuts of both growing season Meanwhile, the lowest values in this respect

Table 2

Table 3

was obtained by the irrigated plants with ordinary water without addition of bio and urea fertilization in the three cuts in the two growing seasons. For example, in the second cut of the first season the mean number of tillers / plant was between 30.0 and 84.9 tiller / plant, whereas in the second cut of the second season it ranged between 26.3 and 133.7 tiller / plant for the treatments of $M_0 + B_0 + N_0$ and that of $M_1 + B_2 + N_3$, respectively.

These results could be explained through the finding of Midan and Tantawy (2013) who mentioned that watering snap bean plants with magnetically treated water resulted in an increase in soil content from available N, P and K consequently enhanced their absorption by plants roots, which was reflected in promoting plant growth parameters. In addition such results were obtained by Nasher (2008) on chick pea (*Cicer orientimum*), Ameen and Kassim (2009) on *Jerbera jamesonii* L. and Vashisth and Nagarjan (2010) on *Helianthus annus* L. Mazrou, Ragia (2013) on *Carum carvi* L. plants, respectively.

Furthermore, these results are similar to those obtained by Nofal *et al*. (2001) and Afify (2009) on *Ammi visnaga* L., Badran *et al. (*2009) on *Nigella sativa* L., and Abido *et al*. (2010) on *Ocimum basilicum* L.

1.3. Fresh weight of leaves per plant:

The data in Table (4) indicate that the fresh weight / plant of *Cymbopogon citratus* was considerably increased as a results of irrigating the plants with magnetized water and the addition of bio and urea fertilization when compared with the control plants irrigated with non-magnetized water and neither bio nor urea fertilization in the three cuts in both growing seasons. The best results in this respect were obtained when the plants were irrigated with magnetized water and received the bio fertilizer (Biogene) plus the highest urea fertilization level (300 kg/fed) in each growing seasons. On the other hand, the lightest plants were produced by the control plants which were irrigated with non-magnetized water without addition of bio- or urea fertilization on the three cuts in each growing season.

For example the fresh weight / plant in the second cut ranged between 177.5 and 1586.1 g / plant in the first season, whereas in the second one it was between 300.5 and 1441.2 g / plant for the treatments of $M_0 + B_0 + N_0$ and that of $M_1 + B_2 + N_3$, respectively.

2. Chemical constituents:

2.1. Essential oil percentage:

The data in Table (5) clearly show that the essential oil percentage in the leaves of *Cymbopogon citratus* stapff plants. were markedly improved as a result of watering the plants with magnetized water besides the application of bio- and urea fertilization during the two experimental seasons. The treatment irrigation with magnetized water and using Biogene as bio fertilizer plus the highest urea fertilization level (300 kg/N/fed) realized the highest essential oil percentage in the leaves of lemon grass plants if compared with the other interaction treatments and the control (M_0, B_0 and N_0) in the three cuts of both growing season. Meanwhile, the lowest values in this respect was obtained by the irrigated plants with ordinary water without addition of bio or urea fertilization in the three cuts in the two growing seasons. For example, the essential oil percentage in the leaves of *Cymbopogon citratus* stapff plants ranged between 0.15 and 0.60% in the second cut of the first season for the treatments of $M_0 + B_0 + N_0$ and that of $M_1 + B_2 + N_3$, respectively.

These results are similar to those obtained by Nofal *et al*. (2001), Mazrou (2008) on *Mentha pipertia*, Afify (2009) on *Ammi visnaga* L., Badran *et al.* (2009) on *Nigella sativa* L. and Abido *et al.* (2010) *on Ocimum basilicum* L. and Mazrou, Ragia (2013) on *Carum carvi* L. plants.

2.2. Essential oil yield in ml/ plant:

The data in Table (6) indicate that the essential oil yield / plant of *Cymbopogon citratus*. stapff plants was considerably increased as a result of irrigating the plants with magnetized water and the addition of

Table 4

Table 5

Table 6

bio and urea fertilization when compared with control plants irrigated with non-magnetized water and received neither bio nor urea fertilization in the three cuts in both growing seasons.

The best results in this respect were obtained when the plants were irrigated with magnetized water and received the bio fertilizer (Biogene) plus the highest urea fertilization level (300 kg /fed) in each growing seasons. On the other hand, the lowest plants were produced by the control plants which were irrigated with ordinary water without addition of bio- or urea fertilization in the three cuts of the two growing seasons.

For example the essential oil / plant in the second cut ranged between 0.27 and 9.5 ml in the first season, whereas in the second one it was between 1.5 and 14.4 ml for the treatments of $M_0 + B_0 + N_0$ and that of $M_1 + B_2 + N_3$, respectively.

The improvement in the essential oil yield /plant could be explained through the effective role of magnetic water which enhanced plant growth in the presence of the bio fertilizer and suitable N dose. These results could be supported by the findings of Mazrou, Ragia (2013) on *Carum carvi* L. Furthermore, these results are in harmony with those obtained by Kandeel *et al.* (2001) on *Foeniculum vulgare* plant, Abdou and El-Sayed (2002) on *Carum carvi* L., Afify (2002) on *Foeniculum vulgare* L., Mazrou (2008) on *Mentha piperita* L. and Abido *et al.* (2011) on spearmint.

2.3. Mineral content of herb:

2.3.1. Total nitrogen percentage:

The data in Table (7) indicate that the total N% of *Cymbopogon citratus* Stapf. plants was considerably increased as a result of irrigating the plants with magnetized water and the addition of bio and urea fertilization when compared with control plants irrigated with non-magnetized water and received neither bio nor urea fertilization in the three cuts in both growing seasons.

The best results in this respect were obtained when the plants were irrigated with magnetized water and received the bio fertilizer (Biogene) plus the highest urea fertilization level (300 kg/fed) in each growing seasons. On the other hand, the lowest plants were produced by the control plants which were irrigated with ordinary water without addition of bio- or urea fertilization in the three cuts of the two growing seasons. For example the total N% in the second cut ranged between.56 and 2.5% in the first season, whereas in the second one it was between 0.6 and 2.6% for the treatments of $M_0 + B_0 + N_0$ and that of $M_1 + B_2 + N_3$, respectively.

These results could be supported by the findings of Ameen and Kassim (2009) on *Jerbera jamesonii* L. and Vashisth and Nagarjan (2010) on *Helianthus annus* L. and Mazrou, Ragia (2013) on *Carum carvi* L. Furthermore, these results are in harmony with those obtained by Kandeel *et al.* (2001) on *Foeniculum vulgare* plant, Abdou and El-Sayed (2002) on *Carum carvi* L., Afify (2002) on *Foeniculum vulgare* L., Mazrou (2008) on *Mentha piperita* L. and Abido *et al.* (2011) on spearmint.

2.3.2. Phosphorus percentage:

The data in Table (8) indicate that phosphorus percentage in the dried herb of *Cymbopogon citratus*. stapff plants. was considerably increased as a result of irrigating the plants with magnetized water and the addition of bio and urea fertilization when compared with control plants irrigated with non-magnetized water and received neither bio nor urea fertilization in the three cuts in both growing seasons.

The best results in this respect were obtained when the plants were irrigated with magnetized water and received the bio fertilizer (Biogene) plus the highest urea fertilization level (300 kg /fed) in each growing seasons. On the other hand, the lowest values in this respect were produced by the control plants which were irrigated with ordinary water without addition of bio- or urea fertilization in the three cuts of the two growing seasons.

Table 7

Table 8

For example the phosphorus percentage in the second cut ranged between 0.25 and 0.99% in the first season, whereas in the second one it was between 0.16 and 0.97% for the treatments of $M_0 + B_0 + N_0$ and that of $M_1 + B_2 + N_3$, respectively.

The improvement in phosphorus percentage could be explained through the effective role of magnetic water which enhanced plant growth in the presence of the bio fertilizer and suitable N dose. These results could be supported by the findings of Ameen and Kassim (2009) on *Jerbera jamesonii* L. and Vashisth and Nagarjan (2010) on *Helianthus annus* L. and Mazrou, Ragia (2013) on *Carum carvi* L. Furthermore, these results are in harmony with those obtained by Kandeel *et al.* (2001) on *Foeniculum vulgare* plant, Abdou and El-Sayed (2002) on *Carum carvi* L., Afify (2002) on *Foeniculum vulgare* L., Mazrou (2008) on *Mentha piperita* L. and Abido *et al.* (2011) on spearmint.

2.3.3. Potassium percentage:

The data in Table (9) indicate that phosphorus percentage of *Cymbopogon citratus*. stapff plants. was considerably increased as a result of irrigating the plants with magnetized water and the addition of bio and urea fertilization when compared with control plants irrigated with non-magnetized water and received neither bio nor urea fertilization in the three cuts in both growing seasons.

The best results in this respect were obtained when the plants were irrigated with magnetized water and received the bio fertilizer (Biogene) plus the highest urea fertilization level (300 kg/fed) in each growing seasons. On the other hand, the lowest K% was produced by the control plants which were irrigated with ordinary water without addition of bio- or urea fertilization in the three cuts of the two growing seasons.

For example the phosphorus percentage in the second cut ranged between 1.98 and 3.4% in the first season, whereas in the second one it was between 1.93 and 3.8% for the treatments of $M_0 + B_0 + N_0$ and that of $M_1 + B_2 + N_3$, respectively.

The improvement in phosphorus percentage could be explained through the effective role of magnetic water which enhanced plant growth in the presence of the bio fertilizer and suitable N dose. These results could be supported by the findings of Ameen and Kassim (2009) on *Jerbera jamesonii* L. and Vashisth and Nagarjan (2010) on *Helianthus annus* L. and Mazrou, Ragia (2013) on *Carum carvi* L. Furthermore, these results are in harmony with those obtained by Kandeel *et al.* (2001) on *Foeniculum vulgare* plant, Abdou and El-Sayed (2002) on *Carum carvi* L., Afify (2002) on *Foeniculum vulgare* L., Mazrou (2008) on *Mentha piperita* L. and Abido *et al.* (2011) on spearmint.

2.4. Photosynthetic pigments:

2.4.1. The total chlorophyll (A + B) content:

The data in Table (10) indicate that total chlorophyll (A + B) content in the leaves of *Cymbopogon citratus* Stapf. plants was considerably increased as a result of irrigating the plants with magnetized water and the addition of bio and urea fertilization when compared with control plants that irrigated with non-magnetized water and received neither bio nor urea fertilization in the three cuts in both growing seasons. The best results in this respect were obtained when the plants were irrigated with magnetized water and received the bio fertilizer (Biogene) plus the highest urea fertilization level (300 kg/fed) in each growing seasons.

On the other hand, the lowest values in this respect were produced by the control plants which were irrigated with ordinary water without addition of bio- or urea fertilization in the three cuts of the two growing seasons. For example, total chlorophyll (A + B) content in the leaves in the second cut ranged between 21.04 and 75.13 mg/g in the first season, whereas in the second one it was between 25.35 and 73.06 mg/g for the treatments of $M_0 + B_0 + N_0$ and that of $M_1 + B_2 + N_3$, respectively.

Table 9

Table 10

The improvement in total chlorophyll (A + B) content could be explained through the effective role of magnetic water which enhanced plant growth in the presence of the bio fertilizer and suitable N dose. These results could be supported by the findings of Ameen and Kassim (2009) on *Jerbera jamesonii* L. and Vashisth and Nagarjan (2010) on *Helianthus annus* L. and Mazrou, Ragia (2013) on *Carum carvi* L. Furthermore, these results are in harmony with those obtained by Kandeel *et al.* (2001) on *Foeniculum vulgare* plant, Abdou and El-Sayed (2002) on *Carum carvi* L., Afify (2002) on *Foeniculum vulgare* L., Mazrou (2008) on *Mentha piperita* L. and Abido *et al* (2011) on spearmint.

2.5.Total carbohydrate percentage:

The data in Table (11) indicate that the total carbohydrate percentage of *Cymbopogon citratus*. stapff plants. was considerably increased as a result of irrigating the plants with magnetized water and the addition of bio and urea fertilization when compared with control plants irrigated with non-magnetized water and received neither bio nor urea fertilization in the three cuts in both growing seasons. The best results in this respect were obtained when the plants were irrigated with magnetized water and received the bio fertilizer (Biogene) plus the highest urea fertilization level (300 kg / fed) in each growing seasons. On the other hand, the lowest values in this respect were produced by the control plants which were irrigated with ordinary water without addition of bio- or urea fertilization in the three cuts of the two growing seasons. For example total carbohydrate percentage in the leaves in the second cut ranged between 12.8 and 25.0% in the first season, whereas in the second one it was between 12.0 and 20.8% for the treatments of $M_0 + B_0 + N_0$ and that of $M_1 + B_2 + N_3$, respectively.

The improvement in total carbohydrate % content could be explained through the effective role of magnetic water which enhanced plant growth in the presence of the bio fertilizer and suitable N dose. These results could be supported by the findings of Ameen and Kassim (2009) on *Jerbera jamesonii* L. and Vashisth and Nagarjan (2010) on *Helianthus annus* L. and Mazrou, Ragia (2013) on *Carum carvi* L. Furthermore, these results are in harmony with those obtained by Kandeel *et al.* (2001) on *Foeniculum vulgare* plant, Abdou and El-Sayed (2002) on *Carum carvi* L., Afify (2002) on *Foeniculum vulgare* L., Mazrou (2008) on *Mentha piperita* L. and Abido *et al.* (2011) on spearmint.

Conclusion:

Irrigation with magnetized water recorded a considerable improvement on the growth and yield parameters as well as essential oil percentage and its yield in the leaves / plant as well as N, P and K% in the dried herb, photosynthetic pigments concentrations in the fresh leaves and total carbohydrate in the produced dried herb were augmented by the treatment of magnetized water in comparison to that of irrigation with ordinary water (non-magnetized) in both growing seasons.

Regarding the effect of interaction between irrigation with magnetic water as well as bio- or urea fertilization levels, it could be concluded that the growth and yield parameters, essential oil content in the leaves as well as the chemical composition of the produced herb of lemon grass plants (namely: N, P and K%, photosynthetic pigments in the fresh leaves and total carbohydrate percentage in the dried herb) were improved when the grown plants fertilized with Biogene as biofertilizers besides using the highest urea fertilization level (300 kg / fed) and irrigated with magnetized water in comparison to those irrigated with non-magnetized water in the two growing seasons. The best results in this respect were obtained by the treatment $M_1 + B_2 + N_3$ in the two seasons. Meanwhile, the irrigated plants with ordinary water without application of bio- or urea fertilization gave significantly the lowest values in this concern.

TABLE 11

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تأثير الرى بالماء المُمغنط واستخدام الأسمدة الحيوية على النمو ومحتوى الزيت الطيّار فى نباتات حشيشة الليمون

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الملخص العربى

اجريت هذه الدراسه بمزرعة كليه الزراعه بشبين الكوم جامعة المنوفيه خلال موسمى ٢٠١٠, ٢٠١١ وذلك بهدف دراسة تأثير بعض المعاملات الزراعيه مثل الرى بالماء الممغنط والتسميد الحيوى والكيماوى اما بصوره منفرده او متداخله على صفات النمو الخضرى وانتاج الزيت الطيار وكذلك بعض المكونات الكميائيه فى نباتات حشيشة الليمون وقد تم فى هذه الدراسه رى النباتات اما بالماء العادى او الماء الممغنط (عن طريق مرور الماء فى انبوب قطره ٢ بوصه وشدته ٤٠٠٠ جاوس) بالاضافه الى استخدام نوعين من الاسمده التجاريه (الريزوباكترين , البيوجين) المحتويه على انواع بكتيريه مثبتة للازوت الجوى علاوة على استخدام التسميد باليوريا بمعدلات (صفر , ١٠٠, ٢٠٠, ٣٠٠ كجم/ فدان) بصوره منفرده او متداخله . وقد صممت التجربه فى قطاعات كاملة العشوائيه (قطاعات منشقه) وقد تم تحليل النتائج المتحصل عليها احصائيا وقد اظهرت نتائج تلك الدراسه الى تحسن واضح

فى كل من صفات النمو الخضرى (ارتفاع النبات – عدد الاشطاء – الوزن الطازج والجاف للنبات وكذلك للفدان) نتيجه لرى النباتات بالماء الممغنط مع استخدام السماد الحيوى (البيوجين) واستعمال المستوى العالى من اليوريا (٣٠٠ كجم/ فدان) .

كما اوضحت النتائج ايضا تحسن كل من محتوى نبات حشيشة الليمون من الزيت الطيار وانتاجيته للنبات وكذلك للفدان كما تحسن ايضا بصوره واضحه محتوى النبات من العناصر الغذائيه (النيتروجين , الفوسفور , البوتاسيوم) وكذلك محتواها من الصبغات النباتيه (كلورفيل ا , كلورفيل ب , الكاروتينات) وكذلك الكربوهيدرات الكليه نتيجه لرى النباتات بالماء الممغنط مع استخدام السماد الحيوى (البيوجين) مع المستوى العالى من اليوريا (٣٠٠كجم/ فدان) وذلك خلال موسمى النمو بينما سجلت معاملة الكنترول المتمثله فى الرى بالماء العادى وبدون استخدام اسمده حيويه او كيماويه خلال موسمى النمو اقل القياسات الخضريه والمحصول وكذلك المكونات الكيماويه للنبات .