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# Response of Growth, Production and Quality of Potato Plants to Application of Mineral and Biofertilizers

**Shimaa Kh.H. Hasan[1], Doaa M.R. Abo- Basha[2] and Neama M. Marzouk [3]**

[1]Potato and Vegetatively Propagated Vegetable Research Department, Agricultural Research Centre, Giza, Egypt.
[2]Plant Nutrition Department, National Research Centre, Dokki, Cairo, Egypt.
[3]Vegetable Research Department, National Research Centre, Dokki, Cairo, Egypt.

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**Corresponding author:**
Hasan, Shimaa

**Email:**
shimaakhamis2000@yahoo.com



**ABSTRACT**

In the National Research Center in Nubaria, Egypt, a field study was carried out in 2023, and 2024 two growing seasons. The purpose of the experiment was to determine how potato cv. Spunta's vegetative development, yield, and chemical composition were affected by varying rates of mineral fertilization (100, 80, and 60% NPK) and foliar spraying of Blue green algal (BGA) extract (1, 2, and 3 cm/ L). In a split plot system, a randomized complete block design was applied.

In this investigation, plant growth and yield characteristics were improved by mineral fertilizers (NPK) applied at 100% as opposed to 80% or 60% NPK. Furthermore, the ratio of N, P, and K minerals in potato leaves, and tuber were highest at 100 or 80% NPK, compared to 60% NPK in both years. The results for potatoes' computed levels of starches, nitrates, carbs, and total sugars showed the same outcomes. When the amount of foliar spraying was raised from 1 to 3 cm/L, the usage of algal extract rose in vegetative characteristics, yield, composition, and chemical analysis. The best vegetative parameters were observed at 100% NPK and the highest concentration of algae extract (3 cm/ L), according to the results of the interaction between mineral fertilizer and algae extract application. However, using 80 or 100% NPK along with a high concentration of algal extract (3 cm/L) improved the yield and it's chemical in both seasons.

**KEYWORDS:** potato, mineral fertilizers, Blue green algal extract, chemical.

## 1. INTRODUCTION

Potatoes are considered an essential crop worldwide and rank fourth among crops. *Solanum tuberosum* L., The potato belongs to the family Solanaceae, and it is grown and consumed in most parts of the world. It contains a lot of carbohydrates, which are a great and reasonably priced energy source. It is also rich in fiber,

minerals, vitamins B and C, and very little fat (Muthoni and Nyamango, 2009). Additionally, it contains a few free amino acids. The potato is one of the products that Egypt exports to other nations and is important to the country's economy as a cash crop and food crop.

Chemical fertilizers are necessary to encourage vegetative growth, nourish the plant, and guarantee high crop harvests. The synthesis of proteins, enzymes, and chlorophyll in plants depends on nitrogen. For plants to grow healthily and produce a high-quality potato crop, the proper amount of nitrogen must be obtained. However, decreasing the amount of nitrogen in the soil affects later-planted crops and reduces yields. Several studies have shown that nitrogen fertilizer increases tuber production overall (Zebarth et al., 2004; Zelalem et al., 2009). Additionally, phosphorus is involved in tuber development and the synthesis of proteins, phospholipids, ATP, and ADP. According to Nkaa et al. (2014) on cowpea and Helmy (2013) on pea, potassium is essential for protein synthesis, assimilate translocation enhancing, enzyme activity stimulation, photosynthesis, and carbohydrate transport. Abd El-Aal et al. (2008) cite the addition of 90 potassium units per fed. to potatoes resulted in excellent tuber yield and quality as well as the plant's maximum vegetative growth parameters. In addition to being expensive, using chemical fertilizers exclusively for plant growth causes has detrimental impacts on human health, pollutes the environment, and eventually leads to a multitude of problems with soil health. (Arisha and Bardisi, 1999).

Efforts have been made to utilize natural fertilizers, which reduce the amount of mineral fertilizers required and safeguard the environment, in order to cut expenses and generate a product free of pollution. Utilizing bionatural algal extract, which includes macro- and microelements, vitamins, proteins, carbs, and amino acids, as well as certain growth regulators, is one such technique. Plant production and growth are enhanced by these nutrients (Abd El-Moniem and Abd-Allah, 2008). Utilizing bionatural inoculation, such as algal extract, is essential because it efficiently provides the plant with vital nutrients. The growth-promoting qualities of algae are advantageous for several vegetable crops (Abdel-Mawgoud et al., 2010). Furthermore, some researchers have shown that using algal extract, as in beans, potatoes, and snap beans, enhances photosynthesis and pigments (Latique et al., 2013).

Mohsen (2012) explained how using biofertilization, which reduces pollution to human health, may lessen the usage of chemical fertilizers, which are now essential because of their high cost, while increasing the number of cloves in garlic heads and their high production.

This study's goal is to determine how algae can improve the quality and yield of potato plants cultivated in sandy soil while lowering the requirement for mineral fertilizers.

## 2. MATERIALS AND METHODS

At the National Research Center is experimental station in the Nubaria Region, Behira Governorate, and North of Egypt. A field experiment was carried out on recently reclaimed land during the two growing seasons of 2023 and 2024. In this study, different rates of mineral fertilization and foliar spraying of biofertilizer [Blue Green Algae (BGA) algae extract] were investigated for their effects on the chemical composition, yield, and vegetative growth of potato cv. Spunta.

Sand, silt, and clay readings were 78.6, 13.49, and 7.5%, respectively, indicating a sandy soil texture. The soil pH was 7.74 and EC recorded 1.13 dS m-1, and available N, P, and K were 2.76, 0.53, and 18.8 mg/100 g soil, respectively.

The experimental setup was a split plot system, with different rates of mineral fertilization NPK were arranged as the main plot, and algae extract levels were assigned at random in the subplot. Both main and subplot were arranged in a randomized complete blocks with 4 replicates. Potato tubers were sown in rows 70 cm wide with a distance of 25 cm between plants. Each plot area was 7 m2 [10m2 Line length*70cm line width*1 number of lines]. Planting dates were January 11th, 2023, and January 17th, 2024. The tubers were harvested 115 days after plating, in both seasons.

### 2.1. The experimental treatments

1. **Mineral fertilization**: three rates of $NH_4(2\ SO_4)$: $P_2O_5$: $K_2O$ $kg^{-1}$ from recommended fertilizer were used as follows:

- 100% NPK of 150 kg of $NH_4$ (2 $SO_4$), 70 kg of $P_2O_5$ and 96 kg of $K_2O$ were fed.
- 80% NPK of 120 kg of $NH_4$ (2 $SO_4$), 56 kg of $P_2O_5$, and 77 kg of $K_2O$ were fed.
- 60% NPK of 90 kg of $NH_4$ (2 $SO_4$), 42 kg of $P_2O_5$, and 58 kg of $K_2O$ were fed.

Regarding fertilization, phosphorus fertilizer was added during field preparation. Fertigation was used to apply both N and K fertilizers using an irrigation system. Three doses of nitrogen are added: the first is added when the ground is prepared as a stimulant dose, the second is added after germination is finished, which is about 40 to 45 days later, and the third is added about three weeks after the second. The first dose of potassium is added after the plant is completed growing, the second dose is added approximately three weeks after the first, or when the tubers have formed.

2. **Blue green algae (BGA)**: three rates of algae extract were used as the following: 1, 2, 3 cm $L^{-1}$.

The alga used in this study is *Spirulina platensis*, a multicellular, photosynthetic blue-green microalga that can grow in a variety of fresh, and brackish waters (Marrez *et al.,* 2014). The source of fresh algae was the Algal Biotechnology Unit, NRC, Egypt. Three foliar sprayings of algae extract treatments were applied to the plants at 45, 60, and 75 days following the planting date.

### 2.2. Studied characters

#### 2.2.1. Vegetative growth

Ninety days after planting, six plants were randomly selected from each plot, order to measure the plant length cm, main stems number, and leaves number. A Minolta SPAD 502 unit chlorophyll meter (Minolta, 1989) was used to measure the amount of chlorophyll at the fifth leaf from the top of the plant.

#### 2.2.2. Yield and its components:

At the end of the growing season, potato tuber yield and quality were measured in order to calculate the total yield, fresh and dried weight, and tuber number.

#### 2.2.3. Chemical analysis

Samples of plants (plant leaves and tuber stems) were dried at 70 $^oC$ till constant weight, then were used for the chemical determinations and were calculated according to the dry weight basis. Where, from each sample, 0.5 g (plant sample power) was digested using 5 $cm^3$ from the mixture of sulfuric ($H_2SO_4$) and perchloric ($HClO_4$) acids (5:1) as described by Cottenie et al. (1982). Total nitrogen % (N) was determined using the modified micro Kjeldhal method (Cottenie et al., 1982) and phosphorus % by the colorimetric method using a flam photometer (Ryan et al., 1996). Concentration of potassium was determined using an atomic absorption spectrophotometer (Jones, 2001). In tuber, total carbohydrates were determined by using a colorimetric method as described by Dubois et al. *(*1956). The percentage of starch content in tubers was determined according to AOAC (2016).

### 2.3. Statistical analysis

The analysis of variance method, as described by Snedecor and Cochran (1980), was used to the data. The Duncan Multiple Range Test at 5% was used to compare treatment means (Duncan, 1955). All data analyses were performed using the *STATISTIX* version 10.0 software.

## 3. RESULTS AND DISCUSSION

### 3.1. Vegetative growing characters

Concerning the effects of mineral fertilizer concentrations on rats (NPK), algae extract (BGA), and their interactions on vegetative growing characteristics of potatoes, information the showing in Table 1 demonstrate a significant increase in all analyzed traits, including plant length (cm), stems number, and leaves number. The observed increases in every growth parameter over both seasons followed the rise in NPK rats from 60% to 100%; these results might be generally explained the fact that the experimental soil area's apparent low available NPK contents reflected its observed strong

response to the increased supplies of these nutrients. The results accord with the findings provided by Abdel-Naby et al. (2018) and Sidiky et al. (2019), who concluded that plants using the commercially suggested rates of mineral fertilizers (NPK) achieved the best sweet potato growth. Moreover, there is agreement with the results of Mukhtar *et al.* (2010) who worked of crop sweet potato Sadek (2000) revealed that all characteristics of sweet potato plant vine growth were gradually and significantly enhanced by the use of N fertilizer. Furthermore, N is the primary component of several byproducts of the metabolism of sweet potato plants, according to Ukom et al. (2009).

When spraying with varying doses of algal (BGA) extract, the vegetative characteristics values were enhanced according to the results showed in Table 1. The values of the qualities under study raised as the amounts of algal extract increased. However, during the two seasons, the foliar spray containing 3% algal extract had the highest reported values. The results generally accorded with the outcomes of Haider et al. (2012); who described how applying with biofertilizer (seaweed extracts) to potato crops increased their vegetative development. Seaweed extracts contain auxins, gibberellins, and precursors of growth regulators like ethylene, betaine, and cytokinins, which may help increase plant growth responses, which could account for the increased plant growth observed as a result of their use.

**Table 1. Effect of interaction between mineral and biofertilizer application on growth parameters of potato plants (2023 - 2024) seasons.**

| Treatments | | First season | | | Second season | | |
|---|---|---|---|---|---|---|---|
| | | Leaves number / plant | Stems number / plant | Plant length (cm) | Leaves number / plant | Stems number / plant | Plant length (cm) |
| **Effect of NPK rates%** | | | | | | | |
| **NPK 100%** | | 11.2 A | 13.7 A | 82.8 A | 11.2 A | 13.7 A | 82.8 A |
| **NPK 80%** | | 10.8 B | 9.8 B | 81.0 B | 10.8 B | 9.8 B | 81.0 B |
| **NPK 60%** | | 10.4 B | 7.6 C | 64.8 C | 10.4 B | 7.6 C | 64.8 C |
| **Effect of Blue green algae ( BGA) cm/L** | | | | | | | |
| **BGA 1 cm/L** | | 8.9 C | 7.8 B | 62.9 C | 8.2 C | 9.6 B | 68.4 C |
| **BGA 2 cm/L** | | 10.1 B | 7.9 B | 66.5 B | 10.9 B | 9.8 B | 75.0 B |
| **BGA 3 cm/L** | | 12.1 A | 10.9 A | 79.6 A | 13.3 A | 11.7 A | 85.1 A |
| **Effect of interaction** | | | | | | | |
| **NPK 100%** | **1** | 78.3 c | 12.0 c | 11.3 b | 73.8 c | 10.2 c | 11.0 c |
| | **2** | 80.5 b | 13.0 b | 12.7ab | 75.0 b | 11.2 b | 12.0 b |
| | **3** | 89.5 a | 16.0 a | 13.7 a | 83.0 a | 15.2 a | 14.0 a |
| **NPK 80%** | **1** | 71.4 de | 8.0 e | 8.7 d | 66.9 e | 6.2 e | 8.3 f |
| | **2** | 81.6 b | 10.3 d | 11.3 b | 76.1 b | 8.4 d | 10.7 d |
| | **3** | 90.1 a | 11.0 cd | 13.7 a | 84.6 a | 10.1c | 11.3 c |
| **NPK 60%** | **1** | 55.6 f | 7.0 f | 7.7e | 51.1 g | 5.2 f | 7.3 g |
| | **2** | 62.9 e | 7.7 f | 8.3 d | 57.4 f | 5.9 f | 9.0 e |
| | **3** | 75.8 d | 8.0 e | 10.0c | 69.3 d | 7.2 e | 11.0 c |

At 5%, values during same column that are followed by the same character do not differ significantly.

Table 1 displays the findings of the interaction impact between the two components that were examined. In both growing seasons, Positive and significant interaction effects were observed in the mean values of the number of stems/plant, number of leaves/plant, and plant length (cm). The mean values of all the aforementioned features increased significantly when NPK fertilizers were added at a 100% rate using foliar spray and a 3 cm/L concentration of

algal extract. Conversely, in two study seasons, the lowest values were at spraying with algae 1 cm/L and fertilizing NPK (60%), as well as the average number of stems and leaves, were recorded. The positive effects of applying algae extract on the investigated vegetative growth characteristics seemed to be generally consistent with the findings of Helaly (2016) and Abdel-Naby et al. (2018), which showed that the biofertilizer treatments, both alone and in combination with mineral fertilizers, improved the sweet potato plant's growth characteristics, such as plant height, branch count, leaf count, and fresh weight of the foliage.

The use of different concentrations of algae extract and traditional NPK mineral fertilizers enhances potato plants tolerance to harsh environmental conditions (Dhansu and Munjal, 2020; Ali *et al.*, 2021).

### 3.2. Tubers yield and its components

According to the findings in Table 2, NPK fertilizer rates of concentrations and algal extract (BGA) had an impact of the average values on following potato characteristics, inclusive tuber number /plant, fresh and dry weight of tuber, and total yield t/fed. Generally, through the two study seasons, as the NPK rate was raised from 60% to 100%, the recorded data has been also increased. At 100% NPK rate, the four traits' highest values were noted and there were no significant differences at 80% NPK rate for a tuber dry weight /plant during both seasons, and for tuber fresh weight and total yield through the second season. However, noted that fertilization at 60 % rate NPK decreased the yield t/fed., and its component.

This outcome is consistent with research done on the same attributes on sweet potato plants by Helaly (2016). This could be clarified by the fact that crops can easily absorb the nutrients found in mineral fertilizers, as shown by Arisha and Bardisi's (1999) research on potato plants.

Potato plants responded favorably to foliar application with of algal extract (BGA) concentrations in terms of tuber yield and its constituent properties. During the two consecutive seasons, the highest average values for the number of tubers per plant and the total amount of tuber produce t/fed. were found for the level of 3 cm/L foliar spray among the algae extract treatments. However, by reducing foliar spray concentrations of algae from 3 cm/L to 1 cm/L during the two seasons, the percentage of yield decreased. The results showed patterns that were comparable to those published by Doss et al. (2015) and Helaly, (2016), demonstrating the impact of applying algal extracts to increasing the productivity of potato crops. Plant hormones, primarily cytokines, and trace nutrients included in the extracts of algae are likely the basis for the extracts' effectiveness (Verkleij, 1992).

The outcomes of the two factors' (NPK% and algae extract concentration) interaction impact are shown in Table 2. The mean numbers of tuber/plant and the total tuber yield t/fed. during both growing seasons were positively and significantly impacted by the interaction. The addition of NPK fertilizer at 80 % NPK rate with 3 cm/L of extract algae (BGA) increase yield significantly, but these mean values did not differ significantly from the highest interaction treatment (100 percent NPK with 3 cm/L BGA). The beneficial effects of applying algae extracts on potato yield and its constituents may be related to the essential function algae extracts as plant growth stimulants, which raise the availability of nutrient supply, enhance the efficiency of macroelements, and help the crop meet certain microelement needs. The results obtained agree by Doss *et al.* (2015), Helaly (2016), and Abdel-Naby *et al.* (2018), who suggested that applying biofertilizer could lower the quantity of mineral fertilizer (NPK) needed for sweet potato plants. (Abies cv.).

The importance of mineral fertilization (NPK) is due to the fact that it is essential for the potato plant’s transporting sugars, mineral absorption, DNA, coenzymes, proteins, physiological activities and photosynthesis (Moniruzzaman et al., 2013).

**Table 2. Effect of interaction between mineral and biofertilizer application on yield and yield component of potato plants (2023-2024) seasons.**

| Treatments | | No of tubers /plant | FW. Tuber g/plant | DW. Tuber g/plant | Total yield ton/fed | No of tubers /plant | FW. Tuber g/plant | DW. Tuber g/plant | Total yield ton/fed |
|---|---|---|---|---|---|---|---|---|---|
| | | First season | | | | Second season | | | |
| **Effect of NPK rate %** | | | | | | | | | |
| **NPK 100%** | | 12.4 A | 748.5 A | 16.3 A | 17.1 A | 12.3 A | 747.6 A | 16.7 A | 16.9 A |
| **NPK 80%** | | 10.2 B | 709.1 B | 16.3 A | 16.4 B | 10.1 B | 708.2 A | 16.7 A | 16.2 A |
| **NPK 60%** | | 8.2 C | 464.0 C | 15.0 B | 14.8 C | 9.1 C | 463.1 B | 15.4 B | 14.7 B |
| **Effect of Blue green algae ( BGA) cm/L** | | | | | | | | | |
| **BGA 1 cm/L** | | 8.4 C | 505.0 C | 15.3 B | 15.0 C | 8.9 C | 504.1 C | 15.7 C | 14.8 B |
| **BGA 2 cm/L** | | 10.3 B | 668.4 B | 15.7 B | 16.3 B | 10.6 B | 667.5 B | 16.1 B | 16.2 A |
| **BGA 3 cm/L** | | 12.1 A | 748.3 A | 16.6 A | 17.0 A | 12.1 A | 747.4 A | 17.1 A | 16.9 A |
| **Effect of interaction** | | | | | | | | | |
| **NPK 100%** | **1** | 11.0 b | 596.6 c | 15.6 c | 15.6 d | 11.0 c | 595.7 c | 16.0 c | 15.5 c |
| | **2** | 13.0 a | 790.8 b | 16.1 b | 17.3 b | 12.0 b | 789.9 b | 16.5 c | 17.2 b |
| | **3** | 13.3 a | 858.2 a | 17.2 a | 18.4 a | 14.0 a | 857.3 a | 17.6 a | 18.3 a |
| **NPK 80%** | **1** | 8.0 e | 523.4 c | 15.4 c | 15.6 d | 8.3 ef | 522.5 c | 15.8 d | 15.5 c |
| | **2** | 9.7 d | 743.9 b | 16.0 b | 16.7 c | 10.7 d | 743.0 b | 16.4 c | 16.5ab |
| | **3** | 13.0 a | 860.1 a | 17.5 a | 17.0 b | 11.3 c | 859.2 a | 17.9 b | 16.9 ab |
| **NPK 60%** | **1** | 6.3 f | 394.8 e | 14.9 d | 13.9 e | 7.3 f | 393.9 e | 15.3 e | 13.7 d |
| | **2** | 8.3 e | 470.6 d | 15.0 c | 15.1 d | 9.0 e | 469.7 d | 15.4 e | 15.0 c |
| | **3** | 10.0 c | 526.6 c | 15.2 c | 15.7 d | 11.0 c | 525.7 c | 15.7 d | 15.5 c |

At 5%, values during same column that are followed by the same character do not differ significantly.

### 3.3. Tuber chemical composition.

Mentioning the results in Table 3 and total chlorophyll in Figure 1, which showe how the chemical composition of potato tuber is impacted with rates of NPK fertilizer, and concentrations of algae extracts, the findings demonstrate a considerable increase in the average levels of starch (%), total sugars (%), carbs (%), nitrate (mg/kg) in Table 3, and chlorophyll content in Figure 1 when various NPK mineral fertilizer rates were applied. The average values for each of the previously listed attributes were much greater for the two NPK fertilizer rates of 100% or 80%, but there were no appreciable differences between them. Overall, the findings of Sidiky et al. (2019) and Abdel-Naby et al. (2018) showed trends that were comparable to those found in this investigation. They found that fertilization has a considerable effect on the sweet potato plant. Specifically, N and K, were identified as an essential step in improving the sweet potato roots quality.

Regarding primary impact of the concentrations of algae extract in Table 3 and total chlorophyll in Figure 2, the results demonstrate that, during the two growing seasons, all parameters' mean values, with the exception of nitrate, increased significantly as the concentrations of blue green algal (BGA) extract increased. The highest significant value was observed by the foliar spraying with a concentration of 3 cm/L. In contrast, nitrates raised in both seasons when amounts of algal extract were applied at first 1 cm/L, then 2 cm/L, and finally 3 cm/L. This data is consistent by Abo-Basha et al. (2019), who found that treating spinach plants with algal extract decreased the amount of nitrate in leaves. These findings may be explained by the means that algal extracts concentrations increased nutrient absorption and process of photosynthesis, which in turn caused more metabolites to build up in reproductive

**Table 3. Effect of interaction between mineral and biofertilizer applications on chemical analysis of tuber potato plants (2023-2024) seasons**.

| Treatments | | Carbohydrate % | $NO_3$-N (mg/kg) | Starch % | Total sugars % | Carbohydrate % | $NO_3$-N (mg/kg) | Starch % | Total sugar % |
|---|---|---|---|---|---|---|---|---|---|
| | | First season | | | | Second season | | | |
| **Effect of NPK rate %** | | | | | | | | | |
| **NPK 100%** | | 33.4 A | 43.5 A | 21,8 A | 4.9 A | 28.5 A | 43.6 A | 21.6 A | 5.0 A |
| **NPK 80%** | | 32.5 A | 42.4 B | 22,2 A | 4.9 A | 28.5 A | 42.5 A | 21.9 A | 4.9 A |
| **NPK 60%** | | 31.3 B | 41.5 C | 18.4 B | 4.0 B | 25.8 B | 41.6 B | 18.2 B | 4.0 B |
| **Effect of Blue green algae ( BGA) cm/L** | | | | | | | | | |
| **BGA 1 cm/L** | | 24.9 C | 44.1 A | 18.8 C | 4.3 B | 24.9 C | 44.2 A | 18.6 C | 4.3 B |
| **BGA 2 cm/L** | | 27.5 B | 42.5 B | 20.8 B | 4.5 B | 27.5 B | 42.6 B | 20,5 B | 4.5 B |
| **BGA 3 cm/L** | | 30.3 A | 40.7 C | 22.8 A | 5.0 A | 30.4 A | 40.9 C | 22.6 A | 5.1 A |
| **Effect of interaction** | | | | | | | | | |
| | **1** | 26.2 c | 45.1 a | 20.4 d | 4.6 c | 26.3 c | 45.3 a | 20.15 c | 4.6 c |
| **NPK** | **2** | 28.4 b | 43.9 b | 21.9 c | 4.8 b | 28.5 b | 44.0 b | 21.64 b | 4.9 b |
| **100%** | **3** | 30.6 ab | 41.5 d | 23.1 a | 5.3 a | 30.6 a b | 41.6 d | 22.91 ab | 5.3 a |
| | **1** | 25.4 c | 44.5 ab | 19.8 e | 4.5 c | 25.4 e | 44.6 b | 19.53 d | 4.5 c |
| **NPK** | **2** | 28.4 b | 42.3 c | 22.4 b | 4.8 b | 28.4 b | 42.5 c | 22.20 ab | 4.8 b |
| **80%** | **3** | 31.7 a | 40.3 e | 24.3 a | 5.5 a | 31.8 a | 40.4 e | 24.08 a | 5.5 a |
| | **1** | 23.0 e | 42.7 c | 16.3 g | 3.7 f | 23.1 f | 42.8 c | 16.08 e | 3.8 f |
| **NPK** | **2** | 25.6 d | 41.2 d | 18.0 f | 3.9 e | 25.7 d | 41.3 d | 17.76 e | 4.0 e |
| **60%** | **3** | 28.7 b | 40.5 e | 21.0 c | 4.3 d | 26.3 c | 40.6 e | 20.79 c | 4.3 d |

At 5%, values during same column that are followed by the same character do not differ significantly.

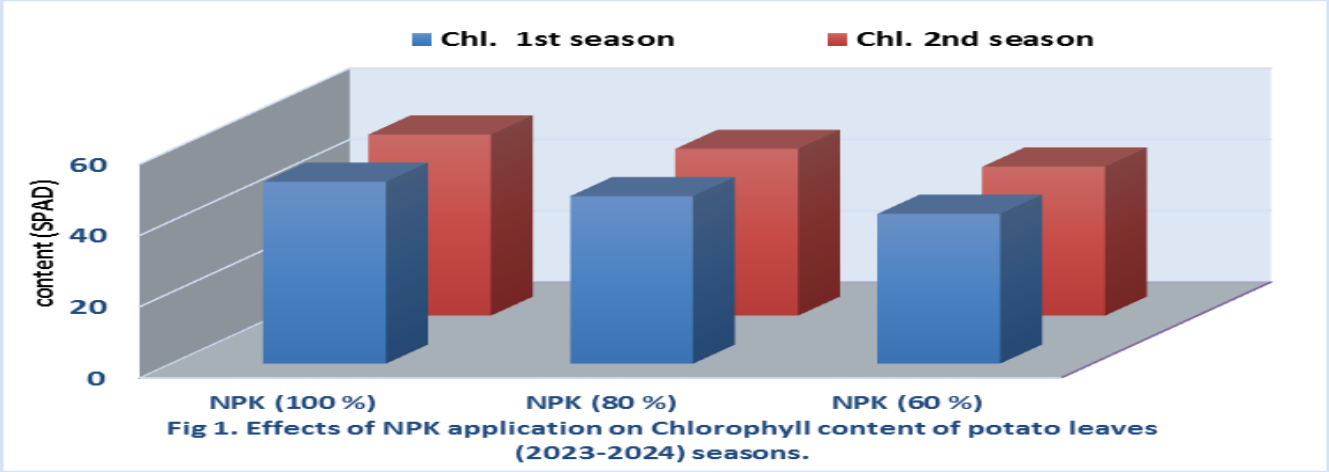


Fig 1. Effects of NPK application on Chlorophyll content of potato leaves (2023-2024) seasons.

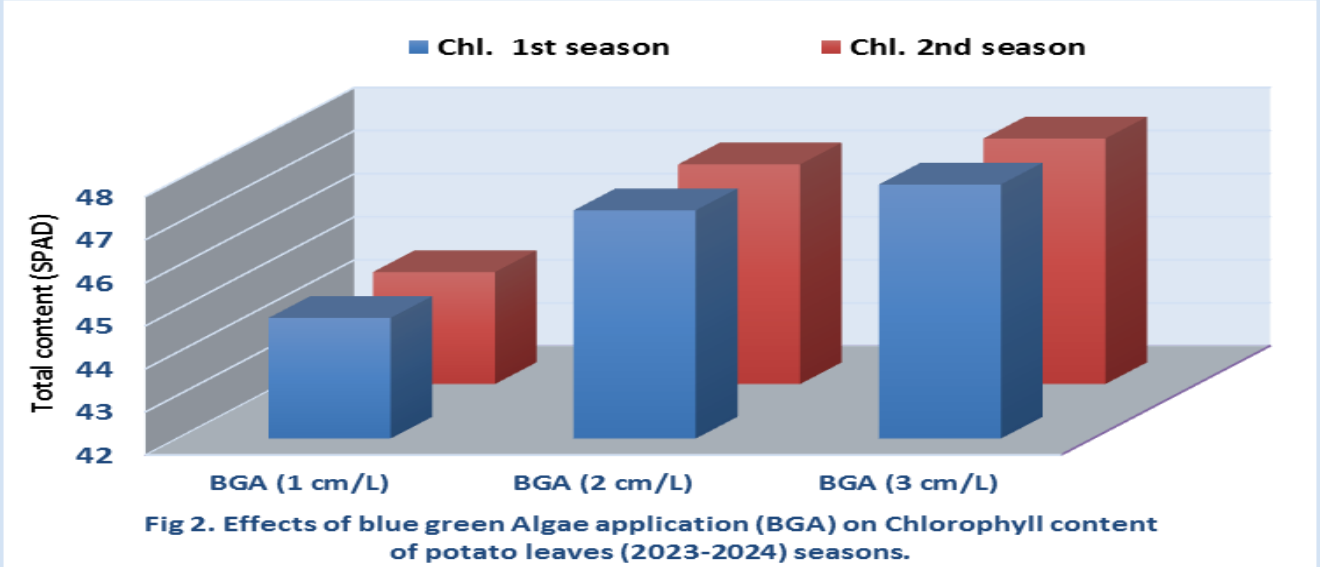


Fig 2. Effects of blue green Algae application (BGA) on Chlorophyll content of potato leaves (2023-2024) seasons.

organs and improved the potato tubers quality (Haider et al., 2012).

According to Table 3 and total chlorophyll in Figure 3, the interaction between the different rates of NPK fertilizer and the different concentrations of algae extract (BGA) tended to significantly influence the differences in the average values of the total sugars, starch, carbohydrates, and chlorophyll content over the course of the two seasons. The mean values of every character under study did not significantly differ between the 100% or 80% NPK mineral fertilizer and algal extract (3 cm/L) combinations over the course of the two seasons. In general, the results demonstrated that adding NPK fertilizer at 80% of the recommended rate produced the greatest mean values across all of the previously discussed treatments and algal extract was sprayed at a rate of 3 cm/L. These outcomes corresponded with the general trend of Abdel-Naby et al. (2018)'s regarding the sweet potato roots' chemical composition. In the first and second seasons, nitrates increased at 100 and then 80% fertilizer and algae extract 1 cm/L and fell at 60% fertilizer and algal extract 3 cm/L (Table 3).

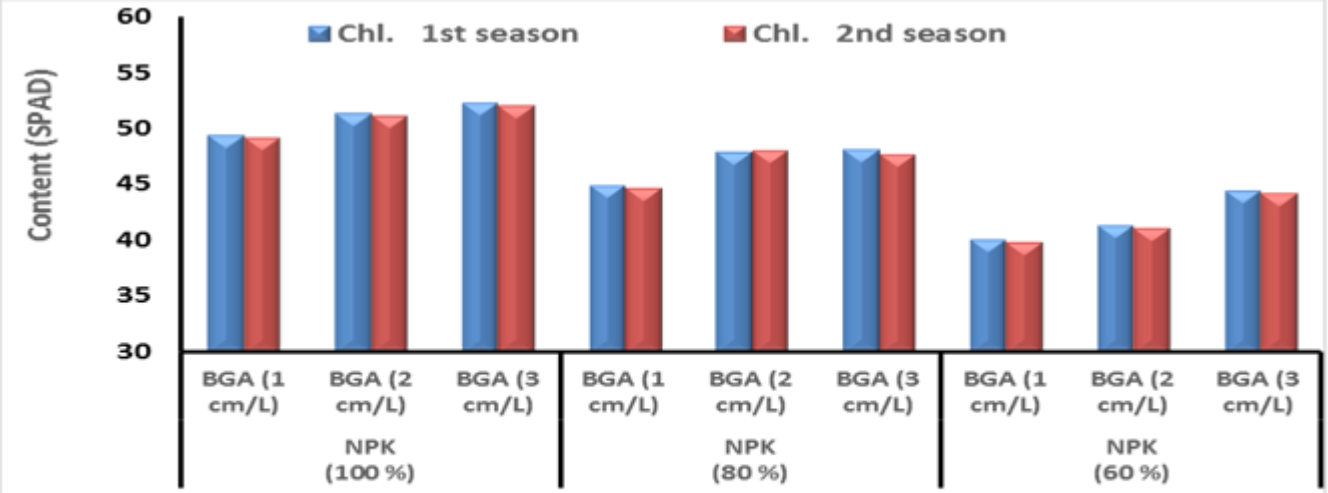


**Fig 3. Effects of interaction between of NPK and algae application on chlorophyll of potato leaves (2023-2024) seasons.**

### 3.4. Mineral composition percentage of leaves and tubers

Table 4 and Finger 4 display the main effects of NPK fertilizer rates and BGA concentrations on the mean values of N (%), P (%), and K (%) contents of potato leaves and tubers during 2023 and 2024 seasons. In both growth seasons, the macronutrient contents of potato tuber (N, P, and K) were significantly impacted by varying rates of chemical fertilizer NPK (Table 4). In comparison to all other rates of mineral fertilization, the greatest rate of NPK fertilizer (100%) was associated with the highest mean values of mineral contents (N, P, and K) of leaves, Finger 4. In general, when the rate of NPK increased from 60% to 100%, the Potato tuber's mineral concentrations (N, P, and K) significantly increased. According to Marschner (1995), nutrient uptake in plants was found to be closely associated with productivity. This could be because increased fertilizer application (NPK) increased the availability of the nutrients; it consequently improved root nutrition and raised the roots' physiological activity to absorb the nutrients. Similar results were reported by Helaly (2016) on sweet potato roots.

Concerning, the impact of spraying with varying concentrations of biofertilizer (BGA) contents of the macronutrient N, P, and K in potato leaves and tuber. The results showed that foliar spraying with concentrate 3 cm/L BGA obtained the highest average value for the percentages of potassium, phosphorus, and nitrogen in tubers (Table 4) and in leaves (Finger 5) during the two growth seasons. This pattern is comparable to that of Ammar et al. (2022), who discovered that biofertilizer considerably raised the N, P, and K% content of potato plants when compared to control treatment. Abou El-Khair et al. (2010) found that the application of blue green algae extract on garlic plants indicated increases in N and P percentages.

The findings of the interaction between the two factors under investigation (different rates of NPK fertilizer and different concentrations of BGA) are shown in Table 4 and Fig. 6 and 7. The average values of the mineral contents (N, P, and K) of potato leaves and tubers in both growing seasons were significantly improved by the interaction. On the other hand, the mean values of the mineral contents (N and P) of the leaves and tubers during the two seasons increased significantly when NPK fertilizer was added at rates of 80% NPK combined with 3 cm/L of algal extracts. However, the percentage of K in the leaves and tubers was highest for the combined treatment of 100% NPK with 3 cm/L BGA, but there was no apparent difference between the treatments of 80% NPK with 3 cm/L BGA during two growth seasons. Ammar et al. (2022) who found similar results with potato tuber.

**Table 4. Effects of interaction between mineral and biofertilizer application on estimation elements % of potato tubers (2023-2024) seasons**

| Treatments | | First season | | | Second season | | |
|---|---|---|---|---|---|---|---|
| | | N% | P% | K% | N% | P% | K% |
| **Effect of NPK rate %** | | | | | | | |
| **NPK 100%** | | 2.30 A | 0.81 A | 3.66 A | 2.23 A | 0.81 A | 3.79 A |
| **NPK 80%** | | 2.19 B | 0.79 A | 3.55 B | 2.23 A | 0.80 A | 3.71 A |
| **NPK 60%** | | 1.80 C | 0.72 B | 3.24 C | 1.83 B | 0.72 B | 3.40 B |
| **Effect of Blue green algae ( BGA) cm/L** | | | | | | | |
| **BGA 1 cm/L** | | 1.74 C | 0.70 C | 2.94 C | 1.77 C | 0.71 B | 3.07 C |
| **BGA 2 cm/L** | | 2.17 B | 0.77 B | 3.43 B | 2.20 B | 0.77 B | 3.58 B |
| **BGA 3 cm/L** | | 2.39 A | 0.84 A | 4.09 A | 2.42 A | 0.85 A | 4.25 A |
| **Effect of interaction** | | | | | | | |
| **NPK 100%** | **1** | 2.10 e | 0.76 d | 3.16 d | 2.13 d | 0.77 c | 3.25 d |
| | **2** | 2.28 d | 0.81 b | 3.64 c | 2.31 b | 0.82 b | 3.80 b |
| | **3** | 2.45 b | 0.84 a | 4.18 a | 2.56 a | 0.85 a | 4.33 a |
| **NPK 80%** | **1** | 1.80 f | 0.73 e | 2.90 e | 1.83 ef | 0.74 cd | 3.05 e |
| | **2** | 2.33 c | 0.78 c | 3.48 b | 2.37 b | 0.78 c | 3.64 c |
| | **3** | 2. 53 a | 0.86 a | 4.27 a | 2.48 a | 0.87 a | 4.43 a |
| **NPK 60%** | **1** | 1.32 g | 0.62 f | 2.76 f | 1.35 f | 0.62 e | 2.92 f |
| | **2** | 1.89 f | 0.71 ef | 3.16 d | 1.92 e | 0.72 d | 3.31 d |
| | **3** | 2.18 e | 0.82 b | 3.82 b | 2.22 c | 0.83 b | 3.25 d |

At 5%, values during same column that are followed by the same character do not differ significantly.

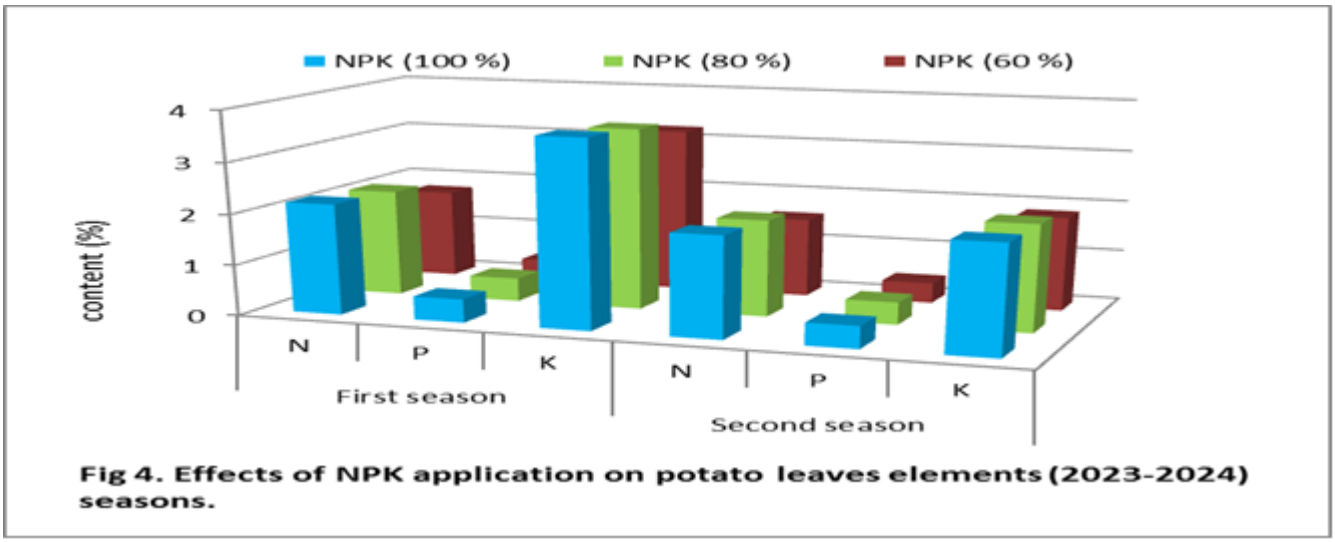


**Fig 4. Effects of NPK application on potato leaves elements (2023-2024) seasons.**

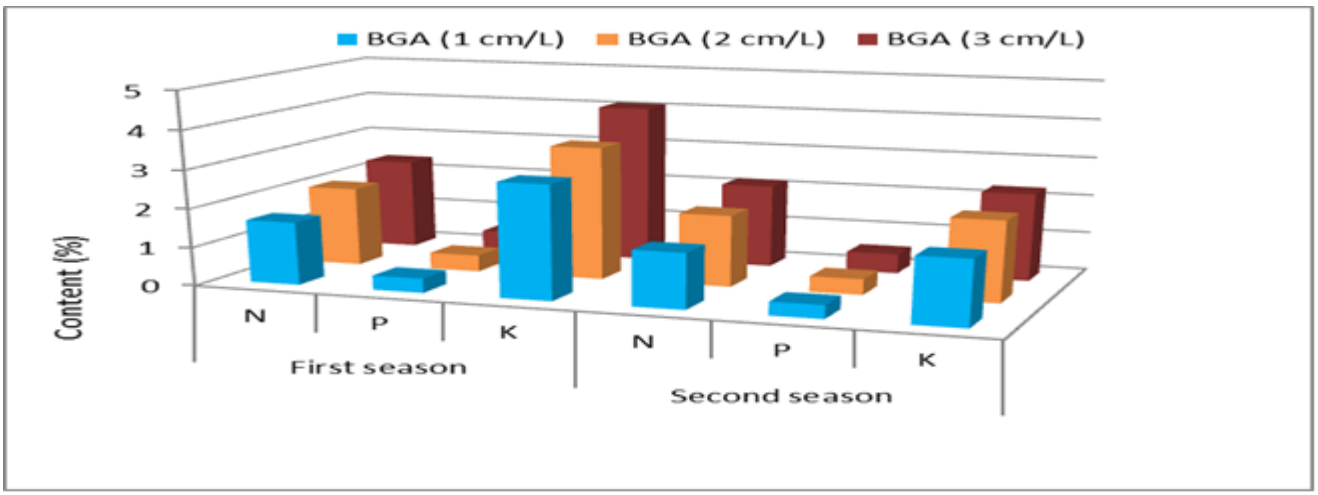


Fig 5. Effects of NPK application on potato leave elements (2023-2024) seasons.

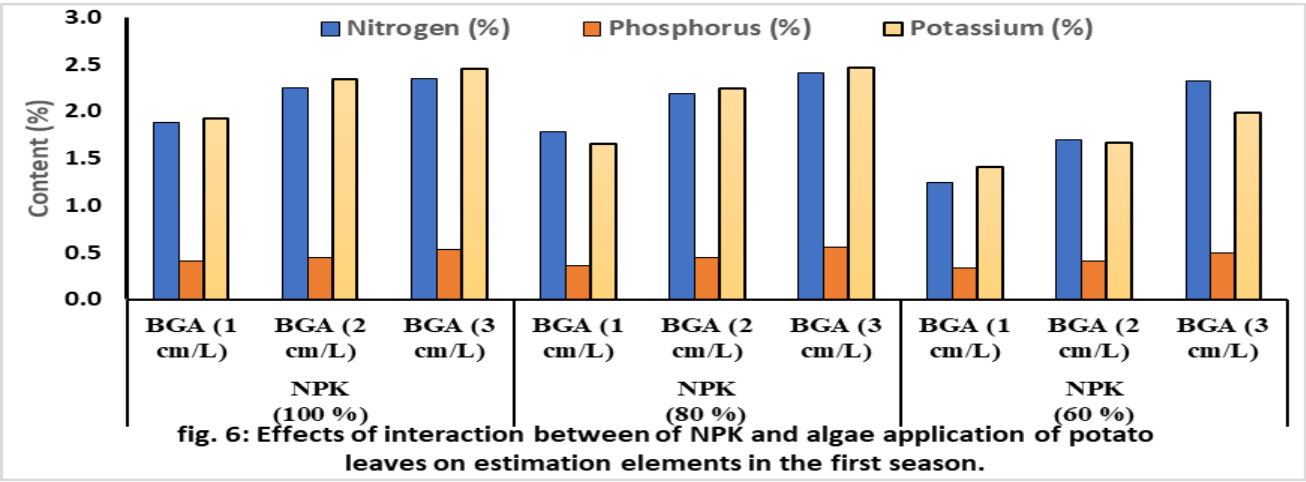


fig. 6: Effects of interaction between of NPK and algae application of potato leaves on estimation elements in the first season.

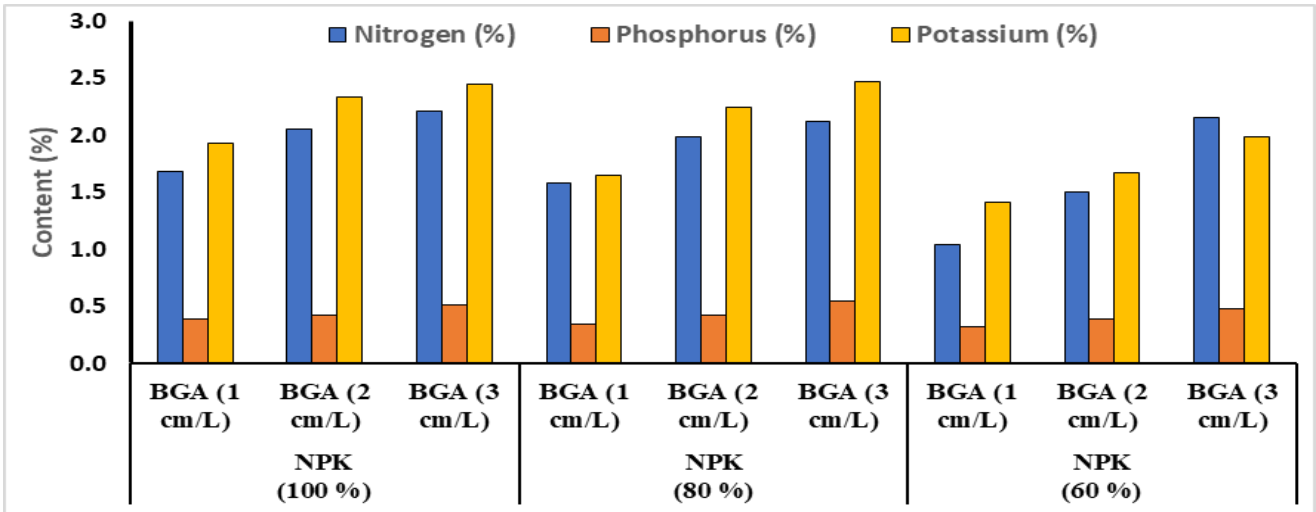


fig. 7: Effects of interaction between of NPK and algae application of potato leaves on estimation elements in the second season.

## 4. CONCLUSION

Although 100% NPK mineral fertilization produced the best results, a bio-fertilizer, such as algae extract, at a rate 3 centimeters per liter, can be used in conjunction with it because the fertilizers advised for potato plants are expensive. In order to save fertilizer costs and improve both the product and the environment, it was advised to use NPK at 80% of the recommended fertilizer with natural fertilizer, which is algal extract sprayed at a rate of 3 cm/L.

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## الملخص العربي

## استجابة نمو وإنتاج وجودة نبات البطاطس لتطبيق التسميد الحيوى والمعدنى

**شيماء خميس حنفى حسن[١]، دعاء محمد رمضان ابو باشا[٢] ونعمه محمد مرزوق[٣]**

[١]قسم بحوث البطاطس و الخضر خضرية التكاثر، معهد بحوث البساتين، مركز البحوث الزراعية.
[٢]قسم بحوث تغذائية النبات، شعبة البحوث الزراعية والبيولوجية، المركز القومى للبحوث.
[٣]قسم بحوث الخضر، شعبة البحوث الزراعية والبيولوجية، المركز القومى للبحوث.

أقيمت التجربة الحلقية فى المركز القومى للبحوث ، النوبارية ، مصر، خلال موسمى الزراعة ٢٠٢٢ و٢٠٢٣م. الهدف من الدراسة تأثير معدلات مختلفة من التسميد المعدنى الموصى به NPK وهى ١٠٠ % و٨٠ % و٦٠ % والرش بمستخلص الطحالب بتركيزات الاتية ١ و ٢ و٣ سم / لتر على نمو الخضرى والمحصول والجودة و الكيماوى للدرنات فى نبات البطاطس صنف "أسبونتا". وقد صممت التجربة فى قطاعات منشقة مرة واحدة.

كان التسميد المعدنى عند معدل ١٠٠٪ يشجع النمو الخضرى والمحصول وجودته مقارنة بمعدل ٨٠ % أو ٦٠ %. أيضا التسميد المعدنى عند معدل ١٠٠٪ أو ٨٠٪ أعطى أعلى قيم للتقديرات الكيماوية مثل النتيروجين والفوسفور والبوتاسيوم سواء فى الأوراق و الدرنات لنبات البطاطس، وكذلك أعطى زيادة الكربوهيدرات والنترات والنشا والسكريات الكلية فى الدرنات مقارنة بمعدل ٦٠٪ فى السنتين. أما الرش بمستخلص الطحالب بتركيز ٣ سم للتر اعطى زيادة كلا من الصفات المدروسة فى التجربة ماعدا النترات للموسمين. فى حين نتائج معاملات التفاعل بين التسميد المعدنى بتركيز ١٠٠٪ مع الرش بمستخلص الطحالب ٣ سم للتر أعطت أعظم قيم للنمو خضرى. وعلى الجانب الأخر، المحصول والمكونات الكيماويه سجل أعلى قيم التعامل بالتسميد المعدنى بتركيز ١٠٠٪ أو٨٠٪ مع الرش بمستلخص الطحالب ٣ سم للتر فى الموسمين.

**الكلمات المفتاحية:** البطاطس، التسميد المعدنى، مستخلص الطحالب الازرقاء الخضراء، كيمياوى.