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Effect of Nitrogenous Concentration Solutions on Vegetative Growth, Yield And Chemical Characters of Celery (*Apium Graveolens* L.)

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ABSTRACT

Celery (*Apium graveolens* L.), a biennial plant of the Apiaceae family. It is frequently used as a vegetable, spice, and natural medicine in Egypt. The objective of this work was to study the effect of three nitrogenous concentration solutions on vegetative, yield and chemical characters of three celery cultivars under floating hydroponic system. Two experiments were conducted in a completely randomized block design with a split-plot arrangement of treatments at three replications during the winter seasons of 2014 and 2015 in hydroponic floating system in a polyethylene greenhouse. The nutrient solutions with three N-level (90,180 and 270 ppm) were assigned to main plots and three celery hybrids cultivars (Utah, Presedent and Montery) were allocated to subplots**.** The results indicated that the intermediate nitrogen level (180 mg. L^{-1}) brought about the highest significant mean values of plant height, number of leaves/ plant, plant fresh weight and total yield kg.m^{-2}. Data, also, expressed that the lowest nitrogenous levels (90 mg. l^{-1}); gave rise of the highest significant mean values for TSS and pH characters, in both seasons. On the other hand, the three nitrogenous levels didn't differ, significantly, in their effects on V.C, total phenols and acidity characters of celery plants, during both seasons. Also, data showed that "Utah" variety showed the highest significant values for vegetative and total yield characters compared with the other tested hybrids.

INTRODUCTION

Celery (*Apium graveolens* L.), a biennial plant of the Apiaceae family. It is frequently used as a vegetable, spice, and natural medicine in Egypt. Leaves and stalks (petioles) of celery are frequent components of salads and the seeds are used for the treatment of various diseases (Shalaby and El-Zorba, 2010; Helaly *et al*., 2014). Celery is rich in nutrients that help maintain a healthy body (Kreck *et al*., 2006) which is recognized for the content of vitamins A, B_1, B_9, C, E, and K, in addition to the minerals Ca, Mn, Mg, P, Fe, and Zn (Shad *et al*., 2011; Domagala-Swiatkiewicz and Gastol, 2012).

In recent decades, the use of soilless culture in crop production has become common and increased significantly throughout the world, not only for growing seedlings and propagation of plants but also for vegetable production (Grillas *et al*. 2001). Its main objective is to give optimal conditions to roots, for the sake of enhancing the growth and development of the whole plant and obtaining high yields of the economically useful part of plant (El-Behairy, 1994; 2001 and Singer, *et al*., 2009;2015).

Soilless culture system, the most intensive production method in today's horticulture industry enables application of specific quality management (Rouphale and Colla, 2005). A floating system is one of the simplest soilless cultivation technique, where plants are grown on trays, polystyrene beds that float over a basin, or fissured polystyrene panels continuously float on a water bed or nutrient solution with a number of advantages compared to cultivation in soil (Balanza *et al*., 2012 and JAKŠE *et al*.,2013). In this way the water surface is completely covered by the floating bed, which allows a very limited growth of algae, and at the same time the nutritive solution is oxygenated by a pump to allow better conditions in the liquid medium. It is an inexpensive and easy hydroponic technique mainly used to produce small-size leafy (baby leaf species) or ready-to-use vegetables and short culture cycle and with high plant density (Nicola *et al*., 2004; 2005 and Kovacic *et al*., 2015).

In this respect, many studies have been carried out to improve the nutritional value of vegetables in soilless culture by changing substrate composition, nutrient solution management, etc. (Marsic and Osvald,2002 and Cross *et al*., 2007). Several studies reported that in general plants produced from soilless culture had a lower dry weight and leaf area, however, significantly higher productivity were observed at harvest (Frezza *et al*., 2005).

Vegetative growth, total yield, earlier yield and yield quality components of crops grown in soilless was higher than those grown from soil-based plants as reported by Rumple *et al*. (1996) on tomato; El-Shinawy and Gawish (2006) on lettuce; Al-Harbi *et al*. (1996) on cucumber, El-Behairy *et al*. (2001) and Singer *et al*. (2009, 2015) on cantaloupe; In addition soil grown lettuce has statistically higher content of zinc and iron whereas, hydroponics grown lettuce has a higher contents of N, P, K, Ca, Cu, Mg and Mn (Santos *et al*., 2003).

Nitrogen is considered one of the major plant nutrients for various vegetable crops production with a maximum quality. Appropriate supplying of nitrogenous fertilization plays on important role for vigorous growth and increased yield (Fontana and Nicola, 2009 and JAKŠE *et al*., 2013). Further, nitrogen deficiency can lower the quality of crops. On the centrally, an excess of nitrogen in the fertilization treatment has a negative effect on the quality, safety, and shelf-life of vegetable products, which has provoked considerable interest in decreasing the nitric nitrogen levels supplied to horticultural crops. It is, also, known that in hydroponic systems, the nitrogen supply has a great influence on the growth and development of horticultural crop plants (Marsic and Osvald, 2002 and Gannella *et al*., 2003). Broad-leaved plants tend to accumulate nitrate, which, following its assimilation, can be reduced to nitrite; this giving rise, by subsequent reaction with amines, to carbogenic nitrosamines (Conversa *et al*., 2004 and Fontana, 2006). Although yield of most vegetables can be increased by the application of high levels of nitrate in the nutrient solution, but this may lead to an accumulation of nitrate in leaves, and the nitrate application itself can cause environmental pollution (Elia *et al*., 1999 and Santamaria *et al*., 2002). Additionally, high nitrate concentrations in leaves are harmful for human health *viz* stomach cancer (Santamaria, 2006).

Lower fertilizer doses and the use of soilless cultivation in greenhouses are advantageous as environmentally-friendly practices since they do not require methyl bromide, used for soil disinfection, and reduce considerably both the contamination of soil by nitrate and the leaching of nitrate to the groundwater, a wide spread problem in Mediterranean regions (Nicola *et al*., 2004 and 2005). Nitrate represents a problem in horticultural crops due to its accumulation and subsequent conversion by humans into toxic substances which can produce illnesses. Due to the possible association between the consumption of nitrate and the development of human diseases (Abd-Elmoniem and El-Behairy, 2004 and Santamaria *et al*., 2001), recently there has been greater control of the levels of nitrate in crops especially for that eaten row. The highest nitrate concentrations (>3000 mg. kg^{-1}) have been found in spinach, lettuce, celery, beet, turnip, radishes, melon, and rhubarb. However, nitrogen concentrations applied depend on agricultural practices, temperature and light in which vegetables are grown, and the concentrations of preexisted nitrate in the soil, fertilizers, and water (Santamaria, 2006).

Monitoring for nitrate in lettuce and spinach has been carried out since1996. Every European unit (EU) member state is required to report levels of nitrate in lettuce and spinach as part of European Commission Regulations. Besides that, some countries have, also, fixed maximum levels for other vegetables. For celery, levels slower than 3000 ppm on a fresh weight basis have been established in Germany, The Netherlands, and Belgium as a safe limit for human consumption (Burns *et al*., 1999). For celery, it has been shown that nitrogen fertilization clearly influences the total nitrate content (Gomez *et al*., 2003). Dependent on the substrate utilized, mineral elements may be absorbed better. Besides, substrates reduce the pollution on soil and water (Madrid *et al*., 1999).

Siomos *et al*. (2001) indicated that plants from a soilless culture had higher nitrate, total nitrogen, phosphorus and potassium content compared to plants harvested from soil culture. In this culture system, high concentration of nitrogenous fertilizer enhances the vegetative growth, which reduce the penetration of light intensity to the whole canopy due to huge foliage and thus reduce the accumulation of ascorbic acid in shaded parts. Enhanced growth of plants due to nitrogenous fertilizer may also have a relative dilution effect in plant tissue. Therefore, excess use of nitrogenous fertilizer increases the concentration of nitrate in plant tissue and simultaneously decreases ascorbic acid, it may have double negative effect on the quality of plant foods (Lee and Kader., 2000).

The objective of this work was to study the effect of three nitrogenous concentration solutions on vegetative, yield and chemical characters of three celery cultivars under floating hydroponic system.

MATERIALS AND METHODS

1-Plant material and culture:

Two experiments were conducted during the winter seasons of 2014 and 2015 in hydroponic floating system in a non-heated greenhouse covered with plastic at private farm, Oxygen hydroponic farm, El-Amreya, Alexandria governorate, Egypt. The experimental design was a completely randomized block design with a split-plot arrangement of treatments at three replications**.**

The nutrient solutions with three N-level (90,180 and 270 ppm) were assigned to main plots and three celery hybrids cultivars (Utah, Presedent and Montery) were allocated to subplots**.** Celery variety seeds were sown on 1st October, and harvest plants in 30th November, during both growing seasons in a plastic pots (7.2 cm diameter and 9 cm height) filled with perlite media, each pot received 10 seeds, and watered with water for three weeks. Then the pots putted in holes into Styrofoam trays (50×100 cm) each tray contained 32 pots (the planting density was 640 plants/ m^2). The trays floating in basin was 1.5 m long, 5.0 m wide and 0.4 m deep and filled with 450 liters of water.

2- Nutrient solution management:

The used nutrient solution was adapted from Cooper solution **(Cooper, 1979)**. The composition of the nutrient solution used in this study was ($mmol^{.}l^{-1}$): N 90 or 180 or 270 ppm (nitrate form): P, 2.0; K, 11.0; Ca, 47; Mg, 2.3; S, 2.2; and ($mmol^{.}l^{-1)}$: Fe, 40.1; Mn, 5.0; Cu, 0.8; Zn, 4.o; B, 30.0; Mo, 0.5. The pH of all the nutrient solutions were cheeked every two days and adjusted to 5.5-6.5 by addition of HCl or NaOH at 0.5 N. The solution electrical conductivity (EC) was maintained between 2 - 2.5 dS/m and the pH was adjusted at 5.5 to 6.5, using H_3P0_4, by means of digital EC and pH meter during the whole period of experimental.

3- Data recorded, sampling and analysis: -

In both experiments celery plants were harvested after 60 days, in both growing seasons. Ten randomly selected plants were taken from each sub-plot to determine the vegetative characters as plant height, plant fresh weight, number of leaves/ plant and total yield/m^2. Percentages of dry weights were determined after drying the samples in an electric oven at 75 ± 5 °C until constant weight (A.O.A.C., 1990). The concentration of nitrate in leaves was analyzed, determined calorimetrically, as described by Cataldo *et al*., (1975) stander curve was developed with KNO_3. Nitrate concentration is given on a fresh weight basis (as is customary in commercial practice).

Total soluble solid in the extracted juice which was measured by a refractometer according to the methods of (Cox and Pearson, 1962). Also, pH value was estimated using Beckman pH meter. Titratable acidity was calculated as a percentage of citric acid

(A.O.A.C., 1990). Likewise, a modified method of (Ranganna, 1986) was used for the extraction of vitamin C from fresh vegetables. Measurement of total phenols (expressed as µg. g^{-1}fresh weight) according to (Snell and Snell, 1953) with folin reagent was followed for the determination. Absorption was measured at 660mµ with photoelectric colorimeter and readings were compared with those obtained from pyrogallol standard solution.

4- Statistical analysis:

All data were statistically analyzed by ANOVA following the procedures outlined in Snedecor and Cochran (1980). Means were separated using the revised least significant differences ($LSD_{0.05}$) when an initial F-test indicated differences among averaged values.

RESULTS AND DISCUSSION

1- Vegetative growth and yield characters

The results illustrating the effects of the different nitrogen concentrations and cultivars on vegetative growth and yield characters of celery plants, during the two seasons of 2014 and 2015 are presented in Table (1).

a- Effect of nitrogen concentration:

The data listed in Table (1) showed that nitrogen concentrations expressed significant differences among the three tested levels in most studied vegetative growth characters, during both seasons. Plant height, number of leaves $plant^{-1}$, plant fresh weight and total yield $kg.m^{-2}$; reflected significant increases as a result of raising the nitrogen application level to 180 mg. L^{-1}, whereas, raising nitrogen levels from 180 mg. L^{-1} to 270 mg. L^{-1} gave approximately similar means. With respect of percentage dry weight character, nitrogen levels did not significantly differ from each other, in both growing seasons.

Also, in general, the intermediate nitrogen level (180 mg. L^{-1}) brought about the highest significant mean values of all vegetative and yield characters except percentage of dry weight, during both seasons. Such positive effects of raising nitrogen levels (from 90 mg. L^{-1} to 180 mg. L^{-1}) on various vegetative growth and yield characters, might be taken place due to the role of nitrogen in activating the vegetative growth, where it plays a major role in cell division and elongation, and its associated role in chlorophyll synthesis and subsequent by the process of photosynthesis and carbon dioxide assimilation (Jasso-Chaverria *et al*., 2005). The lowest nitrogen level 90 mg. L^{-1} decreased, significantly, vegetative growth and yield characters. On the contrary, increasing nitrogen level up to 270 mg. L^{-1} doesn't show significant increases. These results, probably, might be attributed to that too high levels of nutrients induce osmotic stress, ion toxicity and nutrient imbalance, which affected negatively on the obtained values due to nutrient deficiencies (Savvas and Adamidis, 1999). The same results were found by (Santamaria *et al*., 2002) they found increasing of vegetative and total yield of rocket by increasing nitrogen concentration.

b- Effect of varieties:

Data outlined in Table (1) illustrated that "Montery" variety, possessed the highest mean significant values of plant height and number of leaves per plant, during both seasons. However, "Utah" variety showed the highest significant values for plant fresh weight and total yield ($kg.m^{-2}$) characters. While "President" variety reflected the highest significant value for dry weight percentage character. These findings may be taken place due to variations among tested varieties, regarding their sensitivity to ionic proportions. The responses, also, may depend on the genetic characteristics of varieties and typologies (Escobar-Gutiérrez *et al*., 2002).

c- Interaction effects between nitrogen concentration and varieties:

The interaction effects between nitrogen levels and tested varieties on vegetative growth and yield characters of celery as listed in Table (1), reflected similar trends for the effects of variety at all nitrogen levels as a result of absence of interaction effects between both tested factors. However, "Montery" variety showed the highest mean values for plant height and number of leaves per plant at all nitrogen concentrations, during both seasons. While, "Utah" variety; gave the highest mean values for plant fresh weight and total yield character at all nitrogen levels, in both seasons. In the case of percentage dry weight characters all varieties showed, approximately, similar means at all nitrogen levels, during both seasons.

2- Chemical characters:

The obtained data showed the effects of the different nitrogenous concentrations and cultivars on chemical characters of celery plants, during both tested seasons of 2014 and 2015, are presented in Table (2).

a- Effect of nitrogen concentration:

The recorded results illustrated that the highest significant estimated values for nitrate content (mg/kg fresh weight) character were obtained from applying the treatments of 180 and 270 mg. l^{-1} nitrogen levels; whereas, the lowest significant values were obtained from the lowest nitrogen levels (90 mg. l^{-1}) in both seasons. This result is agreement with Demsar and Osvald, 2003 in lettuce. Both nitrate supply and light intensity are known to be critical factors in determining nitrate levels in leafy vegetables (Santamaria, 2006; Anjana and Iqbal, 2007). In the present study, increasing the nutrient solution concentration caused a direct proportional increase in nitrate contents, but the nitrate values in leaf tissues were never as high as the limit value of 4500 mg kg-1 fresh weight imposed by the European Community (Parks *et al*., 2008 and Madrid *et al*., 2008).

Data, also, expressed that the lowest nitrogenous levels (90 mg. l^{-1}); gave rise of the highest significant mean values for TSS and pH characters,in both seasons.

On the other hand, the three nitrogenous levels didn't differ, significantly, in their effects on V.C, total phenols and acidity characters of celery plants, during both seasons.

b- Effect of varieties:

Data reflected that the three tested celery varieties didn’t differ, significantly, respecting their contents from nitrate, total phenols and acidity, during both seasons. "Utah" variety exhibited the highest significant TSS mean values compared to the other two varieties, during both studied seasons.

Table 1. Effect of solution nitrogen concentrations and celery cultivars on vegetative growth and yield characters during the seasons of 2014 and 2015.

N level mg. l^{-1}	Variety	Plant height (cm) 2014	Plant height (cm) 2015	No. leaves $Plant^{-1}$ 2014	No. leaves $Plant^{-1}$ 2015	Plant fresh weight (gm) 2014	Plant fresh weight (gm) 2015	Dry weight (%) 2014	Dry weight (%) 2015	Total yield ($Kg.m^{-2}$) 2014	Total yield ($Kg.m^{-2}$) 2015
Main factors effects											
90		21.91 b	22.42 b	9.588 b	9.812 b	4.398 b	4.436 b	5.426 a	5.327 a	2.815 b	2.839 b
180		24.50 a	25.02 a	11.274 a	10.988 a	5.484 b	5.288 a	5.316 a	5.182 a	3.510 a	3.384 a
270		24.09 a	24.60 a	10.756 a	10.766 a	5.640 a	5.426 a	5.462 a	5.360 a	3.610 a	3.473 a
	Utah	23.04 b	23.56 b	9.722 c	9.944 b	5.598 a	5.362 a	5.306 ab	5.202 ab	3.583 a	3.432 a
	Montery	25.83 a	26.34 a	10.888 a	10.922 a	5.266 b	5.322 a	5.003 b	4.904 b	3.370 b	3.406 a
	president	21.63 c	22.14 c	10.466 b	10.700 a	4.658 c	4.466 b	5.893 a	5.762 a	2.981 c	2.858 b
Interaction effects											
	Utah	21.53 e	22.05 e	9.600 c	9.800 c	4.720 ef	4.506 cd	5.673 ab	5.567 ab	3.021 ef	2.884 c
90	Montery	23.48 c	23.99 c	9.466 c	9.734 c	4.500 f	5.000 bc	4.493 b	4.390 b	2.880 f	3.200 bc
	president	20.71 f	21.23 f	9.700 c	9.900 c	3.974 g	3.800 d	6.110 a	6.023 a	2.543 g	2.432 d
	Utah	24.78 b	25.30 b	9.700 c	9.934 c	5.914 ab	5.680 ab	5.130 ab	5.033 ab	3.785 ab	3.635 ab
180	Montery	26.77 a	27.29 a	11.634 a	11.900 a	5.700 bc	5.534 ab	5.193 ab	5.080 ab	3.648 bc	3.542 ab
	president	21.95 e	22.46 e	10.866 b	11.134 b	4.840 e	4.654 c	5.623 ab	5.433 ab	3.098 e	2.979 c
	Utah	22.80 cd	23.33 cd	9.866 c	10.100 c	6.160 a	5.900 a	5.177 ab	5.007 ab	3.942 a	3.776 a
270	Montery	27.24 a	27.74 a	11.566 a	11.134 b	5.600 c	5.434 ab	5.323 ab	5.243 ab	3.584 c	3.478 ab
	president	22.23 de	22.73 de	10.834 b	11.066 b	5.160 d	4.946 bc	5.947 a	5.830 a	3.302 d	3.165 bc

Values having the same alphabetical letter(s) in common, within a particular group of means in each character, do not significantly differ, using revised L.S.D. test at 0.05 level of probability.

Table 2. Effect of solution nitrogen concentrations and celery cultivars on chemical characters during, the seasons of 2014 and 2015.

N level Mg. l^{-1}	Variety	NO_3 (mg. kg^{-1} fw) 2014	NO_3 (mg. kg^{-1} fw) 2015	TSS (%) 2014	TSS (%) 2015	pH 2014	pH 2015	V.C (µg. g^{-1}fw) 2014	V.C (µg. g^{-1}fw) 2015	Total phenols (µg. g^{-1}fw) 2014	Total phenols (µg. g^{-1}fw) 2015	Acidity (%) 2014	Acidity (%) 2015
Main factors effects													
90		624.9 b	638.9 b	2.611 a	2.517 a	8.026 a	8.034 a	12.42 a	12.37 a	0.3429 a	0.3439 a	0.9386 a	0.9344 a
180		1159.0 a	1164.0 a	2.433 b	2.328 b	8.023 a	8.019 b	15.50 a	12.47 a	0.3396 a	0.3398 a	0.9668 a	0.9696 a
270		1196.0 a	1199.0 a	2.467 ab	2.372 b	8.008 a	8.018 b	12.33 a	12.31 a	0.3462 a	0.3468 a	0.9478 a	0.8339 a
	Utah	1013.0 a	1016.0 a	2.622 a	2.533 a	8.011 c	8.018 c	10.76 b	10.79 b	0.3446 a	0.3448 a	0.9788 a	0.8659 a
	Montery	1015.0 a	1019.0 a	2.433 b	2.344 b	8.016 b	8.024 b	12.93 a	12.92 a	0.3197 a	0.3203 a	0.9761 a	0.9760 a
	president	952.6 a	956.7 a	2.456 b	2.339 b	8.030 a	8.029 a	13.57 a	13.43 a	0.3644 a	0.3653 a	0.8982 a	0.8960 a
Interaction effects													
	Utah	643.3 c	645.7 c	2.967 a	2.867 a	8.013 d	8.020 e	10.70 c	10.70 b	0.3593 a	0.3600 a	0.9420 a	0.9427 a
90	Montery	631.3 c	636.7 c	2.400 b	2.317 b	8.027 c	8.033 b	12.40a-c	12.37 ab	0.3170 a	0.3177 a	0.9787 a	0.9697 a
	president	600.0 c	604.3 c	2.467 b	2.367 b	8.037 b	8.050 a	14.17 a	14.03 a	0.3523 a	0.3540 a	0.8950 a	0.8910 a
	Utah	1196.0 ab	1199.0 ab	2.367 b	2.267 b	8.010 e	8.013 g	10.63 c	10.77 b	0.3440 a	0.3437 a	0.9860 a	0.9917 a
180	Montery	1213.0 a	1219.0 a	2.567 b	2.450 b	8.007 f	8.017 f	13.27a-c	13.20 ab	0.3020 a	0.3023 a	0.9983 a	1.0080 a
	president	1069.0 b	1073.0 b	2.367 b	2.267 b	8.053 a	8.027 c	13.60 ab	13.43 ab	0.3727 a	0.3733 a	0.9160 a	0.9093 a
	Utah	1198.0 ab	1202.0 ab	2.533 b	2.467 b	8.010 e	8.020 e	10.93 bc	10.90 b	0.3303 a	0.3307 a	1.0080 a	0.6633 a
270	Montery	1200.0 ab	1203.0 ab	2.533 b	2.267 b	8.013 d	8.023 d	13.13a-c	13.20 ab	0.3400 a	0.3410 a	0.9513 a	0.9507 a
	president	1189.0 ab	1193.0 ab	2.533 b	2.383 b	8.000 g	8.010 h	12.93a-c	12.83 ab	0.3683 a	0.3687 a	0.8837 a	0.8877 a

*** Values having the same alphabetical letter(s) in common, within a particular group of means in each character, do not significantly differ, using revised L.S.D. test at 0.05 level probability.**

While "President" variety gave the highest significant mean values for pH character, in both seasons. The highest significant mean values for V.C character was obtained from both "Montery and President" varieties compared to "Utah" variety that's showed the lowest value, in both seasons. Explanations for these results could be the genetic variations between varieties in their sensitivity to ionic proportions (Escobar-Gutiérrez *et al*., 2002).

Generally, the capability to accumulate NO_3 - varies in the different species and also within the same species according to the cultivar and genotype with different ploidy level (Santamaria *et al*., 2001and Anjana *et al*., 2007). The effect of different fertilization application on vitamin C found in this study, has also been demonstrated in reviewer (Lee and Kader, 2000). Nitrogen fertilizers especially at high rates, seem to decrease the concentration of vitamin C in many fruit and vegetables.

c-Interaction effects between nitrogenous concentrations and varieties:

The different comparisons among the means of the different treatment combinations between nitrogen levels concentrations and celery varieties on the chemicals characters, illustrated the presence of some interaction effects on some chemicals characters as appears in Table (2).The comparisons among the means of celery plants nitrate content, during both seasons, showed that the three tested varieties did not, significantly, differ at the lowest and highest nitrogen levels (90 and 270 mg.l^{-1}), which was not the case at the intermediate level. At the intermediate nitrogen level (180 mg. l^{-1}), in both seasons, both varieties "Utah and Montery" did not, significantly, differ; whereas, "President" variety with intermediate nitrogen level, brought about the lowest mean value of nitrate content. Concerning TSS character, the treatment combination of 90 mg. l^{-1}nitrogen level with "Utah" variety, led to the highest significant mean value, during both seasons, compared with the other treatment combination which did not differ, significantly, one from another. The treatment combinations of nitrogenous levels and varieties; resulted in significant interaction of their effects on the mean values of pH character. "President" variety, had the highest significant pH mean value with the lowest or intermediate nitrogen levels, but "Montery" variety expressed the highest significant pH mean value with the highest nitrogenous level, in both seasons. In the case of vit. C., total phenols and acidity, the data reflecting the absence of clear interaction effects between the two main factors used.

In conclusion, "Utah" variety showed the highest significant values for vegetative and total yield characters compared with the other hybrids. Using the intermediate nitrogen level (180 mg. L^{-1}) brought about the highest significant mean values of plant height, number of leaves/ plant, plant fresh weight and total yield kg.m^{-2} for celery plants growing under floating hydroponics system.

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تأثير تركيزات المحلول النيتروجيني على مواصفات النمو الخضري والمحصول والصفات الكيماوية لمحصول الكرفس

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الكرفس (*Apium graveolens* L.) هو نبات ثنائي الحول يتبع العائلة الخيمية. يتم استخدامه في مصر كخضروات، وفي التوابل، وفي الطب الطبيعي. الهدف الرئيسي من هذه التجربة هو دراسة تأثير ثلاثة محاليل ذات تركيزات مختلفة من النيتروجين على النمو الخضري والمحصول والصفات الكيميائية على ثلاثة أصناف من الكرفس تحت نظام الزراعة المائية العائمة. أجريت تجربتان خلال موسمي الشتاء عام ٢٠١٤ و ٢٠١٥ في نظام الزراعة المائية في ألواح البولي ايثيلين. تم تجهيز محاليل المغذيات بثلاثة مستويات من التيتروجين (٩٠ و١٨٠ و ٢٧٠ جزء في المليون) في القطع الرئيسية وثلاثة هجن من الكرفس أصناف (Utah, Presedent and Montery) تم وضعها في القطع المنشقة. وأشارت النتائج إلى أن المستوى المتوسط من النيتروجين (١٨٠ ملجم/لتر) أدت للحصول على أعلى القيم معنوياً من ارتفاع النبات (سم)، عدد الأوراق / نبات، و الوزن الطازج للنبات (جم) والمحصول الكلي كجم/م[2]. كما أوضحت النتائج أيضا أن إستخدام أقل مستوى من النيتروجين (٩٠ ملجم/لتر) أدى للحصول على أعلى القيم معنوياً من المواد الصلبة الذائبة الكلية ودرجة الحموضة، في كلا الموسمين. من ناحية أخرى، فإن مستويات النيتروجين الثلاثة لم تختلف، معنوياً، في تأثيرها على محتوى الأوراق من فيتامين C، والفينولات الكلية والحموضة لنباتات الكرفس، خلال الموسمين. أيضاً أوضحت النتائج أن الصنف "Utah" أعطى أعلى القيم معنوياً من المجموع الخضري والمحصول الكلي مقارنة بالهجن الأخرى. وتوصي الدراسة بأن استخدام هجين الكرفس "Utah" مع استخدام المحلول المغذي المستخدم ويحتوي تركيز ١٨٠ ملجم/لتر أدى للحصول على أعلى نمو خضري ومحصول وجودة لنباتات الكرفس.