EFFECT OF CHEMICAL FERTILIZATION, BIOFERTILIZER AND THIDIAZURON ON GROWTH AND YIELD OF CELERY (APIUM GRAVEOLENS L.) PLANT.

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Abstract

This study was conducted during two successive seasons of 2014-2015 and 2015-2016 at Biotechnology Department, Phytochemistry Department and Farm of Applied Research Center of Medicinal Plants (ARCMP) affiliated to the National Organization for Drug Control And Research (NODCAR). The present work aimed to investigate the effect of inoculation Apium graveolens L. seeds with arbuscular mycorrhizal fungi (my) and/or microbein (mi) biofertilizer and foliar spray plants with Thidiazuron (TDZ) combined with chemical fertilizer at half or full dose of NPK on number of spores Am fungi (kg soil⁻¹), AM fungi colonization, enzymatic activities (dehydrogenase activity [µg TPF/g dry soil/day] & Nitrogenase activity [nmol C₂H₄/g rhizosphere/ hour]), growth parameters (fresh weight of shoots per plant (g), fresh weight of roots per plant (g), dry weight of shoots per plant (g), dry weight of roots per plant (g), Plant height (cm), number of umbel per plant [at full flowering stage] & dry weight of fruits per plant [at harvest stage]) and chemical composition (plant pigments [chlorophyll a, chlorophyll b and carotenoides], macro elements content (%), total carbohydrates, and crude protein). The results in both seasons showed that, the highest values of number of AM fungi spores (kg soil⁻¹) in celery (Apium graveolens L.) roots, AM fungi colonization %, enzymatic activities, growth parameters and chemical composition obtained at inoculating seeds with mixture of mycorrhizal and microbein at full dose of NPK.

Keywords: biofertilizer, thidiazuron, apium graveolens, mycorrhizal, microbein

Introduction

Apium graveolens Linn. (Apiaceae) is commonly known as Celery (Norman and Max, 2001). It is an erect, annual or biennial herb. The roots are numerous, succulent and well developed. The stem branches are angular or fistular, and are conspicuously jointed. The leaves are oblong to obovate, pinnate or trifoliolate. The leaflets are ovate to suborbicular and 3-lobed. The flowers are white or greenish white and very small. The fruit is a schizocarp consisting of two mericarps, sub-orbicular to ellipsoid, greyish brown to brown with pale ridges, aromatic and slightly bitter (Teng et al., 1985). The primary phytochemical analysis on the seed extract of Apium graveolens indicates the
presence of carbohydrates, flavonoids, steroids, and glycosides in the methanolic extract. The plant included phenols and furocoumarins. Furocoumarins contained celerin, bergapten, apiumoside, apiumetin, apigravrin, ostenol, isopimpinellin, isoimperatorin, celereoside, and 5 and 8-hydroxy methoxypsoralen. Phenols included graveobioside A and B, apiin, apigenin, isoquercitrin, tannins and phytic acid. Celery seeds contain 2 to 3% essential oil. Its oil contains mostly limonene (usually 60 percent), selinene (10 %), furocoumarin and furocoumarin glycosides and their flavonoids (Khare, 2008). Celery (Apium graveolens) is a medicinal plant in traditional medicine with numerous health benefits. Celery involves in the prevention of cardiovascular disease (Sowbhagya, 2001), lowering blood glucose in diabetic mice (Gelodar and Nazify, 1997), lowering blood pressure and strengthening the heart (Lans, 2006). Experimental studies report antifungal (Momin and Nair, 2001) and anti-inflammatory effects of celery (Mencherini et al., 2007) and anticoagulant activity (Sowbhagya et al., 2001). It is root leads to an increase of calcium and decrease of potassium in the heart tissue (Bernard and Stiehl, 1986). Essential oil of celery has antibacterial effects. This plant has cooperation in the molecular mechanisms and cellular targets that have a significant effect on the treatment of human cancers (Atta, 1998). Celery root and leaves have the property of eliminating OH and DPPH radicals. It also reduces the severity of liposomal peroxidation that represents renewal and conservation activities of it (Zidorn et al., 2005).

The term biofertilizer or called 'microbial inoculants' can be generally defined as a preparation containing live or latent cells of efficient strains of nitrogen fixing, phosphate solubilizing or cellulytic microorganisms used for application of seed, soil or composting areas with the objective of increasing the numbers of such microorganisms and accelerate certain microbial process to augment the extent of the availability of nutrients in a form which can assimilated by plant (Board, 2004). In large sense, the term may be used to include all organic resources (manure) for plant growth which are rendered in an available form for plant absorption through microorganisms or plant associations or interactions (Board, 2004).

Biofertilizers are the products containing living cells of different types of microorganisms which have the ability to mobilize nutritionally important elements from a non-useable to a usable forms through biological processes. Although the advent of the phenomenon is more than a century old, the need of its commercial exploitation was not applied (Saber, 1993; Hegde et al, 1999). Microorganisms play an important role in various chemical transformations of soils and thus, influence the availability of major nutrients like nitrogen, phosphorus, potassium and sulphur to the plants. Cyanobacteria and phosphate-solubilizing bacteria were used as biofertilizers to increase crop production (Earanna and Govindan, 2002).

General growth and cell division stimulation becomes saturated at low levels of TDZ, making the chemical more effective than purine type cytokinins. Thidiazuron (N-phenyl-N’-1,2,3-thiadiazol-5-phenyl urea), is a synthetic diphenylurea (DPU) type cytokinin that is thought to encourage the synthesis and/or accumulation of purine type cytokinins (Thomas and Katterman, 1986). In agriculture, TDZ is used as a defoliant particularly in cotton. It is sprayed on a field to defoliate the plants before the boll harvest. (Snipes and Cathey, 1992) found that a tank mix of TDZ and another defoliant (they tested ethephon, tribufos, and dimethinpin) worked well to negate the effect of
environmental conditions on the efficacy of the chemicals in promoting leaf abscission.

The aim of the present work was to study the effect of my, mi and TDZ combined with half or full dose of NPK on growth, yield and chemical composition of celery plant.

MATERIALS AND METHODS

This work was carried out during two successive seasons 2014-2015 and 2015-2016 at Biotechnology Department, phytochemistry Department and Farm of Applied Research Center of Medicinal Plants (ARCMP) affiliated to the National Organization for Drug Control And Research (NODCAR).

MATERIALS

Plant material

Seeds of *Apium graveolens* L. obtained from agriculture Research Center (EL gamma st., giza, Egypt).

**microorganisms material:**

1. mycorrhizal (contains *Gloums* spp., *Gigaspora* spp. and *Acaulospora* spp. V 1:1:1) obtained from soil, water and environment research institute.

2. mycrobein (biofertilizer containing N-fixing (such as *Azotobacter* and *Azospirillum*) and P-dissolving bacteria (Such as *Pseudomonas* and *Bacillus megatheium*) produced and distributed commercially by the general organization for agriculture equalization fund. Ministry of Agriculture, Egypt.

**Mycorrhizal and microbein** coated the seed of celery pre-planting by mixing with a fine mist of 10% sugar solution and mixing seed with the microbein and Mycorrhizal spores.

**Thiduazoran growth regulators**

Obtained from commercially compound named prop 50 WP (containing 50% TDZ).

Plants were sprayed with 10 ml of a solution containing ( 5 mg/l TDZ dissolving in water containing 0.01% tween 20%) using a hand atomizer. Weighing the plants before and after spraying showed that approximately 5 to 7 ml of the solution adhered to each plant. Control plants were sprayed with water containing 0.01% tween 20% but without TDZ.

**Soil used**

The soil used in the present work are collected the from farm of Applied Research Center soil of Medicinal Plants (ARCMP) related to The National Orgnization for Drug Control And Research (NODCAR) and initially analyzed for chemical and
physical characters according to Black et al. (1965). These characters are presented in Table (1).

Table (1): Chemical and physical characteristics of experimental soil

| EC mmohs/cm | SP | Ph | Soluble ions (meq/L) |
|-------------|----|----|----------------------|
| 7.5         | 26 | 8.1| Ca$$^{++}$$ 8.10      |
|             |    |    | Mg$$^{++}$$ 9.32      |
|             |    |    | Na$$^{+}$$ 2.57        |
|             |    |    | K$$^{+}$$ .80         |
|             |    |    | CO$_3^{-}$ ----       |
|             |    |    | HCO$_3^{-}$ 2.6       |
|             |    |    | Cl$^{-}$ 4.24         |
|             |    |    | SO$_4^{2-}$ 13.93     |

Some physical characteristics of the experimental soil

| Particle size distribution (%) | Texture class |
|--------------------------------|---------------|
| Coarse sand                    | Fine sand     |
| 47.15                           | 23.17         |
| 19.91                           | 9.77          |

Experimental design and layout

The experiment was laid out in randomized block design (RBD) (6X7m) with 3 replications; each block was prepared to contain 10 rows. Randomization of the treatments was done with the help of random number table as advocated by Fisher, 1950. The treatments were:

1) Control (untreated plants with chemical and bio-fertilizer)
2) Recommended dose of chemical fertilizer.
3) Recommended dose of chemical fertilizer + mycorrhizal
4) Recommended dose of chemical fertilizer + microbein
5) Recommended dose of chemical fertilizer + TDZ
6) Recommended dose of chemical fertilizer + mycorrhizal + microbein
7) Recommended dose of chemical fertilizer + mycorrhizal + TDZ
8) Recommended doses of chemical fertilizer + microbein + TDZ
9) Half recommended dose of chemical fertilizer.
10) Half recommended dose of chemical fertilizer + mycorrhizal
11) Half recommended dose of chemical fertilizer + microbein
12) Half recommended dose of chemical fertilizer + TDZ
13) Half recommended dose of chemical fertilizer + mycorrhizal + microbein
14) Half recommended dose of chemical fertilizer + mycorrhizal + TDZ
15) Half recommended doses of chemical fertilizer + microbein + TDZ

Recommended dose of chemical fertilizer were 200 Kg/Fadden superphosphate (12.5% P$_2$O$_5$) added before planting, while the plants were fertilizer with 200 Kg/Fadden ammonium sulphate (20.6 % N) and 50 Kg/Fadden potassium sulphate (50% KO$_2$) after 30 and 45 days from planting at two stage.

Seeds of celery planting in green house in August and transfer plantlet to farm in October the harvest were in May.

The data recorded were:

1. Determination number of spores Am fungi (kg soil$^{-1}$) and AM fungi colonization

The percentage of AM fungi colonization in plant root tissues was determined as described by Philips and Hayman (1970)
2. Enzymatic activities determinations

a. dehydrogenase activity (µg TPF/g dry soil/day)

The dehydrogenase activity was estimated according to (Skujins and Burns, 1976).

b. Nitrogenase activity (nmol C₂H₄/g rhizosphere/hour)

The activity of nitrogenase enzyme was determined by the acetylene reduction technique according to Hardy et al. (1973).

3. Growth parameters

The recorded data for the experiments at three periods (2 [December], 4 [February] and 6 [April] months) were as follows:

[fresh weight of shoots per plant (g), fresh weight of roots per plant (g), dry weight of shoots per plant (g), dry weight of roots per plant (g), Plant height (cm), number of umbel per plant (at full flowering stage) and dry weight of seeds per plant (at harvest stage)]

4. Chemical composition

a. Determination of plant pigments

Leaf samples were used to measure Chl. a, b (Arnon, 1949) and Carotenoid contents (Lichtenthaler and Wellburn, 1983).

b. Determination of total carbohydrates in the dried herb

The content of total carbohydrates of the samples was determined by the phenol sulfuric acid method (Dubois et al., 1956 and Krishnaveni et al., 1984).

c. Crude protein content (%)

Sample of celery leaves were analysed separately for nitrogen content (%) by colorimetric method (Snell and Snell, 1949). Nitrogen content is multiplied with 6.25 factors to calculate crude protein content in head (A.O.A.C., 1960).

d. Macro elements determination

1. Nitrogen

Nitrogen content was determined by the modified micro-Kjeldahl method as described by Pregl, (1945).

2. Phosphorus

The phosphorus content was estimated after wet ashing by using molybdic acid to form phosphomolybdate complex, and then reduced with aminoaphthosulphuric acid to complex molybdenum blue which was measured calorimetrically (at 660 µm) using a standard curve of potassium dihydrogen phosphate as recommended by Murphy and Riley (1962).

3. Potassium
Potassium was determined using a flame photometer as described by (Jackson, 1965).

**Statistical analysis:**

Data recorded on vegetative growth and chemical compositions were statistically analyzed, and separation of means was performed using the least significant difference (L.S.D.) test at the 5% level, as described by (Snedecor and Cochran, 1967).

**RESULTS AND DISCUSSIONS**

**Microbiological parameters**

a) **number of AM fungi spores (kg soil⁻¹)**

Data concerning the effect of treated celery (Apium graveolens L.) plant with chemical, bio-fertilizer and TDZ on number of AM fungi spores (kg soil⁻¹) are presented in Table (2). Data showed that inoculation of celery (Apium graveolens L.) seeds with AM mycorrhizal led to significantly increase in number of AM fungi spores (kg soil⁻¹) compared to un-inoculated seeds.

Also the data showed that the highest values of number of AM fungi spores (kg soil⁻¹) were 3.2x10⁵ and 3.3x10⁴ in celery (Apium graveolens L.) roots obtained at inoculation of seeds with mixture of mycorrhizal and mycrobein at full dose of NPK in the first and second seasons, respectively.

These results were in accordance with the finding of Ramakrishnan and Bhuvaneswari (2014) on Eleusine coracana (L.) Gaertn, they investigated that combined inoculation of AM Fungi with Azospirillium and Azotobacter significantly increased number of AM spores in soil. In this connection Edyta et al. (2015) who concluded that treated strawberry with the bioproducts (mixture of AM fungi: Glomus species, Trichoderma viride, and rhizosphere bacterial species (Bacillus subtilis, Pseudomonas fluorescens and Streptomyces spp.) led to increase in the number of spores of AMF.

a) **AM fungi colonization %**

Data presented in Table (3) showed the response of celery (Apium graveolens L.) to inoculation of seeds with biofertilizer and/or foliar plants with TDZ at half or full recommended doses of NPK. The obtained results reported that inoculating of celery (Apium graveolens L.) seeds with mycorrhizal led to significant increase in AM fungi colonization % compared to un-inoculated seeds.

Data also recorded that inoculation of celery (Apium graveolens L.) seeds with a mixture of mycorrhizal plus microbein at full recommended dose of NPK gave the highest values of AM fungi colonization % were (100.10 and 100.18%) scored at the first and second seasons, respectively, but the lowest values obtained by zero treatment were (15.99% and 16%) scored at the first and second seasons, respectively.
Generally, the obtained results were in harmony with the finding of Ramakrishnan and Bhuvaneswari (2014) they found that combined inoculation of AM Fungi with Azospirillum and Azotobacter significantly increased percent root colonization in roots of Eleusine coracana (L.) Gaertn. Soliman et al. (2015) they indicated that inoculation of Delonix regia seedling with biofertilizer (Arbascular mycorrhizal fungi, Azotobacter chroococum, yeast strains and mixture of all inoculums) led to significant increase in AM fungi colonization % compared to the un-inoculated seedlings at the recommended dose of NPK chemical fertilizers under the same condition.

**Dehydrogenase activity (µg TPF/g dry soil/day)**

Table (4) proved the extended effect of chemical, bio-fertilizer and TDZ on dehydrogenase activity (µg TPF/g dry soil/day) in rhizosphere of celery (Apium graveolens L.) plant. The obtained results showed that inoculation of celery (Apium graveolens L.) seeds with a mixture of mycorrhizal plus microbein at full recommended dose of NPK gave the highest values of dehydrogenase activity (µg TPF/g dry soil/day) were (119.50 and 126.90) scored at the first and second seasons respectively compared to control and other treatments. On the other hand, the lowest values obtained by zero treatment were (19.80 and 25.20) scored at the first and second seasons respectively.

These results were in accordance with the findings of Amal et al. (2014) revealed that dehydrogenase activity (µg TPF/100 g soil Day\(^{-1}\)) under different inoculation treatments of Thiobacillus A1, A2 and/or AM fungi were higher than those of un inoculated treatments, after 60 and 90 days of planting. In this respect, Haddad et al. (2014) showed that the highest significant increase in percentages of enzyme activity (dehydrogenase) was recorded in the treatment inoculated Eucalyptus camaldulensis with the mixed microbial treatment (Azotobacter chroococum, Bacillus circulans and Arbuscular mycorrhizal fungi AMF) a rather than that of individual and dual treatments in two seasons.

**Nitrogenase activity (nmol C\(_2\)H\(_4\)/g rhizosphere/ hour)**

Data concerning the effect of chemical, bio-fertilizer and TDZ on nitrogenase activity (nmol C\(_2\)H\(_4\)/g rhizosphere/ hour) in rhizosphere of celery (Apium graveolens L.) plant are presented in Table (5). Data showed that inoculation of celery (Apium graveolens L.) seeds with microbein led to significantly increase of nitrogenase activity (nmol C\(_2\)H\(_4\)/g rhizosphere/ hour) compared to control or other treatments.

Also the data cleared that the highest values of nitrogenase activity were (558.18 and 572.90 nmol C\(_2\)H\(_4\)/g rhizosphere/ hour) obtained with inoculation of celery (Apium graveolens L.) seeds with a mixture of mycorrhizal plus microbein at full recommended dose of NPK scored at the first and second seasons respectively, but the lowest values obtained by zero treatment were (88.60 and 89.90) scored at the first and second seasons respectively.

These results were in agreement with the findings of Hadad et al. (2014) They showed that the highest significant increase in percentages of enzyme activity (nitrogenase) was recorded in the treatment inoculated Eucalyptus camaldulensis with the mixed microbial treatment (Azotobacter chroococum, Bacillus circulans and
Arbuscular mycorrhizal fungi AMF) are rather than that of individual and dual treatments in two seasons. Nitrogenase activity (N\textsubscript{2}-ase) was used as a criterion of atmospheric nitrogen fixation by diazotrophs. Three different types of nitrogen fixing bacteria viz., Azotobacter vinelandii, Paenibacillus polymyxa and Pseudomonas fluorescens were isolated from rhizosphere of field-grown sugarcane in Barak Valley, Assam.

**Growth parameters**

As for the effect of chemical, bio-fertilizer and TDZ on [fresh weight of shoots per plant (g), fresh weight of roots per plant (g), dry weight of shoots per plant (g), dry weight of roots per plant (g), Plant height (cm), number of umbel per plant (at full flowering stage) and dry weight of seeds per plant (at harvest stage)], the obtained results in Tables (6, 7, 8, 9, 10, 11 and 12) indicated that all treatments significantly increased growth parameters as compared to zero in two season.

Data also showed that the highest values of growth parameters [fresh weight of shoots per plant (80.00, 255 and 850 g/plant) and (93.00, 269.00 and 863.00 g/plant), fresh weight of roots per plant (8.00, 16.20 and 60.00 g/plant) and (9.00, 17.20 and 62.00 g/plant), dry weight of shoots per plant (9.30, 35.00 and 165.00 g/plant) and (11.00, 38.00 and 170.00 g/plant), dry weight of roots per plant (1.40, 2.75 and 10.00 g/plant) and (1.60, 3.40 and 11.20 g/plant), Plant height (32.00, 64.70 and 159.00 cm) and (35.20, 70.00 and 164.00 cm), number of umbel per plant (392.00 and 402.00) and dry weight of seeds per plant (128.80 and 132.42 g/plant)] obtained by treated celery (Apium graveolens L.) plants with full NPK plus mycorrhizal and microbein at three periods (2, 4 and 6 months) during in the first and second seasons, respectively.

However, the lowest values of growth parameters [fresh weight of shoots per plant (36.25, 130.60 and 300.00 g/plant) and (37.80, 170.00 and 380.00 g/plant), fresh weight of roots per plant (3.30, 6.90 and 38.00 g/plant) and (3.80, 7.20 and 40.00 g/plant), dry weight of shoots per plant (3.90, 18.30 and 57.00 g/plant) and (4.20, 19.00 and 58.00 g/plant), dry weight of roots per plant (0.60, 1.55 and 6.50 g/plant) and (0.67, 1.70 and 6.50 g/plant), Plant height (12.00, 25.00 and 70.00 cm) and (14.50, 28.00 and 73.00 cm), number of umbel per plant (185.00 and 190.00) and dry weight of seeds per plant (40.30 and 45.90 g/plant)] obtained by zero treatment at three periods (2, 4 and 6 months) during in the first and second seasons, respectively.

The results were in accordance with the finding of Kundu et al. (2011) reported that all the inorganic and biofertilizer combinations exhibited profound effect on growth, yield and fruit quality than inorganic fertilizer alone on pruned mango orchard cv. Amrapali, and concluded that the treatments 100% NPK + Azotobacter + VAM and 75% NPK + Azotobacter + VAM were effective and may be adopted to improve the vegetative growth and productivity with quality fruits. In this respect, Harb et al., (2011) on Nigella sativa L. plants, indicated that the biofertilization (Glomus macrocarpus fungus or Nitrobein bacteria) or organic manure alone or in combination with half or full NPK fertilizer increased plant height (cm), No. of branches and leaves, root length (cm) as well as herb and root dry weight when compared with un inoculated plants (control). Also, the best significant results of herb and root dry weight were found with mycorrhizal fungus and Azotobacter with full NPK fertilizers treatment as compared to the other treatments under study. Also, G. macrocarpus
fungus+Nitrobein+organic manure with full NPK fertilizer treatment were more effective in increasing the seed yield per plant and fadden than the other treatments under study.

Similar results were recorded by Singh et al. (2011) recorded that treated stevia (Stevia rebaudiana Bertoni) with 100% NPK + Azotobactor gave higher fresh and dry herb yield per hectare as compared to other treatment combinations. In this respect, El-Aal and El-Rahman (2014) found that, the best results of vegetative growth on sweet ananas melon plant, photosynthetic pigments content total fruiting/plant and chemical composition of leaves and fruits were obtained with the application of biofertilizer+full chemical fertilization dose. In this connection, Soliman et al. (2015) indicated that inoculation of Delonix regia seedlings with bio-fertilizers (Arbascular mycorrhizae fungi, Azotobacter chroococcum, yeast strains and mixture of all inoculum) led to significant increase in growth characters (plant height, root length, number of branches/plant, total fresh and dry weights/plant), microbial populations and AM fungi colonization (%), enzymatic activities, compared to the un-inoculated seedlings (as control) at the recommended dose of NPK chemical fertilizers under the same conditions.

Effect of chemical , bio-fertilizer and TDZ on chemical composition of celery (Apium graveolens L.) Plant

Data concerning the effect of inoculation celery (Apium graveolens L.) seeds with mycorrhizal and/or microbein and sprayed plants with TDZ combine chemical fertilizer at half or full dose of NPK on plant pigments [chlorophyll a, chlorophyll b and carotenoides], total carbohydrates, crude protein, content (%) and Macro elements are presented in Tables (13- 20).

Data showed that inoculation celery (Apium graveolens L.) seeds with mixture of mycorrhizal and microbein at full dose of NPK gave the highest values of plant pigments [chlorophyll a were (0.85, 1.30 and 1.80 mg/g F.W.) and (1.42, 1.40 and 2.00 mg/g F.W.), chlorophyll b (0.35, 0.49 and 0.60 mg/g F.W.) and (0.37, 0.51 and 0.63 mg/g F.W.), carotenoides (0.48, 0.66 and 0.82 mg/g F.W.) and (0.50, 0.75 and 1.00 mg/g F.W.)], total carbohydrates (30, 37 and 43%) and (32, 40 and 45%), crude protein (21.25, 28.75 and 33.75%) and (21.13, 28.44 and 41.88%), and Macro elements (nitrogen [3.40, 4.60 and 5.40%] and [3.70, 4.55 and 6.70%], phosphorus [0.45, 0.66 and 0.70%] and [0.55, 0.70 and 0.77%], potassium [1.92, 2.65 and 3.00%] and [2.20, 2.80 and 3.50%] at three periods (2, 4 and 6 months) in the first and second seasons respectively. On the other hand, zero treatment gave the lowest values of plant pigments [chlorophyll a were (0.39, 0.50 and 0.60 mg/g F.W.) and (0.42, 0.55 and 0.64 mg/g F.W.), chlorophyll b (0.15, 0.20 and 0.25 mg/g F.W.) and (0.17, 0.23 and 0.29 mg/g F.W.), carotenoides (0.22, 0.25 and 0.28 mg/g F.W.) and (0.26, 0.29 and 0.34 mg/g F.W.)], total carbohydrates (15, 18 and 21%) and (16, 19 and 21%), crude protein (6.88, 7.06 and 7.50%) and (7.63, 8.63 and 9.06%), and Macro elements (nitrogen [1.10, 1.13 and 1.20%] and [1.22, 1.38 and 1.45%], phosphorus [0.15, 0.19 and 0.26%] and [0.17,
0.21 and 0.29%), potassium [(0.65, 0.87 and 1.20%) and (0.72, 1.00 and 1.20%)] at three periods (2, 4 and 6 months) in the first and second seasons, respectively.

Suke et al. (2011) reported that treated maize (Zea mays L.) with recommended dose fertilizer + Azotobacter + PSB led to increased in chlorophyll content, nitrogen, phosphorus and potassium content in leaves, Protein and starch content in grain. The NPK-bacterial fertilizer combinations influenced positively the educed phosphorus and potassium by ryegrass (Lolium perenne L.). plant, these results were reported by (Jakab et al., 2011). El-Quesni et al. (2013) reported that chlorophyll a, b and carotenoids were increased with mixed biofertilizers application. Total carbohydrates content significantly increased in leaves and roots of Jatropha seedlings treated with phosphorien, microbien. Such increment in photosynthetic pigments, which reflect in photosynthesis processes and led to increase in carbohydrate contents.

El-Aal and El-Rahman (2014) found that the best results of photosynthetic pigments content, total fruiting/plant and chemical composition of leaves and fruits on sweet ananas, melon plant, were obtained with the application of biofertilizer+full chemical fertilization dose. Soliman et al . (2015) showed that inoculation Delonix regia seedlings with bio-fertilizers (Arbascular mycorrhizae fungi, Azotobacter chroococcum, yeast strains and mixture of all inoculums) led to significant increase chemical composition (plant pigments, total carbohydrates, proline content, N, P, K) besides antioxidant enzymes such as catalase (CAT),and peroxidase (POD) compared to the un-inoculated seedlings (as control) at the recommended dose of NPK chemical fertilizers under the same conditions.

| Treatment          | Growing season       |          |          |          |
|--------------------|----------------------|----------|----------|----------|
|                    | 2014-2015            | 2015-2016| Mean     |
| Control            | 0.78 X 10^4          | 0.74 X 10^4| 0.76 X 10^4|
| full dose          | 0.95 X 10^4          | 0.97 X 10^4| 0.96 X 10^4|
| full + my          | 2.90 X 10^4          | 3.00 X 10^4| 2.95 X 10^4|
| full + mi          | 1.30 X 10^4          | 1.38 X 10^4| 1.34 X 10^4|
| full + TDZ         | 0.93 X 10^4          | 0.92 X 10^4| 0.92 X 10^4|
| full + my + mi     | 3.20 X 10^4          | 3.30 X 10^4| 3.25 X 10^4|
| full + my + TDZ    | 2.80 X 10^4          | 2.92 X 10^4| 2.86 X 10^4|
| full + mi + TDZ    | 1.20 X 10^4          | 1.40X 10^4 | 1.30 X 10^4|
| half dose          | 0.87 X 10^4          | 0.94 X 10^4| 0.90 X 10^4|
| half + my          | 2.22 X 10^4          | 1.95 X 10^4| 2.08 X 10^4|
| half + mi          | 1.78 X 10^4          | 1.30 X 10^4| 1.54 X 10^4|
| half + TDZ         | 0.90 X 10^4          | 0.89 X 10^4| 0.89 X 10^4|
| half + my + mi     | 2.10 X 10^4          | 2.35 X 10^4| 2.22 X 10^4|
| half + my + TDZ    | 1.90 X 10^4          | 2.20 X 10^4| 2.05 X 10^4|
| half + mi + TDZ    | 1.00 X 10^4          | 1.00 X 10^4| 1.00 X 10^4|
| Mean               | 1.65X 10^4           | 1.68X 10^4 |          |
Table 3 Effect of Mycorrhiza, microbin and TDZ on soil mycorrhizal colonization (%) cultivated with celery plants (50 days after transplanting) grown under two levels of NPK during 2014/2015 and 2015/2016 seasons.

| Treatment                | Growing season |       |       |       |
|--------------------------|----------------|-------|-------|-------|
|                          | 2014-2015      | 2015-2016 | Mean  |
| Control                  | 15.99          | 16.00  | 15.99 |
| full dose                | 28.99          | 30.00  | 29.495|
| full + my                | 95.6           | 100.16 | 97.88 |
| full + mi                | 30.15          | 36.9   | 33.525|
| full + TDZ               | 25             | 25.00  | 25.00 |
| full + my + mi           | 100.1          | 100.18 | 100.14|
| full + my + TDZ          | 80.2           | 88.9   | 84.55 |
| full + mi + TDZ          | 40.22          | 42.8   | 41.51 |
| half dose                | 16.9           | 17.9   | 17.4  |
| half + my                | 59.3           | 65.7   | 62.5  |
| half + mi                | 29             | 30.00  | 29.5  |
| half + TDZ               | 17.5           | 18.9   | 18.2  |
| half + my + mi           | 73             | 78.3   | 75.6  |
| half + my + TDZ          | 62.18          | 68.33  | 65.255|
| half + mi + TDZ          | 31.7           | 35.00  | 33.35 |
| Mean                     | 54.68          | 58.00  |       |

Table 4. Effect of Mycorrhiza, microbin and TDZ on soil dehydrogenase activity (µg TPF/g dry soil/hr) cultivated with celery plants (50 days after transplanting) grown under two levels of NPK during 2014/2015 and 2015/2016 seasons.

| Treatment                | Growing season |       |       |       |
|--------------------------|----------------|-------|-------|-------|
|                          | 2014-2015      | 2015-2016 | Mean  |
| Control                  | 19.80          | 25.20  | 22.50 |
| full dose                | 70.8           | 75.3   | 73.05 |
| full + my                | 93.92          | 98.16  | 96.04 |
| full + mi                | 77.7           | 83.5   | 80.6  |
| full + TDZ               | 65.85          | 69.5   | 67.675|
| full + my + mi           | 119.5          | 126.9  | 123.2 |
| full + my + TDZ          | 100.18         | 115.2  | 107.69|
| half dose                | 32.2           | 38.00  | 35.1  |
| half + my                | 54.8           | 58.9   | 56.85 |
| half + mi                | 49.6           | 53.12  | 51.36 |
| half + TDZ               | 40.3           | 44.3   | 42.3  |
| half + my + mi           | 74.7           | 79.8   | 77.25 |
| half + my + TDZ          | 61.4           | 64.9   | 63.15 |
| half + mi + TDZ          | 55.9           | 59.8   | 57.85 |
| Mean                     | 72.73          | 78.01  | 75.40 |

Table 5. Effect of Mycorrhiza, microbin and TDZ on soil nitrogenase activity (nmol C₂H₄/g soil/hr) cultivated with celery plants (50 days after transplanting) grown under two levels of NPK during 2014/2015 and 2015/2016 seasons.

| Treatment                | Growing season |       |       |       |
|--------------------------|----------------|-------|-------|-------|
|                          | 2014-2015      | 2015-2016 | Mean  |
| Control                  | 38.4           | 42.5   | 39.45 |
| full dose                | 70.8           | 76.3   | 73.55 |
| full + my                | 93.92          | 99.16  | 96.04 |
| full + mi                | 77.7           | 83.5   | 80.6  |
| full + TDZ               | 65.85          | 69.5   | 67.675|
| full + my + mi           | 119.5          | 126.9  | 123.2 |
| full + my + TDZ          | 100.18         | 115.2  | 107.69|
| half dose                | 32.2           | 38.00  | 35.1  |
| half + my                | 54.8           | 58.9   | 56.85 |
| half + mi                | 49.6           | 53.12  | 51.36 |
| half + TDZ               | 40.3           | 44.3   | 42.3  |
| half + my + mi           | 74.7           | 79.8   | 77.25 |
| half + my + TDZ          | 61.4           | 64.9   | 63.15 |
| half + mi + TDZ          | 55.9           | 59.8   | 57.85 |
| Mean                     | 72.73          | 78.01  | 75.40 |
### Table 6. Effect of Mycorrhiza, microbin and TDZ on shoot fresh weight (g) of celery plants sampled 2,4 and 6 months after transplanting and grown under two levels of NPK during 2014/2015 and 2015/2016 seasons.

| Treatment          | Growing season |        |
|--------------------|----------------|--------|
|                    | 2014-2015      | 2015-2016 |
| Control            | 88.60          | 89.90  |
| full dose          | 171.9          | 175.3  |
| full + my          | 273.16         | 278.3  |
| full + mi          | 488.2          | 492.2  |
| full + TDZ         | 158.7          | 161.1  |
| full + my + mi     | 558.18         | 572.9  |
| full + my + TDZ    | 299.4          | 303.6  |
| full + mi + TDZ    | 469.27         | 476.2  |
| half dose          | 104.9          | 112.8  |
| half + my          | 233.37         | 269    |
| half + mi          | 392            | 399    |
| half + TDZ         | 131.33         | 136.4  |
| half + my + mi     | 388.9          | 395.8  |
| half + my + TDZ    | 227.2          | 239.8  |
| half + mi + TDZ    | 437.5          | 442.2  |
| Mean               | 331.19         | 340.79 |

Table 7. Effect of Mycorrhiza, microbin and TDZ on root fresh weight (g) of celery plants sampled 2,4 and 6 months after transplanting and grown under two levels of NPK during 2014/2015 and 2015/2016 seasons.

| Treatment (A) | Growing season |
|---------------|----------------|
|               | 2014-2015      | 2015-2016 |
| Control       | 36.25          | 130.6    |
| full dose     | 40             | 128      |
| full + my     | 47             | 215      |
| full + mi     | 42             | 195      |
| full + TDZ    | 41             | 185      |
| full + my + mi| 80             | 255      |
| full + my + TDZ| 60            | 245      |
| half dose     | 40.5           | 150      |
| half + my     | 47             | 162      |
| half + mi     | 46             | 155      |
| half + TDZ    | 45             | 153      |
| half + my + mi| 49.8           | 170      |
| half + my + TDZ| 48.9           | 168     |
| half + mi + TDZ| 47.5           | 165      |
| Mean          | 51.65          | 189.733  |

L.S.D.0.05 a=6.71 b=3.21 ab= 11.01 a=7.2 b=3.30 ab=12.2
### Table 8. Effect of Mycorrhiza, microbin and TDZ on mean dry weight of shoots (g/plant) of celery plants sampled 2, 4 and 6 months after transplanting and grown under two levels of NPK during 2014/2015 and 2015/2016 seasons.

| Treatment (A) | Growing season | 2014-2015 | 2015-2016 |
|--------------|----------------|-----------|-----------|
|              | Sampling data (month) (B) | 2 | 4 | 6 mean | 2 | 4 | 6 mean |
| Control      | 3.3 | 6.9 | 38 | 16.1 | 3.80 | 7.20 | 40 | 17 |
| full dose    | 7  | 14.7 | 49 | 23.57 | 7.4 | 15.3 | 50 | 32.65 |
| full + my    | 7.8 | 15.9 | 50 | 24.57 | 8 | 16.2 | 50 | 33.1 |
| full + mi    | 7.5 | 15.6 | 48 | 23.70 | 7.9 | 15.8 | 52 | 33.9 |
| full + TDZ   | 7.2 | 14.8 | 40 | 20.67 | 7.8 | 15.5 | 50 | 32.75 |
| full + mi + mi | 8  | 16.2 | 60 | 28.07 | 9 | 17.2 | 62 | 39.6 |
| full + my + mi | 7.8 | 15.4 | 55 | 26.07 | 8.8 | 17.3 | 58 | 37.65 |
| full + mi + TDZ | 7.5 | 15.5 | 54 | 25.67 | 8.3 | 17.9 | 56 | 36.95 |
| half dose    | 4  | 9.4 | 40 | 17.80 | 5 | 9.2 | 40 | 26.1 |
| half + my    | 4.4 | 9  | 49 | 20.80 | 5.2 | 11 | 50 | 30.5 |
| half + mi    | 4.2 | 8.6 | 46 | 19.60 | 5.1 | 9.4 | 48 | 28.7 |
| half + TDZ   | 4.1 | 8.5 | 45 | 19.20 | 4.8 | 9.6 | 40 | 24.8 |
| half + mi + mi | 4.7 | 8.8 | 46 | 18.30 | 5 | 9.2 | 40 | 26.1 |
| half + my + TDZ | 5  | 10.4 | 50 | 21.80 | 5.7 | 10.9 | 52 | 31.45 |
| half + my + mi + TDZ | 4.8 | 10.2 | 48 | 21.00 | 5.5 | 10.5 | 50 | 30.25 |
| half + mi + TDZ | 4.7 | 10 | 46 | 20.23 | 5.3 | 10 | 49 | 29.5 |

Mean 6.15 | 12.71 | 49.47 | 6.86 | 13.55 | 51.67

L.S.D.0.05 a=0.95 b=0.43 ab=1.63 a=1.22 b=0.64 ab=1.96

### Table 9. Effect of Mycorrhiza, microbin and TDZ on root dry weight (g) of celery plants sampled 2, 4 and 6 months after transplanting and grown under two levels of NPK during 2014/2015 and 2015/2016 seasons.

| Treatment (A) | Growing season | 2014-2015 | 2015-2016 |
|--------------|----------------|-----------|-----------|
|              | Sampling data (month) (B) | 2 | 4 | 6 mean | 2 | 4 | 6 mean |
| Control      | 3.90 | 18.30 | 57.00 | 26.4 | 4.20 | 19.00 | 57.00 |
| full dose    | 4.20 | 24.65 | 100.00 | 42.95 | 4.60 | 26.00 | 104.00 |
| full + my    | 5.00 | 31.15 | 119.00 | 51.71 | 5.50 | 32.00 | 122.00 |
| full + mi    | 4.70 | 27.80 | 113.00 | 48.5 | 5.40 | 29.00 | 116.00 |
| full + TDZ   | 4.50 | 36.40 | 107.00 | 49.3 | 5.20 | 28.00 | 118.00 |
| full + mi + mi | 9.30 | 35.00 | 165.00 | 69.76 | 11.00 | 38.00 | 170.00 |
| full + my + mi | 7.80 | 32.80 | 140.00 | 59.93 | 9.00 | 37.00 | 145.00 |
| full + my + TDZ | 6.70 | 21.40 | 123.00 | 50.36 | 7.80 | 33.00 | 126.00 |
| half dose    | 4.00 | 23.30 | 63.00 | 30 | 5.00 | 23.00 | 70.00 |
| half + my    | 4.70 | 22.00 | 74.00 | 33.56 | 5.80 | 25.00 | 77.00 |
| half + mi    | 4.50 | 21.25 | 71.00 | 32.25 | 5.20 | 24.00 | 74.00 |
| half + TDZ   | 4.30 | 24.00 | 67.00 | 31.76 | 5.20 | 23.00 | 71.00 |
| half + my + mi | 5.80 | 24.00 | 81.00 | 36.93 | 6.20 | 25.00 | 84.00 |
| half + my + TDZ | 5.50 | 23.50 | 79.00 | 36 | 6.00 | 24.00 | 82.00 |
| half + mi + TDZ | 5.30 | 24.8 | 77.00 | 35.7 | 6.00 | 24.00 | 80.00 |

Mean 5.78 | 27.60 | 101 | 6.55 | 26.75 | 105.32

L.S.D.0.05 a=2.44 b=1.22 ab=4.63 a=3.10 b=1.7 ab=5.10


| Sampling data (month) (B) | 2 | 4 | 6 | mean | 2 | 4 | 6 | Mean |
|--------------------------|---|---|---|------|---|---|---|------|
| Control                  | 0.60 | 1.55 | 6.50 | 2.88 | 0.67 | 1.70 | 6.50 | 2.95 |
| full dose                | 1.20 | 2.50 | 8.20 | 3.96 | 1.40 | 3.00 | 9.20 | 4.53 |
| full + my                | 1.35 | 2.70 | 8.40 | 4.15 | 1.50 | 3.20 | 9.40 | 4.7  |
| full + mi                | 1.25 | 2.60 | 8.00 | 3.95 | 1.40 | 3.10 | 9.00 | 4.5  |
| full + TDZ               | 1.20 | 2.46 | 6.60 | 3.42 | 1.40 | 3.00 | 7.90 | 4.1  |
| full + my + mi           | 1.40 | 2.75 | 10.00| 4.71 | 1.60 | 3.40 | 11.20| 5.4  |
| full + my + TDZ          | 1.37 | 2.60 | 9.90 | 4.62 | 1.50 | 3.20 | 10.30| 5.00 |
| full + mi + TDZ          | 1.30 | 2.58 | 5.50 | 3.12 | 1.10 | 2.00 | 7.60 | 4.7  |
| full + TDZ               | 1.46 | 1.98 | 8.07 | 2.86 |
| Mean                     |     |     |     |      |     |     |     |      |
| L.S.D.0.05 a=0.51 b=0.27 ab=0.72 a=0.55 b=0.30 ab=0.78 |

Table 10. Effect Myco, micro and TDZ on plant height (cm) of celery at different sampling periods and grown under two levels of NPK during 2014/2015 and 2015/2016 seasons. Effect of Mycorrhiza, microbin and TDZ on shoot height(cm) of celery plants sampled 2, 4 and 6 months after transplanting and grown under two levels of NPK during 2014/2015 and 2015/2016 seasons.

| Growing season | 2014-2015 | 2015-2016 |
|----------------|-----------|-----------|
| Control        | 12.00     | 73.00     |
| full dose      | 25.00     | 146.00    |
| full + my      | 25.00     | 152.00    |
| full + mi      | 28.00     | 150.00    |
| full + TDZ     | 27.00     | 150.00    |
| full + my + mi | 32.00     | 164.00    |
| full + mi + TDZ| 30.00     | 158.00    |
| half dose      | 15.00     | 79.00     |
| half + my      | 17.00     | 84.00     |
| half + mi      | 17.00     | 83.00     |
| half + TDZ     | 16.00     | 80.00     |
| half + my + mi | 19.00     | 90.00     |
| half + my + TDZ| 18.00     | 88.00     |
| half + mi + TDZ| 17.00     | 85.00     |
| Mean           | 23.13     | 73.13     |
| L.S.D.0.05 a=6.63 b=3.09 ab=12.12 a=7.22 b=3.61 ab=13.10 |
Table 11. Effect of Mycorrhiza, microbin and TDZ on number of umbel/plant of celery plants grown under two levels of NPK during 2014/2015 and 2015/2016 seasons.

| Treatment               | Growing season |         |         |         |
|-------------------------|----------------|---------|---------|---------|
|                         | 2014-2015      | 2015-2016 | mean    |         |
| Control                 | 185.00         | 190.00  | 187.5   |         |
| full dose               | 312.00         | 322.00  | 317     |         |
| full + my               | 373.00         | 377.00  | 375     |         |
| full + mi               | 356.00         | 361.00  | 358.5   |         |
| full + TDZ              | 342.00         | 347.00  | 344.5   |         |
| full + my + mi          | 392.00         | 402.00  | 397     |         |
| full + my + TDZ         | 380.00         | 384.00  | 382     |         |
| full + mi + TDZ         | 377.00         | 380.00  | 378.5   |         |
| half dose               | 226.00         | 230.00  | 228     |         |
| half + my               | 238.00         | 244.00  | 241     |         |
| half + mi               | 236.00         | 240.00  | 238     |         |
| half + TDZ              | 230.00         | 235.00  | 232.5   |         |
| half + my + mi          | 268.00         | 272.00  | 270     |         |
| half + my + TDZ         | 252.00         | 263.00  | 257.5   |         |
| half + mi + TDZ         | 252.00         | 260.00  | 256     |         |
| Mean                    | 284.2          | 319     |         |         |
| L.S.D.0.05              | 7.95           | 9.15    |         |         |
Table 1. Effect of Mycorrhiza, microbin and TDZ on seed yield (g/plant) of celery plants grown under two levels of NPK during 2014/2015 and 2015/2016 seasons.

| Treatment       | Growing season |          |          |
|-----------------|----------------|----------|----------|
|                 | 2014-2015      | 2015-2016| mean     |
| Control         | 40.30          | 45.90    | 43.1     |
| full dose       | 58.60          | 108.12   | 83.36    |
| full + my       | 118.40         | 122.70   | 120.55   |
| full + mi       | 112.20         | 118.20   | 115.2    |
| full + TDZ      | 105.90         | 115.50   | 110.7    |
| full + my + mi  | 128.80         | 132.42   | 130.61   |
| full + my + TDZ | 125.70         | 127.00   | 126.35   |
| full + mi + TDZ | 123.50         | 125.60   | 124.55   |
| half dose       | 52.90          | 57.80    | 55.35    |
| half + my       | 59.90          | 63.90    | 61.9     |
| half + mi       | 56.40          | 61.90    | 59.15    |
| half + TDZ      | 55.50          | 61.30    | 58.4     |
| half + my + mi  | 70.70          | 59.50    | 65.1     |
| half + my + TDZ | 66.30          | 77.00    | 71.65    |
| half + mi + TDZ | 60.40          | 72.30    | 66.35    |
| Mean            | 86.43          | 95.14    |          |

L.S.D.0.05: 7.27 8.97
Table 13. Effect of Mycorrhiza, microbin and TDZ on chlorophyll (a) concentration (mg/g f.wt.) in leaves of celery plants sampled 6 months after transplanting grown under two levels of NPK during 2014/2015 and 2015/2016 seasons.

| Treatment (A)         | Growing season | 2014-2015 | 2015-2016 |
|-----------------------|----------------|-----------|-----------|
|                       | Sampling data (month) (B) | 2 | 4 | 6 | mean | 2 | 4 | 6 | mean |
| Control               |                | 0.39 | 0  | 0  | 0.49 | 2 | 5 | 4 | 0.53 |
| full dose             |                | 0.59 | 0.90 | 1.30 | 0.93 | 0.65 | 1.20 | 1.50 | 1.11 |
| full + my             |                | 0.67 | 1.10 | 1.60 | 1.12 | 0.89 | 1.28 | 1.90 | 1.35 |
| full + mi             |                | 0.67 | 0.98 | 1.5  | 1.05 | 0.85 | 1.20 | 1.80 | 1.28 |
| full + TDZ            |                | 0.66 | 0.93 | 1.45 | 1.01 | 0.89 | 1.20 | 1.80 | 1.29 |
| full + my + mi        |                | 0.85 | 1.30 | 1.80 | 1.31 | 1.42 | 1.40 | 2.00 | 1.6  |
| full + my + TDZ       |                | 0.77 | 1.20 | 1.72 | 1.23 | 1.29 | 1.30 | 1.90 | 1.49 |
| full + mi + TDZ       |                | 0.75 | 1.15 | 1.52 | 1.14 | 1.20 | 1.20 | 1.50 | 1.3  |
| half dose             |                | 0.49 | 0.72 | 0.94 | 0.71 | 0.55 | 0.90 | 1.40 | 0.95 |
| half + my             |                | 0.54 | 0.79 | 1.10 | 0.81 | 0.67 | 0.98 | 1.30 | 0.98 |
| half + mi             |                | 0.50 | 0.73 | 1.00 | 0.74 | 0.60 | 0.88 | 1.20 | 0.89 |
| half + TDZ            |                | 0.50 | 0.65 | 0.99 | 0.71 | 0.65 | 0.85 | 1.10 | 0.86 |
| half + my + mi        |                | 0.55 | 0.72 | 1.20 | 0.82 | 0.65 | 0.85 | 1.20 | 0.90 |
| half + my + TDZ       |                | 0.53 | 0.72 | 1.18 | 0.81 | 0.62 | 0.80 | 1.20 | 0.87 |
| half + mi + TDZ       |                | 0.51 | 0.75 | 1.15 | 0.80 | 0.60 | 0.80 | 1.20 | 0.86 |
| Mean                  |                | 0.59 | 0.92 | 1.35 | 0.83 | 1.08 | 1.45 |       |     |

L.S.D.0.05 a=0.37 b=0.22 ab=0.57 a=0.43 b=0.19 ab=0.71
Table 14. Effect of Mycorrhiza, microbin and TDZ on chlorophyll (b) concentration (mg/g f.wt.) in leaves of celery plants sampled 6 months after transplanting grown under two levels of NPK during 2014/2015 and 2015/2016 seasons.

| Treatment (A) | Growing season |              |              | Sampling data (month) (B) |              |              |              |              |              |              |              |              |              |              |
|---------------|----------------|--------------|--------------|---------------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
|               | 2014-2015 | 2015-2016 |              | 2  | 4  | 6  | mean | 2  | 4  | 6  | mean | 2  | 4  | 6  | mean |
| Control       | 0.15     | 0.20         | 0.25         | 0.20 | 0.17 | 0.20 | 0.29 | 0.23 | 0.29 | 0.23 | 0.20 | 0.17 | 0.20 | 0.17 |
| full dose     | 0.30     | 0.39         | 0.50         | 0.39 | 0.32 | 0.41 | 0.54 | 0.42 | 0.42 | 0.42 | 0.30 | 0.39 | 0.50 | 0.46 |
| full + my     | 0.31     | 0.46         | 0.55         | 0.44 | 0.33 | 0.48 | 0.58 | 0.46 | 0.46 | 0.46 | 0.31 | 0.40 | 0.52 | 0.42 |
| full + mi     | 0.29     | 0.40         | 0.52         | 0.40 | 0.31 | 0.42 | 0.55 | 0.42 | 0.42 | 0.42 | 0.29 | 0.40 | 0.52 | 0.42 |
| full + TDZ    | 0.28     | 0.38         | 0.50         | 0.38 | 0.30 | 0.40 | 0.53 | 0.41 | 0.41 | 0.41 | 0.28 | 0.38 | 0.50 | 0.46 |
| full + my + mi| 0.35   | 0.43         | 0.60         | 0.48 | 0.37 | 0.51 | 0.63 | 0.50 | 0.50 | 0.50 | 0.35 | 0.43 | 0.60 | 0.50 |
| full + my + TDZ| 0.33    | 0.43         | 0.58         | 0.44 | 0.34 | 0.45 | 0.60 | 0.46 | 0.46 | 0.46 | 0.33 | 0.43 | 0.58 | 0.46 |
| full + mi + TDZ| 0.32  | 0.42         | 0.58         | 0.44 | 0.35 | 0.44 | 0.58 | 0.45 | 0.45 | 0.45 | 0.32 | 0.42 | 0.58 | 0.45 |
| half dose     | 0.20     | 0.30         | 0.36         | 0.28 | 0.23 | 0.32 | 0.40 | 0.30 | 0.30 | 0.30 | 0.20 | 0.30 | 0.36 | 0.30 |
| half + my     | 0.23     | 0.36         | 0.40         | 0.33 | 0.26 | 0.38 | 0.44 | 0.36 | 0.36 | 0.36 | 0.23 | 0.36 | 0.40 | 0.36 |
| half + mi     | 0.20     | 0.32         | 0.40         | 0.30 | 0.22 | 0.34 | 0.44 | 0.33 | 0.33 | 0.33 | 0.20 | 0.32 | 0.40 | 0.33 |
| half + TDZ    | 0.20     | 0.30         | 0.40         | 0.30 | 0.22 | 0.32 | 0.45 | 0.33 | 0.33 | 0.33 | 0.20 | 0.30 | 0.40 | 0.33 |
| half + my + mi| 0.27   | 0.37         | 0.47         | 0.37 | 0.30 | 0.39 | 0.50 | 0.39 | 0.39 | 0.39 | 0.27 | 0.37 | 0.47 | 0.39 |
| half + my + TDZ| 0.27  | 0.36         | 0.45         | 0.36 | 0.30 | 0.38 | 0.48 | 0.38 | 0.38 | 0.38 | 0.27 | 0.36 | 0.47 | 0.38 |
| half + mi + TDZ| 0.25 | 0.34         | 0.43         | 0.34 | 0.27 | 0.36 | 0.47 | 0.36 | 0.36 | 0.36 | 0.25 | 0.34 | 0.43 | 0.36 |
| Mean          | 0.28     | 0.39         | 0.49         | 0.30 | 0.20 | 0.30 | 0.53 | 0.42 | 0.42 | 0.42 | 0.28 | 0.39 | 0.49 | 0.53 |

L.S.D.0.05 a=0.10  b=0.06  ab=0.14  a=0.20  b=0.12  ab=0.27
Table 15. Effect of Mycorrhiza, microbin and TDZ on carotenoid concentration (mg/g f.wt.) in leaves of celery plants sampled 6 months after transplanting grown under two levels of NPK during 2014/2015 and 2015/2016 seasons.

| Treatment (A)         | 2014-2015 | 2015-2016 |
|-----------------------|-----------|-----------|
|                       | 2         | 4         | 6         | mean | 2         | 4         | 6         | mean |
| Control               | 0.22      | 0.25      | 0.28      | 0.25  | 0.26      | 0.29      | 0.34      | 0.29  |
| full dose             | 0.41      | 0.54      | 0.70      | 0.55  | 0.44      | 0.60      | 0.84      | 0.62  |
| full + my             | 0.45      | 0.60      | 0.75      | 0.60  | 0.47      | 0.71      | 0.86      | 0.68  |
| full + mi             | 0.43      | 0.58      | 0.74      | 0.58  | 0.45      | 0.69      | 0.87      | 0.67  |
| full + TDZ            | 0.42      | 0.56      | 0.762     | 0.58  | 0.44      | 0.66      | 0.85      | 0.65  |
| full + my + mi        | 0.48      | 0.66      | 0.82      | 0.65  | 0.50      | 0.75      | 1.00      | 0.75  |
| full + my + TDZ       | 0.47      | 0.64      | 0.80      | 0.63  | 0.49      | 0.77      | 0.97      | 0.74  |
| full + mi + TDZ       | 0.46      | 0.62      | 0.79      | 0.62  | 0.48      | 0.70      | 0.95      | 0.71  |
| half dose             | 0.30      | 0.37      | 0.40      | 0.35  | 0.33      | 0.42      | 0.46      | 0.40  |
| half + my             | 0.32      | 0.39      | 0.50      | 0.40  | 0.34      | 0.43      | 0.59      | 0.45  |
| half + mi             | 0.31      | 0.37      | 0.49      | 0.39  | 0.33      | 0.42      | 0.57      | 0.44  |
| half + TDZ            | 0.30      | 0.36      | 0.47      | 0.37  | 0.37      | 0.41      | 0.55      | 0.44  |
| half + my + mi        | 0.35      | 0.36      | 0.46      | 0.38  | 0.35      | 0.42      | 0.54      | 0.43  |
| half + my + TDZ       | 0.34      | 0.35      | 0.45      | 0.38  | 0.35      | 0.41      | 0.53      | 0.43  |
| half + mi + TDZ       | 0.33      | 0.35      | 0.45      | 0.37  | 0.35      | 0.40      | 0.50      | 0.41  |
| Mean                  | 0.37      | 0.47      | 0.62      | 0.42  | 0.56      | 0.73      |

L.S.D.0.05 a=0.13 b=0.07 ab=0.20 a=0.18 b=0.15 ab=0.27
Table 16. Effect Myco, micro and TDZ on nitrogen % in dry shoots of celery at different sampling periods and grown under two levels of NPK during 2014/2015 and 2015/2016 seasons.

| Treatment (A) | 2014-2015 | 2015-2016 |
|---------------|-----------|-----------|
|               |           |           |
| Growing season|           |           |
|               | 2  4  6  mean | 2  4  6  mean |
| Control       | 1.10 1.13 1.20 1.14 1.22 1.38 1.45 1.35 |
| full dose     | 2.50 3.10 3.65 3 2.40 3.40 3.90 3.2 |
| full + my     | 2.80 3.50 4.30 3.5 2.90 3.78 4.50 3.7 |
| full + mi     | 2.60 3.30 4.17 3.3 2.70 3.60 4.30 3.5 |
| full + TDZ    | 2.50 3.20 4.00 3.2 2.60 3.50 4.10 3.4 |
| full + my + mi| 3.40 4.60 5.40 4.4 3.70 4.55 6.70 4.9 |
| full + my + TDZ| 3.00 4.20 4.90 4 3.50 4.43 6.20 4.71 |
| full + mi + TDZ| 1.90 4.00 4.50 3.4 3.20 4.20 5.90 4.4 |
| half dose     | 1.35 1.70 2.15 1.7 1.48 1.80 2.20 1.82 |
| half + my     | 1.68 2.00 2.30 1.99 1.76 2.22 2.40 2.1 |
| half + mi     | 1.63 1.80 2.10 1.84 1.70 2.12 2.30 2.04 |
| half + TDZ    | 1.52 1.60 1.90 1.67 1.65 2.00 2.16 1.93 |
| half + my + mi| 1.91 2.30 2.60 2.27 2.45 2.75 2.50 2.56 |
| half + my + TDZ| 1.85 2.20 2.50 2.18 2.29 2.60 2.80 2.56 |
| half + mi + TDZ| 1.72 2.10 2.40 2.17 2.21 2.50 2.70 2.47 |
| mean          | 2.00 2.87 3.7 2.55 3.17 3.79 |

L.S.D.0.05 a= 0.37 b=0.16 ab=0.50 a=0.40 b=0.20 ab=0.58
Table 17. Effect of Mycorrhiza, microbin and TDZ on phosphorus concentration (%) in shoot of celery plants sampled 6 months after transplanting grown under two levels of NPK during 2014/2015 and 2015/2016 seasons.

| Treatment (A) | Growing season |           |           |           |           |           |           |           |
|---------------|----------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
|               |                | 2014-2015 |           |           | 2015-2016 |           |           |           |
| Sampling data (month) (B) |  |  |  |  |  |  |  |  |
| Control       | 0.15 | 0.19 | 0.26 | 0.2 | 0.17 | 0.21 | 0.29 | 0.22 |
| full dose     | 0.33 | 0.50 | 0.55 | 0.46 | 0.40 | 0.54 | 0.56 | 0.50 |
| full + my     | 0.38 | 0.58 | 0.65 | 0.53 | 0.46 | 0.62 | 0.63 | 0.57 |
| full + mi     | 0.36 | 0.56 | 0.68 | 0.53 | 0.43 | 0.60 | 0.60 | 0.54 |
| full + TDZ    | 0.35 | 0.54 | 0.62 | 0.50 | 0.41 | 0.58 | 0.60 | 0.53 |
| full + my + mi| 0.45 | 0.66 | 0.70 | 0.60 | 0.55 | 0.70 | 0.77 | 0.67 |
| full + my + TDZ| 0.42 | 0.60 | 0.68 | 0.56 | 0.53 | 0.66 | 0.75 | 0.64 |
| full + mi + TDZ| 0.40 | 0.58 | 0.66 | 0.54 | 0.50 | 0.62 | 0.70 | 0.60 |
| half dose     | 0.23 | 0.29 | 0.36 | 0.29 | 0.27 | 0.32 | 0.38 | 0.32 |
| half + my     | 0.25 | 0.33 | 0.34 | 0.30 | 0.31 | 0.36 | 0.42 | 0.36 |
| half + mi     | 0.25 | 0.31 | 0.36 | 0.31 | 0.30 | 0.33 | 0.42 | 0.35 |
| half + TDZ    | 0.29 | 0.29 | 0.35 | 0.31 | 0.29 | 0.32 | 0.40 | 0.33 |
| half + my + mi| 0.24 | 0.39 | 0.41 | 0.33 | 0.35 | 0.40 | 0.40 | 0.38 |
| half + my + TDZ| 0.27 | 0.36 | 0.38 | 0.33 | 0.33 | 0.38 | 0.42 | 0.37 |
| Mean          | 0.32 | 0.46 | 0.52 | 0.39 | 0.49 | 0.54 |       |       |
| L.S.D.0.05    | a=0.08 | b=0.04 | ab=0.14 | a=0.10 | b=0.08 | ab=0.18 |       |       |
Table 18. Effect of Mycorrhiza, microbin and TDZ on potassium concentration (%) in shoot of celery plants sampled 6 months after transplanting grown under two levels of NPK during 2014/2015 and 2015/2016 seasons.

| Treatment (A) | 2015-2016 | 2014-2015 |
|---------------|-----------|-----------|
|               | 2  | 4  | 6  | mean | 2  | 4  | 6  | mean |
| Control       | 0.65| 0.87| 1.20| 0.90 | 0.72| 1.00| 1.20| 0.97  |
| full dose     | 1.45| 2.00| 2.60| 2.01 | 1.75| 2.30| 2.70| 2.25  |
| full + my     | 1.55| 2.50| 3.00| 2.35 | 1.85| 2.56| 3.10| 2.46  |
| full + mi     | 1.50| 2.30| 2.80| 2.2  | 1.80| 2.53| 3.00| 2.44  |
| full + TDZ    | 1.46| 2.10| 2.70| 2.08 | 1.75| 2.20| 3.10| 2.35  |
| full + my + mi| 1.92| 2.65| 3.00| 2.52 | 2.20| 2.80| 3.50| 2.50  |
| full + my + TDZ| 1.75| 2.47| 2.90| 2.37 | 2.20| 2.70| 3.10| 2.66  |
| full + mi + TDZ| 1.63| 1.34| 2.78| 1.91 |
| half dose     | 0.85| 1.15| 1.50| 1.16 | 0.90| 1.20| 1.40| 1.16  |
| half + my     | 0.92| 1.30| 1.65| 1.29 | 0.95| 1.36| 1.52| 1.27  |
| half + mi     | 0.88| 1.20| 1.55| 1.24 | 1.00| 1.40| 1.60| 1.33  |
| half + TDZ    | 0.86| 1.20| 1.55| 1.20 | 1.00| 1.40| 1.62| 1.34  |
| half + my + mi| 1.10| 1.50| 1.90| 1.50 | 1.10| 1.60| 1.85| 1.51  |
| half + my + TDZ| 0.95| 1.40| 1.75| 1.36 | 1.10| 1.50| 1.75| 1.45  |
| half + mi + TDZ| 0.87| 1.32| 1.70| 1.29 | 1.00| 1.43| 1.70| 1.37  |
| Mean          | 1.28| 1.79| 2.29| 1.35 | 2.016| 2.53|

L.S.D.0.05 a=0.57  b=0.24  ab=0.94  a=0.74  b=0.34  ab=1.34
Table 19. Effect of Mycorrhiza, microbin and TDZ on carbohydrate concentration (%) in shoot of celery plants sampled 6 months after transplanting grown under two levels of NPK during 2014/2015 and 2015/2016 seasons.

| Treatment (A) | 2014-2015 | 2015-2016 |
|--------------|-----------|-----------|
|              | 2 | 4 | 6 | mean | 2 | 4 | 6 | mean |
| Control      | 15 | 18 | 21 | 18 | 16 | 19 | 21 | 18.66 |
| full dose    | 25 | 31 | 35 | 30.33 | 27 | 33 | 36 | 32 |
| full + my    | 26 | 34 | 39 | 33 | 30 | 38 | 39 | 35.66 |
| full + mi    | 24 | 32 | 37 | 31 | 28 | 36 | 36 | 33.33 |
| full + TDZ   | 22 | 30 | 35 | 29 | 26 | 35 | 40 | 33.66 |
| full + my + mi | 30 | 37 | 43 | 36.66 | 32 | 40 | 45 | 39 |
| full + my + TDZ | 28 | 35 | 42 | 35 | 30 | 38 | 41 | 36.33 |
| full + mi + TDZ | 25 | 34 | 40 | 33 | 27 | 36 | 39 | 34 |
| half dose    | 17 | 19 | 21 | 19 | 20 | 23 | 28 | 23.66 |
| half + my    | 20 | 24 | 26 | 23.33 | 22 | 25 | 28 | 25 |
| half + mi    | 17 | 22 | 24 | 21 | 20 | 23 | 26 | 23 |
| half + TDZ   | 17 | 22 | 24 | 21 | 19 | 21 | 25 | 21.66 |
| half + my + mi | 25 | 30 | 32 | 29 | 27 | 32 | 35 | 31.33 |
| half + my + TDZ | 23 | 28 | 30 | 27 | 25 | 30 | 34 | 29.66 |
| half + mi + TDZ | 23 | 26 | 28 | 25.66 | 25 | 28 | 31 | 28 |
| Mean         | 24.2 | 30.26 | 34 | 26.73 | 32.66 | 35.8 |

L.S.D.0.05 a=6.30  b=2.40  ab=9.10  a=7.12  b=2.94  ab=10.32
Table 20. Effect of Mycorrhiza, microbin and TDZ on crude protein concentration (%) in shoot of celery plants sampled 6 months after transplanting grown under two levels of NPK during 2014/2015 and 2015/2016 seasons.

| Treatment (A) | Growing season |
|---------------|----------------|
|               | 2014-2015       | 2015-2016       |
|               | 2 4 6 mean      | 2 4 6 mean      |
| Control       | 6.88 7.06 7.50 7.14 7.63 8.63 9.06 8.44 |
| full dose     | 15.63 19.38 22.81 19.27 15.00 21.25 24.38 20.21 |
| full + my     | 17.50 21.88 26.88 22.08 18.13 23.63 28.13 23.29 |
| full + mi     | 16.25 20.63 26.06 20.98 16.88 22.50 26.88 22.08 |
| full + TDZ    | 15.63 20.00 25.00 20.21 16.25 21.88 25.63 21.25 |
| full + my + mi| 21.25 28.75 33.75 27.91 23.13 28.44 41.88 31.15 |
| full + mi + TDZ | 18.75 26.25 30.63 25.21 21.88 27.69 38.75 29.44 |
| half dose     | 8.44 10.63 13.44 10.83 9.25 11.25 13.75 11.41 |
| half + my     | 10.50 12.50 14.38 12.46 11.00 13.88 15.00 13.29 |
| half + mi     | 10.19 11.25 13.13 11.52 10.63 13.25 14.38 12.75 |
| half + TDZ    | 9.50 10.00 11.88 10.46 10.31 12.50 13.50 12.10 |
| half + my + mi| 11.94 14.38 16.25 14.19 15.31 17.19 15.63 16.04 |
| half + mi + TDZ| 11.56 13.75 15.63 13.64 14.31 16.25 17.50 16.02 |
| mean          | 13.92 17.97 21.13 15.95 19.85 23.69              |

L.S.D.0.05 a=3.35  b=1.23  ab=4.22  a=4.45  b=1.75  ab=5.80

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الملخص العربي

تأثير التسميد الحيوي والكيماوي والرش بالTDZ على نمو ومحصول نبات الكرفس الأفريقي

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أجريت تجربتان حقيقتان بمزج مركب الدراسات التطبيقية لبحث النباتات الطبية التابع للهيئة القومية للرقابة والبحوث الدوائية خلال موسمي 2014/2015 و2015/2016. تأثير استخدام TDZ بجرعة كاملاً من النيتروجين والفسفور والبوتاسيوم، وكذلك رش النباتات في الريبوتين (النيتروجين واليودجين) ونسبة إضافية جذور الكرفس الأفريقي بالميكرويزة، على نمو ومحصول نبات الكرفس الأفريقي، ورصد عوامل مثل الوزن الجذر، وارتفاع الجذور، والزمن النضج، والزمن النضج لكل نبات، وزمن الري، وعلى بعض الصفات الحمضية والكيميائية (عدد النور، وزمن الري، ونوع النباتات، وزمن النور لكل نبات) وعلى بعض العناصر الكبيرة، مثل نباتات الكيماوي، نباتات النيتروجين، البخور، الكاروتينات، الكاروتينات الليزرية، والكلاسيكية. وأوضحت النتائج أن تأثير TDZ على النباتات المحفولة والمشكلة في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتين، في الريبوتي