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# EFFECT OF CYANOBACTERIA AS AN ALTERNATIVE SOURCE OF MINERAL NITROGEN ON THE YIELD AND CHEMICAL COMPOSITION OF RED CABBAGE UNDER SOILLESS CULTURE SYSTEM

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## ABSTRACT

A soilless culture experiment was carried out in plastic house of Soils and Water Department, Faculty of Agriculture, Al-Azhar University (Nasr City, Cairo, Egypt) during the winter seasons of 2014 and 2015 to investigate the effect of two cyanobacteria isolates (*Anabaena variabilis* and *Nostoc commune*) as alternative sources of mineral nitrogen on yield and chemical composition of red cabbage (*Brassica oleracea* var *capitata* forma *rubra* L.) cv. Ruby Perection F1 hybrid. Cyanobacteria isolates were introduced to Hoagland nutrient solution minus N, 0.50 or 0.75 strength. Results showed the highest significant values of fresh and dry weights of red cabbage leaves and nitrogen content were found with the addition of *N. commune* to 0.75 strength of Hoagland nutrient solution followed by the addition of *A. variabilis* to 0.75 strength of the nutrient solution followed by full strength of the nutrient solution. While the highest values of anthocyanins and vitamin c were found with addition of either *N. commune* or *A. variabilis* to Hoagland nutrient solution minus N followed by the full nutrient solution. The addition of cyanobacteria isolates to 0.5 strength of Hoagland nutrient solution caused a significant increase in the yield of red cabbage and nitrogen content as compared with half strength of the nutrient solution. On the other hand, the lowest results were recorded with Hoagland nutrient solution minus N, while the addition of *N. commune* or *A. variabilis* to Hoagland nutrient solution minus N caused significant increases in all the tested parameters. The results indicate the importance of cyanobacteria for the quality of the red cabbage yield and reducing the chemical fertilizer input. On the other hand, the relatively reduction in the yield of red cabbage resulted from the addition of cyanobacteria to the nutrient solutions minus nitrogen can be acceptable if we take into consideration the high contents of anthocyanins and vitamin c which act as antioxidants in human diet as well as the low content of nitrate.

***Key words:*** *cyanobacteria, mineral nitrogen, red cabbage, anthocyanins, vitamin c, soilless culture.*

## 1. INTRODUCTION

The chemical nitrogen fertilizers are widely used in agriculture and contribute to considerable part of production costs. Therefore, elevated production costs are mainly a result of the use of chemical nitrogen fertilizers which are used to promote growth of crops and in turn their yield (Ladha and Reddy, 2003; Awodun, 2008). On the other hand, chemical nitrogen fertilizers have many constraints being expensive, harmful to the environment, and their over application can lead to toxic N build up in the cultivated crops, which can affect human health negatively (WHO, 1995; Robert, 1997).

Chemical N fertilizer has limited availability to subsistence farmers as they are unable to afford them (Wagner, 1997). Reducing this expense of chemical nitrogen fertilizers would require alternative sources, which are renewable, inexpensive and readily available. One of the most important sources is microorganisms. Since microorganisms not only reduce the use of chemical fertilizers by circulation of nutrients, but also increase the absorption of some nutrients such as NPK by plant growth promoting bacteria (Dilfuza, 2007). Also, some microorganisms can generate biological nitrogen *via* biological processes such as those involving the symbiotic relationship with plants. On the other hand, cyanobacteria are almost exclusively free-living and ideally suited to an independent existence, but many of them have the capacity to form specific associations with protista, fungi and plants (Rai *et al.,* 2000). Many of them also exhibit biological nitrogen fixation, and have been exploited as biofertilizers in agriculture, wherein they are known to contribute 20-25 kg N/ha/season and enhance soil fertility (Yanni, 1992; Prasanna and Karthik, 2006). Therefore, cyanobacteria offer a suitable alternative source to chemical nitrogen fertilizers and increase the soil productivity both directly and indirectly (Vaishampayan *et al.,* 2001; Mishra and Pabbi, 2004).

Cyanobacteria also possess a tremendous potential for producing a wide range of biologically active molecules such as auxins and gibberellins (Zaccaro *et al.,* 2006). The biocontrol of bacterial and fungal diseases as well as improving soil structure and porosity through secretion of polysaccharides aiding in soil aggregation are among the important functions of cyanobacteria (Karthikeyan *et al.,* 2007; Banerjee and Sarkar, 2008). Cyanobacteria are prominent in habitants of many agricultural soils, where they potentially contribute towards biological nitrogen fixation, help in phosphate solubilization and mineral release to improve soil fertility and crop productivity. However, beside naturally fertilizing and balancing mineral nutrition in the soil, many cyanobacteria are known to release various kinds of biologically active substances like proteins, vitamins, carbohydrates, amino acids, polysaccharides and phytohormones that function as elicitor molecules to promote plant growth and help them to fight against biotic and abiotic stress (Singh, 2014)

The increase in growth parameters like germination rate, shoot length, root length and biomass had been shown to be positively correlated with inoculation by cyanobacteria. Rice plant (*Oryza sativa*) variety (UPR 1823) inoculated with different cyanobacterial strains, showed accumulation of phenylpropanoids, flavonoids, phytohormones and chlorophyll in the leaves of rice plant. Differential systemic accumulation of phenylpropanoids in plant leaves led to conclude that cyanobacterial inoculation correlates positively with plant growth promotion and stress tolerance in rice (Singh *et al.*, 2011). Beneficial effects of cyanobacterial inoculation were reported, not only for rice, but for other crops such as wheat, soybean, oat, tomato, radish, cotton, sugarcane, maize, chili, bean muskmelon and lettuce (Arif *et al*., 1995; Maqubela *et al*., 2008 and Shariatmadari *et al*., 2011).

The aim of the present work was to investigate the effect of two cyanobacteria isolates as alternative sources of mineral nitrogen on yield, anthocyanins, vitamin c, and some nutrient contents of red cabbage plants grown under soilless culture system.

## 2. MATERIALS AND METHODS

An experiment of soilless culture system was carried out in plastic house of Soils and Water Department, Faculty of Agriculture, Al-Azhar University (Nasr City, Cairo, Egypt). The experiment was arranged in a completely randomized block design. Nine treatments were made up as follows: Hoagland nutrient solution minus N, Hoagland nutrient solution minus N plus *A. variabilis* , Hoagland nutrient solution minus N plus *N.commune*, 0.5 strength of Hoagland nutrient solution, 0.5 strength of Hoagland nutrient solution plus *A. variabilis* , 0.5 strength of Hoagland nutrient solution plus *N. commune*, 0.75 strength of Hoagland nutrient solution plus *A. variabilis* , 0.75 strength of Hoagland nutrient solution plus *N. commune*and full strength of Hoagland nutrient solution. Seedlings of red cabbage plant (*Brassica oleracea* var *capitata* forma *rubra* L.) cv. Ruby Perection F1 hybrid were transplanted on winter seasons of 2014 and 2015 in perforated bags (8 cm diameter x 12 cm length) filled with peat moss

**Table (1): Biomass and amounts of fixed nitrogen by cyanobacteria isolates at different times.**

| **Cyanobacteria isolates** | **mg dry weight /100 ml culture** | | | | | | | **mg N /100 ml culture** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Times (weeks)** | | | | | | | | | | | | | |
| | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 2 | 4 | 6 | 8 | 10 | 12 | 14 |
| *A. variabilis* | 75 | 200 | 290 | 350 | 400 | 440 | 450 | 0.54 | 1.52 | 2.66 | 3.75 | 4.54 | 5.12 | 5.52 |
| *N. commune* | 67 | 211 | 280 | 370 | 420 | 450 | 470 | 1.50 | 2.51 | 3.75 | 4.93 | 5.83 | 6.55 | 7.11 |

| | **Phytohormones (µg /100 ml) after 21 days** | | |
|---|---|---|---|
| | **Auxine** | **Gibbrellin** | **Cytokinin** |
| *A. variabilis* | 7.65 | 10.50 | 3.88 |
| *N. commune* | 6.61 | 7.15 | 2.15 |

*A. variabilis =Anabaena variabilis* *N. commune = Nostoc commune* mixed with perlite (1:1v/v). The soilless culture system consists of tubes from plastic (PVC), nutrient solution tank 50 liter (one tank for every tube) and submersible pumps (40 W) to pump the nutrient solution to the upper end of the plastic tube. The nutrient solution returns back to the solution tank by gravity with slop (1.5%). One plant was planted in each bag. The bags were placed in tubes from plastic polyvinylchloride (PVC), which rises from the ground a distance of 50 cm. The final plant spacing in the tube was 25 cm, while the distance between the tubes was 40 cm.

Four salts were used to prepare three different strengths of Hoagland macronutrients solution (0.5, 0.75 and 1.0) as follows: calcium nitrate, potassium nitrate, potassium mono phosphate and magnesium sulphate. Whereas, Hoagland nutrient solution minus N was prepared from the four salts as follows: calcium mono phosphate, calcium sulphate, potassium sulphate and magnesium sulphate. Micronutrients were included according to Hoagland and Arnon (1950). The cyanobacteria isolates (*A. variabilis* or *N. commune*) were added to Hoagland nutrient solutions (minus N, 0.50 and 0.75 strength of the nutrient solution) as one liter of homogenous algal growth per 50 liter of nutrient solution every two weeks. The pH of all nutrient solutions was kept in the range of 5.5 - 6.5. All nutrient solutions were completely renewed every two weeks.

After fourteen weeks from transplanting, the plants were harvested and fresh weight was recorded. Plants were washed with distilled water, dried at 70 $^{o}$C and ground, then plant samples were wet digested using both $HClO_4$ and $H_2SO_4$ acids mixture to determine NPK and micronutrients. Total N was determined by micro Kjeldahe technique (Gerhardt - Vapodest 30S – Germany), total P was determined by Spectrophotometer (JENWAY-Models 670S UV/VIS - UK) and total K was determined by Flame photometer (JENWAY-Models PFP7- UK) according to methods described by Page *et al.* (1982). The micronutrients (Fe, Mn, Zn and Cu) were determined by Inductively Coupled Plasma Spectrometry (ICP) JY JOBIN YVON HORIBA- Model (Ultima 2) France, according to the procedure of EPA (Environmental Protection Agency, 1991). Assessment of $NO_3^-$ in leaves was performed using Brucine method reported by Holty and Potworowski (1972). The outer third and fourth leaves of red cabbage were used to determine total anthocyanins and ascorbic acid according to methods described in AOAC (1990) and expressed as mg/100 g fresh weight. Total sugars were determined in dry weight as described in AOAC (1990) and expressed as g /100 g dry weight. Statistical analysis was carried out by MSTATC and comparisons of means were made using LSD test according to Snedecor and Cocharn (1980).

### 2.1. Isolation and identification of cyanobacteria isolates

Two cyanobacteria isolates (*Anabaena variabilis* and *Nostoc commune*) were isolated from the soils of Kafr El-Sheikh and Mattroh Governorates, respectively. The purified isolates were identified to be *A. variabilis* and *N. commune* by (El-Zawawy 2016). The modified Watanabe medium (Watanabe *et al.*, 1951) as a nitrogen free culture medium was used for the growth of cyanobacteria isolates which consist of the following (g/l): (0.30 $K_2HPO_4$, 0.20 Mg $SO_4.7H_2O$, 0.20 $K_2SO_4$, 0.10 $CaCO_3$, 2.00 glucose), 100 ml of micronutrient solution (g/l): (2.80 $H_3BO_3$, 0.22 Zn $SO_4.7H_2O$, 0.08 Cu $SO_4.5H_2O$, 1.80 $MnCl_2$, 0.02 molybdic acid) and 0.20 ml of Fe $Cl_3$ 1%.

The flasks containing fresh liquid modified Watanabe medium were inoculated with *A. variabilis* or *N. commune* and incubated under artificial illumination (2500 Lux) up to fourteen weeks for growth. The biomass dry weight and the amounts of fixed nitrogen in growth medium of two cyanobacteria isolates were determined at different times (Table 1) according to Page *et al*. (1982). Separation and determination of phytohormones (auxin, geberillin and cytokinin) were carried out by gas liquid chromatography method after 21 days according to Staden *et al.* (1973).

## 3. RESULTS AND DISCUSSION

### 3.1. Effect of cyanobacteria as alternative source of nitrogen in Hoagland solution on fresh and dry weights and nitrate content of red cabbage plants

Data in Table (2) revealed that the addition of *N. commune* or *A. variabilis* to Hoagland nutrient solution minus N caused a significant increase in the fresh and dry weights of red cabbage plants as compared with non-addition of either *N. commune* or *A. variabilis*. Also, the addition of cyanobacteria to either 0.5 or 0.75 strength of Hoagland nutrient solution caused a significant increase in the fresh and dry weights of red cabbage plants as compared with non-addition of them at half and full strength of Hoagland nutrient solution, respectively. It is clear that the differences among treatments were significant. These increases of fresh and dry weights as a result of addition of cyanobacteria might be attributed to fixed nitrogen, which constitutes one of the major yield limiting factors for crop production and growth regulating substances endogenously produced by cyanobacteria (Mahmoud, 2005).

**Table (2): Effect of different treatments on fresh and dry weights and nitrate content of red cabbage plants.**

| Treatments / No. season | Fresh weight (g/plant) | Dry weight (g/plant) | Fresh weight (g/plant) | Dry weight (g/plant) | Nitrate content (mg/kg fresh weight) | |
|---|---|---|---|---|---|---|
| | 2014 | | 2015 | | 2014 | 2015 |
| **Full Hoagland nutrient solution** | 1305.13 | 26.52 | 1312.50 | 28.75 | 381.0 | 374.00 |
| **Hoagland nutrient solution minus N** | 111.29 | 1.55 | 102.00 | 1.620 | ND | ND |
| **Hoagland nutrient solution minus N plus *A. variabilis*** | 822.67 | 10.40 | 810.000 | 11.32 | ND | ND |
| **Hoagland nutrient solution minus N plus *N. commune*** | 916.67 | 14.35 | 922.310 | 15.60 | ND | ND |
| **Half Hoagland nutrient solution** | 1007.09 | 17.25 | 1015.00 | 19.15 | 140.0 | 145.00 |
| **0.5 Hoagland nutrient solution plus *A. variabilis*** | 1094.11 | 20.25 | 1095.67 | 21.65 | 150.67 | 149.00 |
| **0. 5 Hoagland nutrient solution plus *N. commune*** | 1183.93 | 23.20 | 1190.50 | 26.00 | 158.0 | 154.67 |
| **0.75Hoagland nutrient solution plus *A. variabilis*** | 1437.98 | 29.75 | 1406.27 | 32.34 | 264.0 | 253.33 |
| **0.75 Hoagland nutrient solution plus *N. commune*** | 1589.25 | 32.40 | 1761.00 | 34.50 | 275.0 | 258.00 |

These results are also in agreement with those obtained by Sukor (2013) and Mancy and Abdeen (2015) on lettuce plants, who concluded that nitrogen fixation produced by cyanobacteria plays a crucial role in the plant growth, chlorophyll formation, leaf photosynthesis and yield of lettuce plant. The highest significant values of fresh weights (1589.25, ,1761.00 g/plant) and dry weights (32.40, 34.50 g/plant) of red cabbage in two seasons were recorded at 0.75 Hoagland nutrient solution plus *N. commune*, followed by 0.75 Hoagland nutrient solution plus *A. variabilis* (1437.98, 1406.27, 29.75 and 32.34 g/plant), followed by full Hoagland nutrient solution (1305.13, 1312.5, 26.52 and 28.75 g/plant), respectively; while the least values (111.29, 102.00, 1.55 and 1.62 g/plant) were obtained with Hoagland nutrient solution minus N.

Concerning nitrate content in leaves of red cabbage plants data in Table (2) show that the highest contents of $NO_3^-$ (381 and 374 mg /kg fresh weight) were obtained when plants were treated with full Hoagland nutrient solution in comparison with other treatments. Whereas, $NO_3^-$ was not detected at the following treatments; Hoagland nutrient solution minus nitrogen, Hoagland nutrient solution minus nitrogen plus *A. variabilis* and Hoagland nutrient solution minus nitrogen plus *N. commune*. In this concern, European Food Safety Authority (EFSA, 2008) reported that an acceptable daily intake of nitrate from vegetables was 3.7 mg /kg of body weight /day, which equal to 222 mg nitrate per day for a 60 kg adult person. Although highly variable, dietary exposure to nitrate from sources other than vegetables is estimated to be on average in the range of 35-44 mg/person/day of which some 20 mg/person/day is contributed by water. It is worth mentioning that these values were previously identified by the Joint FAO/WHO Expert Committee on Food Additives (FAO/WHO, 2003). They also added that, a toxicological endpoint of concern for nitrate is nitrosamine formation and the potential for tumour formation. However, when nitrate is consumed in a normal diet containing vegetables, other bioactive substances concomitantly consumed, such as the antioxidant vitamin C, may inhibit the endogenous formation of nitrosamines. Based on the above, the importance of cyanobacteria is shown as an alternative source of nitrogen to produce crops containing no nitrate.

### 3.2. Effect of cyanobacteria as alternative source of nitrogen in Hoagland solution on contents of macro and micronutrient of red cabbage plants

Data in Tables (3 and 4) represent the contents of some macro and micronutrient in red cabbage

**Table (3): Effect of different treatments on macronutrient contents of red cabbage plants.**

| Treatments / No. season | N content (%) | | P content (%) | | K content (%) | |
|---|---|---|---|---|---|---|
| | 2014 | 2015 | 2014 | 2015 | 2014 | 2015 |
| **Full Hoagland nutrient solution** | 2.35 | 2.60 | 0.45 | 0.44 | 3.50 | 3.70 |
| **Hoagland nutrient solution minus N** | 0.09 | 0.07 | 0.04 | 0.03 | 1.30 | 1.24 |
| **Hoagland nutrient solution minus N plus *A. variabilis*** | 1.00 | 1.10 | 0.42 | 0.42 | 3.20 | 3.04 |
| **Hoagland nutrient solution minus N plus *N. commune*** | 1.24 | 1.37 | 0.42 | 0.43 | 3.30 | 3.10 |
| **Half Hoagland nutrient solution** | 1.50 | 1.66 | 0.27 | 0.30 | 1.85 | 1.80 |
| **0.5 Hoagland nutrient solution plus *A. variabilis*** | 1.74 | 1.98 | 0.29 | 0.31 | 1.90 | 1.82 |
| **0. 5 Hoagland nutrient solution plus *N. commune*** | 2.01 | 2.29 | 0.30 | 0.32 | 2.00 | 1.85 |
| **0.75Hoagland nutrient solution plus *A. variabilis*** | 2.70 | 2.91 | 0.35 | 0.37 | 2.55 | 2.40 |
| **0.75 Hoagland nutrient solution plus *N. commune*** | 3.06 | 3.32 | 0.36 | 0.36 | 2.60 | 2.44 |
| **LSD at 5%** | 0.22 | 0.23 | 0.04 | 0.04 | 0.47 | 0.42 |

**Table (4): Effect of different treatments on micronutrient contents of red cabbage plants.**

| Treatments / No. season | Fe content (mg/kg) | | Mn content (mg/kg) | | Zn content (mg/kg) | | Cu (mg/kg) | |
|---|---|---|---|---|---|---|---|---|
| | 2014 | 2015 | 2014 | 2015 | 2014 | 2015 | 2014 | 2015 |
| **Full Hoagland nutrient solution** | 141.00 | 161.00 | 108.00 | 120.00 | 84.00 | 90.00 | 54.00 | 45.00 |
| **Hoagland nutrient solution minus N** | 30.00 | 25.00 | 19.00 | 16.00 | 14.00 | 16.00 | 9.00 | 8.00 |
| **Hoagland nutrient solution minus N plus *A. variabilis*** | 132.00 | 153.00 | 102.00 | 119.00 | 80.00 | 88.00 | 51.00 | 44.00 |
| **Hoagland nutrient solution minus N plus *N. commune*** | 138.00 | 157.00 | 104.00 | 116.00 | 83.00 | 91.00 | 53.00 | 47.00 |
| **Half Hoagland nutrient solution** | 75.00 | 94.00 | 57.50 | 71.00 | 42.00 | 49.00 | 27.00 | 23.00 |
| **0.5 Hoagland nutrient solution plus *A. variabilis*** | 80.50 | 97.00 | 61.00 | 73.00 | 45.00 | 48.00 | 29.00 | 25.00 |
| **0. 5 Hoagland nutrient solution plus *N. commune*** | 84.00 | 92.50 | 64.00 | 75.50 | 46.75 | 51.00 | 30.00 | 26.00 |
| **0.75Hoagland nutrient solution plus *A. variabilis*** | 108.90 | 124.00 | 82.00 | 100.00 | 62.00 | 68.00 | 40.00 | 36.00 |
| **0.75 Hoagland nutrient solution plus *N. commune*** | 111.76 | 122.00 | 83.70 | 98.00 | 63.00 | 67.00 | 42.00 | 34.00 |
| **LSD at 5%** | 10.43 | 9.02 | 7.30 | 6.51 | 5.06 | 7.27 | 4.00 | 4.02 |

plants in two seasons of 2014 and 2015 as affected by application of cynobacteria isolates. The contents of nitrogen in seasons 2014 and 2015 showed the same trends of fresh and dry weights of red cabbage plants. These results could be interpreted on the basis that nitrogen is one of the most limiting nutrients in crop production especially with leafy vegetables, where it improves the quality and quantity of dry matter and protein (Uchida, 2000; Tita *et al.,* 2013) and nitrogen is very important as a macronutrient largely involved in metabolic actions and protein synthesis, resulting in increased vegetative and reproductive growth and ultimately leads to yield of the crops (Birkhold and Darnell, 1991 ; Marschner, 1995).

Regarding the effect of cyanobacteria isolates on N content, it is clear that, the highest values in two seasons were obtained due to the addition of *N. commune* to 0.75 strength of Hoagland nutrient solution followed by the addition of *A. variabilis* to 0.75 strength and full Hoagland nutrient solution, respectively; while the lowest values were obtained at Hoagland nutrient solution minus N. Also, the obtained values which affected by other treatments were found to be in between. It is worth motioning that, the high content of nitrogen in leaves of red cabbage with the addition of either *N. commune* or *A. variabilis* to 0.75 strength of Hoagland nutrient solution may be due to the availability of nitrogen from two sources, fixed nitrogen by cyanobacteria and Hoagland nutrient solution.

Concerning phosphorus and potassium contents in leaves of red cabbage, Table (3) show that, the contents of both were in harmony with their concentrations in Hoagland nutrient solution. On the other hand, contents of P and K in leaves under the addition of either *N. commune* or *A. variabilis* to Hoagland nutrient solution minus N were significantly higher than those obtained with Hoagland nutrient solution minus N. This effect may be attributed to growth promotion by the addition of cyanobacteria which fixed and released nitrogen as well as other products in its surrounding environment, therefore positively affected plant growth and nutrients uptake (Ladha and Reddy, 2003). Also, growth regulating substances produced by cyanobacteria play a role on growth promotion and plant nutrition by increasing nutrients uptake by the plants (Dilfuza, 2007). These results are in agreement with those obtained by Mancy and Abdeen (2015) on lettuce plants grown under nutrient film technique as affected by the application of blue green algae. The highest values of P and K contents in leaves of red cabbage in two seasons were recorded when plants were treated with full Hoagland nutrient solution followed by Hoagland nutrient solution plus *N. commune* followed by Hoagland nutrient solution plus *A. variabilis* with no significant differences among them. This effect may be due to contain these treatments on all required nutrients including nitrogen as compared with Hoagland nutrient solution minus N whereas; the lowest values were obtained at treatment of Hoagland nutrient solution minus N.

Concerning micronutrient (Fe, Mn, Zn and Cu) contents in leaves of red cabbage plants, Table (4) show that the contents were associated with their concentrations in the growth media. Where, full Hoagland nutrient solution gave the highest contents of these nutrients followed by treatments of Hoagland nutrient solution minus N which supplemented by cyanobacteria, *N. commune* or *A. variabilis*. While the least values were recorded with Hoagland nutrient solution minus N. These data are in agreement with Alan (2012) who found that the different combinations of Hoagland's solution and *Azolla filiculoides* positively affected the uptake of macro and micronutrients in shoots and roots of *Beta vulgaris* grown in hydroponic cultures.

### 3.3 Effect of cyanobacteria as alternative source of nitrogen in Hoagland solution on contents of anthocynines and ascorbic acid of red cabbage plants.

Data in Table (5) show the contents of anthocynines, ascorbic acid and total sugar in leaves of red cabbage plants as affected by the addition of cyanobacteria isolates to Hoagland nutrient solution in seasons of 2014 and 2015. Contents of anthocynines, ascorbic acid and total sugar significantly increased by the addition of cyanobacteria isolates (*N. commune* or *A. variabilis*) to different treatments of Hoagland nutrient solution as compared with Hoagland nutrient solution minus N. Also, the different treatments can be arranged in the descending order; Hoagland nutrient solution minus N plus *N. commune* > Hoagland nutrient solution minus N plus *A. variabilis* > full Hoagland nutrient solution with non-significant differences among them followed by 0.75 Hoagland nutrient solution plus *N. commune* > 0.75Hoagland nutrient solution plus *A. variabilis* with non-significant differences between them followed by 0. 5 Hoagland nutrient solution plus *N. commune* > 0.5 Hoagland nutrient solution plus *A. variabilis* > half Hoagland nutrient solution with non-significant differences among them, finally Hoagland nutrient solution minus N, respectively.

**Table (5): Effect of different treatments on anthocynines and ascorbic acid levels of red cabbage plants.**

| Treatments / No. season | Anthocynines (mg/100g fresh weight) | | Ascorbic acid (mg/100g fresh weight) | | Total sugars (g /100g dry weight) | |
|---|---|---|---|---|---|---|
| | 2014 | 2015 | 2014 | 2015 | 2014 | 2015 |
| **Full Hoagland nutrient solution** | 105.00 | 110.50 | 40.00 | 42.40 | 14.00 | 15.80 |
| **Hoagland nutrient solution minus N** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Hoagland nutrient solution minus N plus *A. variabilis*** | 108.00 | 116.00 | 41.50 | 43.50 | 14.25 | 16.20 |
| **Hoagland nutrient solution minus N plus *N. commune*** | 111.67 | 120.00 | 42.00 | 44.50 | 15.00 | 16.65 |
| **Half Hoagland nutrient solution** | 54.50 | 60.00 | 17.00 | 18.20 | 7.100 | 8.70 |
| **0.5 Hoagland nutrient solution plus *A. variabilis*** | 55.33 | 61.00 | 17.75 | 19.00 | 7.500 | 9.00 |
| **0. 5 Hoagland nutrient solution plus *N. commune*** | 60.00 | 64.00 | 18.50 | 19.60 | 8.00 | 9.65 |
| **0.75Hoagland nutrient solution plus *A. variabilis*** | 85.00 | 90.00 | 28.50 | 29.90 | 10.75 | 12.90 |
| **0.75 Hoagland nutrient solution plus *N. commune*** | 80.83 | 87.00 | 30.36 | 31.90 | 11.11 | 13.30 |
| **LSD at 5%** | 5.67 | 8.19 | 2.35 | 2.40 | 1.56 | 1.96 |

Contents of anthocynines and ascorbic acid had the same trends of sugar contents in the leaves of red cabbage, since anthocynines like any glycoside, composed from aglycone and sugar. In addition, the increase in the level of ascorbic acid may also be related to the increase in the amount of sugars particularly D-glucose which converted into this vitamin (Davies *et al.*, 1991). This trend in the formation of anthocyanines and ascorbic acid may be due to the increase in translocation and accumulation of sugars in the leaves of red cabbage, which attributed to their contents from potassium, where potassium enhances sugar translocation and accumulation in plant. Therefore, the importance of sugars amount to anthocyanines and ascorbic acid formation is assured as it was found in leaves of red cabbage (Mazza and Miniati, 1993). The accumulation of anthocyanines and ascorbic acid is affected by some factors such as levels of auxin and gibberllins particularly at the later stages of plant development (Saure, 1990). Therefore, the presence of growth regulating substances (auxins, gibberllin and cytokine) produced by cyanobacteria isolates supported plant growth, formation and accumulation of vital compounds such as anthocyanines and ascorbic acid. Based on the above results, it may be concluded that the addition of cyanobacteria as an alternative source of mineral nitrogen to nutrient solutions used in soilless culture systems can reduce the use of mineral nitrogen and consequently it can reduce the hazard effect resulted from excess consumption of mineral fertilizers.

**Conclusion**

The results indicate the importance of addition of cyanobacteria as an alternative source of mineral nitrogen**,** which leads to the safe use of the fresh crop of red cabbage and increase its quality due to the low contents of nitrogen ($NO_3^-$) and the high contents of anthocyanins and ascorbic acid (vitamin c), which acts as antioxidants in human diet and thus reduce the use of chemical fertilizers.

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**تأثيرالسيانوباكتريا كمصدربديل للنيتروجين المعدني على المحصول والتركيب الكيميائي للكرنب الأحمر تحت نظام الزراعة بدون تربة**

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**ملخص**

أجريت تجربة زراعة بدون تربة في صوبة بلاستيكية بقسم الاراضى والمياه - كلية الزراعة جامعة الأزهر ( مدينة نصر- القاهرة - مصر) خلال موسمى 2014 , 2015 لدراسة تأثير اضافة سلالتين من السيانوباكتريا (سلالة *N. commune* وسلالة *A. variabilis*) كمصادر بديلة للنيتروجين المعدني إلى محلول هوجلاند المغذى وذلك على المحصول والتركيب الكيماوى للكرنب الاحمر صنف (Ruby Perection F1 hybrid) حيث اضيفت السلالات الى محاليل هوجلاند (غير المحتوى على النيتروجين - 0,5 هوجلاند - 0,75 هوجلاند). ويمكن تلخيص اهم النتائج المتحصل عليها في النقاط التالية:-

أدت اضافة السيانوباكتريا (سواء سلالة *N. commune* او سلالة *A. variabilis*) الى محلول هوجلاند غير المحتوى على النيتروجين فى موسمى الدراسة إلى زيادة محصول الكرنب الأحمرومحتوى النيتروجين بالمقارنة بعدم اضافة هذه السلالات الى معاملة محلول هوجلاند الغير محتوى على النيتروجين. كانت افضل النتائج لمحصول نبات الكرنب الأحمر و محتوى النيتروجين فى موسمى الدراسة عند اضافة سلالة *N. commune* او سلالة *A. variabilis* الى معاملة 0,75 هوجلاند .كانت افضل النتائج لحامض الاسكوربك والانثوسيانين كمضادات اكسدة عند اضافة سلالة *N. commune* او سلالة *A. variabilis* الى معاملة محلول هوجلاند الغير محتوى على النيتروجين -اظهرت اضافة السيانوباكتريا (سواء سلالة *N. commune* او سلالة *A. variabilis*) الى معاملة 0,5 هوجلاند تفوق معنوى فى محصول الكرنب الأحمر ومحتوى النيتروجين بالمقارنة بعدم اضافة السيانوباكتريا الى تلك المعاملة. وتشير النتائج إلى أهمية السيانوباكتريا لجودة محصول الكرنب الأحمر و كذلك الحد من استخدام الأسمدة الكيماوية. من ناحية أخرى، فإن الانخفاض النسبي لمحصول الكرنب الأحمر الناتج عن اضافة السيانوباكتريا الى المحاليل المغذية الغير محتوية على النيتروجين يمكن قبوله إذا أخذنا فى الاعتبار الاستخدام الآمن لهذا المحصول نظراً لارتفاع محتواها من حامض الاسكوربك والانثوسيانين كمضادات اكسدة وكذلك انخفاض محتواها من النترات .

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