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# EFFECT OF POTASSIUM APPLICATION METHODS ON GARLIC PLANTS GROWN UNDER SANDY SOIL CONDITIONS

**Hany G. Zyada* and Enas A. Bardisi**

Hort. Dept., Fac. Agric., Zagazig Univ., Egypt

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**ABSTRACT:** Two field experiments were carried out during the two consecutive winter seasons of 2015/2016 and 2016/2017 at El-Khattara Experimental Farm, Faculty of Agriculture, Zagazig University, Sharkia Governorate, Egypt, to study the effect of potassium sulphate 50% $K_2O$ (60, 90, 120 and 150 kg/fad.) as soil application, potassium silicate (0.0, 3.0 and 6.0 $cm^3$/l) as foliar application and their interaction on the growth characters, plant dry weight, total yield and bulb quality of garlic cv. Balady grown in sandy soil under drip irrigation system. The results emphasized that potassium sulphate at 120 or 150 kg/fad., was the best levels used for its superiority in producing the tallest plants, number of leaves/plant, bulb and neck diameters, the heaviest dry weight of bulbs, leaves and roots, total yield/fad., TSS and NPK percentages in bulb and leaves of garlic compared to the lowest levels under study. Meanwhile, foliar spray by potassium silicate at 6.0 $cm^3$/l gave the highest values of growth, NPK in leaves and bulbs and total yield in both seasons. The present study recommends that using potassium sulphate 120 kg/fad., combined with 6.0 $cm^3$/l of potassium silicate for increasing total yield per fad., of garlic (cv. Balady) grown in sandy soil under similar field conditions.

**Key words:** Garlic, potassium, silicate, soil and foliar application, yield, bulb quality.

## INTRODUCTION

Garlic (*Allium sativum* L.) which belongs to family Alliaceae is one of the oldest vegetable crops under cultivation in the world. It is come in the second most important crops cultivated and used among alliums after onion. Garlic cloves commonly used as a spice or condiments as well as many medical purposes (contains Allicin in di allyle di sulfide form). Increasing garlic production has become great necessary to meet the ever increased demand of exportation and local consumption **(El-Hifny, 2010)**. The ever-increased consumption of vegetables, demands both horizontal and vertical agriculture extension in the new reclaimed soils. These soils are normally poor in their nutrient elements, as well as most of fertilizers elements which using to increase fertility of these are either fixed in the soil or leached to pollute the environment.

So the foliar feeding of nutrients in these soils conditions can achieve a good result in the growth and productivity of different crops especially in sandy soil conditions. Potassium (K) is an essential nutrient that affects most of the biochemical and physiological processes that influence plant growth and metabolism. It also contributes to the survival of plants exposed to various biotic and a biotic stress. Also, it plays a vital role for a normal cell division, translocation of carbohydrates and reduction of nitrates. On the other hand, potassium never appear to represent a permanent structural component, but it has a metabolic role **(Black, 1960)**.

Silicon has been described as a non-essential of plant nutrient, but it can play a vital role to improve disease resistance in plant **(Farbes and Watson, 1992)**. Silicon has important potential in the plant growth and development **(Datnoff *et al.*, 2001)**. Potassium silicon is the main source of soluble potassium and silicon. In general, plants require silica to resist against biotic and a

*** Corresponding author. Tel. :** +201007016878
**Email address**: hgzyada@yahoo.com

biotic stress **(Ma, 2004)**. The presence of silicon can reduce the harmful effect of metal elevation and improve water use efficiency and photosynthesis rate in plant.

The most vegetative parameters, yield and its components of garlic were significantly increased with increasing the applied K-levels up to 96 kg $K_2O$/fad. (**Abdel Fattah *et al.*, 2002; El-Sayed and El-Morsy, 2012)**. Potassium at 210 kg/fad., gave the best results for plant height, number of leaves/plant and leaves dry weight of garlic **(Mahfooz *et al.*, 2016).**

Therefore, this study aims to investigate the effect of potassium levels and methods of application on growth, yield and quality of garlic plants grown in sandy soil conditions under drip irrigation system.

## MATERIALS AND METHODS

A field experiment was done during the two successive winter seasons of 2015/2016 and 2016/2017 at El-Khattara Experimental Farm, Faculty of Agriculture, Zagazig University, Sharkia Governorate, Egypt, to study the effect of different sources of potassium on the growth characters, plant dry weight, yield and bulb quality of garlic plants cv. Balady grown in sandy soil conditions under drip irrigation system. The experimental soil was sandy in texture and chemical properties were 7.18 and 7.54 pH, 0.38 and 0.45% organic matter, 1.90 and 2.17 ds/m for EC, 0.048 and 0.053% total N, 12.6 and 13.0 ppm available N, 15.2 and 16.9 ppm available P and 48.9 and 54.2 ppm available K in the first and second seasons, respectively. This experiment was included twelve treatments which were the combination between four levels of potassium sulphate (60, 90, 120 and 150 kg/faddan) as soil application and three concentrations of potassium silicate solution (0.0, 3 and 6 $cm^3$/l) as foliar application.

These treatments were distributed in a split plot design with three replications. The levels of potassium sulphate were randomly distributed in the main plots, while potassium silicate concentrations were randomly distributed in the sub plots. The area of the experimental unit was 10.80 $m^2$. It contained three dripper lines each of 6 m length and 0.60 m width. One line was used to measure vegetative growth parameters and the other two lines were used for yield determination. In addition, one row was left between each two experimental unit as a guard row to avoid the overlapping of spraying solutions. Garlic cloves were selected from uniformity in shape and size sown on both sides of the dripper lines at distance 7.5 cm apart. All experimental units received equal amounts of botanical compost at 30 $m^3$/faddan during soil preparation. The recommended amounts of mineral N and P fertilizers which use in garlic cultivation under sandy soil conditions were added to all experimental units (one third were added with botanical compost during soil preparation and the rest were added into eight equal doses every 15 days intervals beginning at 30 days from cultivations). Ammonium sulphate (20.5% N) and calcium super phosphate (16-18% $P_2O_5$) were used as a source of nitrogen and phosphorus, respectively. While Potassium sulphate (48% $K_2O$) was used as a source of potassium and added also as soil application to experimental units (depend on treatments) as follows: one third of potassium sulphate were added during soil preparation with botanical compost while the two thirds were added into eight equal portions every 15 days intervals beginning at 30 days from cultivation in the soil with N and P fertilizers. The plants were sprayed with potassium silicate (11% Si and 60% $K_2O$) beginning 60 days from planting, two times 15 days by intervals (60 and 75 days after planting). The cloves of garlic cv. Balady were sown on 20 September and 28 September in the first and second seasons, respectively. The other normal agricultural treatments for growing garlic plants, except fertilization treatments were practiced.

### Data Recorded

A random sample of five plants from each sub plot was taken at 135 days after planting and the following data were recorded:

#### Plant growth

Plant height (cm), number of leaves/plant, neck diameter (cm) and bulb diameter (cm) were determined. Also, the different parts of garlic plant, *i.e.,* roots, leaves and bulb were oven dried at 70$^o$ C till constant weight, and then dry weight of leaves/plant (g), dry weight of bulb/ plant (g) and dry weight of roots/plant (g) were recorded.

#### Yield components

At proper maturity stage of bulbs (about 200 days after planting), bulbs in every plot were harvested, then translocated to a shady place in the same day for curing then total yield (ton/ faddan) was calculated.

#### Bulb quality

At harvest time, five bulbs were randomly taken from each treatment and oven dried at 70°C till constant weight, and NPK percentages of bulbs and leaves were determined according to the methods described by **Bremner and Mulvaney (1982)**, **Olsen and Sommers (1982)** and **Jackson (1970)**, respectively. As well as total soluble solids (TSS) as Brix° by using a hand refractometer of garlic bulbs were determined.

### Statistical Analysis

All the data were subjected to statistical analysis of variance according to **Snedecor and Cocharn (1980)**. Means separation was done by LSD at 0.05 level of probability.

## RESULTS AND DISCUSSION

### Plant Growth Characters

#### Effect of potassium sulphate levels

Marked influences on garlic growth characters were observed due to using the different potassium fertilization levels (Table 1). The highest value for each of plant height, number of leaves/plant, bulb and neck diameter and bulbs, leaves and roots dry weights (g) were obtained by plants which treated with 150 kg potassium sulphate/ fad., followed without significant differences with plants supplied with 120 kg/ fad., compared to the lowest level (60 kg/fad.) in both seasons.

These results may be due to the role of K element in metabolism and many processes which sustain and encourage plant vegetative growth and development. Moreover, potassium plays a major role in many physiological and biochemical processes such as cell division and elongation and metabolism of carbohydrates and protein compounds (**Marschner, 1995**). Moreover, **Nurzyska-Wierdak *et al.* (2012)** reported that increasing rates of potassium contributed to an increase in plant height, number of leaves per rosette and fresh weight of leaves of *Eruca sativa* plants. The positive effect of potassium on growth parameters may be due to that potassium increased efficiency of the plant for utilization nitrogen which is essential for plant growth as well as other processes related to nitrogen metabolism **(Forshey and Makee, 1970)**. In this respect, the enhancement effect of potassium on vegetative growth may be due to not only promoting the translocation of newly synthesized photosynthesis but, also it has a beneficial effect on the metabolism processes which reflected on plant growth **(Gardener *et al.*, 1985)**.

The obtained results are in good harmony with those reported by **Abdel Fattah *et al.* (2002)**, **El Sayed and El Morsy (2012), Ali (2013) and Mahfooz *et al.* (2016)** on garlic. They found that application of potassium at highest rates significantly increased plant height, number of leaves, leaf area/plant and bulb diameter compared with the other rates.

#### Effect of potassium silicate concentrations

Differently, plant height, leaf number per plant, neck diameter and dry weights per plant were significantly affected by potassium silicate concentration (Table 2). In the mean time, the growth characters except leaf number/plant were significantly increased by application of the highest potassium silicate concentration (6 $cm^3$/l) compared to control in the two seasons.

Applying K-silicate ($K_2SiO_3$) to garlic plants increased plant growth which could be attributed to the role of Silicon in elongating and strengthening plant roots resulting in increasing the ability to take up more amounts of nutrients from the soil solution. Potassium, which is an important nutirant for plants, has a positive effect on their growth and dry weights (**Abdelkader *et al.*, 2016** on roselle and **Ayub *et al.*, 2018** on okra). However, **Shedeed (2018)** reported that weekly foliar spraying of potassium silicate in a gradual increased series of concentrations (5, 6, 7, 8, 9, 10 $cm^3$/l) resulted in a significant effect on all growth parameters (plant height, stem diameter, leaf area, No. of leaves/plant, fresh and dry weight of leaves and stem of maize).

#### Effect of combination between potassium sulphate levels and potassium silicate concentration

On the other side, the combination between the different levels of potassium sulphate and potassium silicate treatments in the two seasons can be seen in Tables 3 and 4. The results indicated that the prevalence of applying the different combinations in improving vegetative growth characters as plant height, number of leaves per garlic plant, bulb and neck diameters as well as leaves, roots and bulb weights per plant.

Table 1. Effect of potassium sulphate levels on growth characters of garlic plants at 135 days after planting during 2015/ 2016 and 2016/2017 seasons

| Potassium sulphate (kg/faddan) | Plant height (cm) | Leaf number/ plant | Bulb diameter (cm) | Neck diameter (cm) | Bulb dry weight/plant (g) | Leaf dry weight/plant (g) | Root dry weight/plant (g) |
|---|---|---|---|---|---|---|---|
| | | | | 2015/2016 season | | | |
| **60** | 63.47 | 7.60 | 2.47 | 1.36 | 11.70 | 7.02 | 0.61 |
| **90** | 67.87 | 7.67 | 2.68 | 1.36 | 12.00 | 8.49 | 0.69 |
| **120** | 70.97 | 8.03 | 2.88 | 1.45 | 12.61 | 8.70 | 0.77 |
| **150** | 74.70 | 8.37 | 2.90 | 1.50 | 13.88 | 9.51 | 0.86 |
| **LSD at 5%** | 2.97 | 0.48 | 0.23 | 0.11 | 0.09 | 1.54 | 0.15 |
| | | | | 2016/2017 season | | | |
| **60** | 65.45 | 7.70 | 2.50 | 1.30 | 11.89 | 7.03 | 0.60 |
| **90** | 66.74 | 7.68 | 2.66 | 1.31 | 12.14 | 8.34 | 0.71 |
| **120** | 71.25 | 7.88 | 2.78 | 1.44 | 12.66 | 8.27 | 0.75 |
| **150** | 74.00 | 8.33 | 2.84 | 1.49 | 13.45 | 9.20 | 0.84 |
| **LSD at 5%** | 2.15 | 0.25 | 0.18 | 0.08 | 0.25 | 1.41 | 0.05 |

Table 2. Effect of potassium silicate concentrations on growth characters of garlic plants at 135 days after planting during 2015/2016 and 2016/2017 seasons

| Potassium silicate ($cm^3/l$) | Plant height (cm) | Leaf number/ plant | Bulb diameter (cm) | Neck diameter (cm) | Bulb dry weight/plant (g) | Leaf dry weight/plant (g) | Root dry weight/plant (g) |
|---|---|---|---|---|---|---|---|
| | | | | 2015/2016 season | | | |
| **Control** | 68.60 | 7.80 | 2.78 | 1.36 | 12.19 | 8.15 | 0.71 |
| **3** | 67.20 | 7.87 | 2.63 | 1.40 | 12.64 | 7.97 | 0.71 |
| **6** | 71.95 | 8.07 | 2.77 | 1.48 | 12.81 | 8.91 | 0.78 |
| **LSD at 5%** | 3.31 | 0.27 | NS | 0.07 | 0.06 | 0.76 | 0.16 |
| | | | | 2016/2017 season | | | |
| **Control** | 68.01 | 7.93 | 2.67 | 1.31 | 12.02 | 7.83 | 0.71 |
| **3** | 67.76 | 7.86 | 2.65 | 1.38 | 12.54 | 7.83 | 0.71 |
| **6** | 72.32 | 7.89 | 2.75 | 1.46 | 13.04 | 8.98 | 0.78 |
| **LSD at 5%** | 2.06 | 0.21 | NS | 0.05 | 0.14 | 1.41 | 0.16 |

**Table 3. Effect of the combination between potassium sulphate levels and potassium silicate concentrations on growth characters of garlic plants at 135 days after planting during 2015/2016 and 2016/2017 seasons**

| Potassium sulphate (kg/faddan) | Potassium silicate ($cm^3/l$) | | | | | |
|---|---|---|---|---|---|---|
| | control | 3 | 6 | Control | 3 | 6 |
| | First season (2015/2016) | | | Second season (2016/2017) | | |
| | | | | Plant height (cm) | | |
| **60** | 63.00 | 55.80 | 71.60 | 65.33 | 58.53 | 72.50 |
| **90** | 66.00 | 68.90 | 68.70 | 64.13 | 66.83 | 69.27 |
| **120** | 71.70 | 67.60 | 73.60 | 69.17 | 70.40 | 74.17 |
| **150** | 73.70 | 76.50 | 73.90 | 73.40 | 75.27 | 73.33 |
| **LSD at 5%** | | 6.16 | | | 4.11 | |
| | | | | Leaf number/plant | | |
| **60** | 7.60 | 7.10 | 8.10 | 7.87 | 7.40 | 7.83 |
| **90** | 7.30 | 7.90 | 7.80 | 7.67 | 7.80 | 7.57 |
| **120** | 8.10 | 7.90 | 8.10 | 7.87 | 7.73 | 8.03 |
| **150** | 8.20 | 8.60 | 8.30 | 8.33 | 8.53 | 8.13 |
| **LSD at 5%** | | 0.64 | | | 0.43 | |
| | | | | Bulb diameter (cm) | | |
| **60** | 2.50 | 2.10 | 2.80 | 2.40 | 2.37 | 2.73 |
| **90** | 2.67 | 2.77 | 2.60 | 2.60 | 2.67 | 2.70 |
| **120** | 2.97 | 2.87 | 2.80 | 2.87 | 2.73 | 2.73 |
| **150** | 3.00 | 2.80 | 2.90 | 2.83 | 2.83 | 2.86 |
| **LSD at 5%** | | 0.37 | | | 0.28 | |
| | | | | Neck diameter (cm) | | |
| **60** | 1.30 | 1.27 | 1.50 | 1.23 | 1.20 | 1.47 |
| **90** | 1.27 | 1.40 | 1.40 | 1.20 | 1.37 | 1.37 |
| **120** | 1.40 | 1.47 | 1.47 | 1.43 | 1.43 | 1.47 |
| **150** | 1.47 | 1.47 | 1.57 | 1.40 | 1.53 | 1.53 |
| **LSD at 5%** | | 0.17 | | | 0.12 | |

**Table 4. Effect of the combination between potassium sulphate levels and potassium silicate concentrations on dry weight of garlic plants at 135 days after planting during 2015/2016 and 2016/2017 seasons**

| Potassium sulphate (kg/faddan) | Potassium silicate ($cm^3$/l) | | | | | |
|---|---|---|---|---|---|---|
| | Control | 3 | 6 | control | 3 | 6 |
| | 2015/2016 season | | | 2016/2017 season | | |
| | | | Bulb dry weight/plant (g) | | | |
| **60** | 10.80 | 12.37 | 11.93 | 11.33 | 12.31 | 12.02 |
| **90** | 11.73 | 12.43 | 11.83 | 11.44 | 12.61 | 12.37 |
| **120** | 12.93 | 12.50 | 12.40 | 12.18 | 12.59 | 13.21 |
| **150** | 13.30 | 13.26 | 15.09 | 13.13 | 12.67 | 14.54 |
| **LSD at 5%** | | 0.13 | | | 0.34 | |
| | | | Leaf dry weight/plant (g) | | | |
| **60** | 5.10 | 6.79 | 8.14 | 6.47 | 5.76 | 8.89 |
| **90** | 8.65 | 7.99 | 8.84 | 7.85 | 8.20 | 8.97 |
| **120** | 8.10 | 8.84 | 9.19 | 8.25 | 7.87 | 8.70 |
| **150** | 10.05 | 9.00 | 9.50 | 8.75 | 9.50 | 9.37 |
| **LSD at 5%** | | 1.98 | | | 2.70 | |
| | | | Root dry weight/plant (g) | | | |
| **60** | 0.63 | 0.56 | 0.64 | 0.51 | 0.62 | 0.67 |
| **90** | 0.70 | 0.76 | 0.63 | 0.72 | 0.65 | 0.77 |
| **120** | 0.73 | 0.76 | 0.82 | 0.74 | 0.76 | 0.75 |
| **150** | 0.78 | 0.78 | 1.04 | 0.74 | 0.93 | 0.86 |
| **LSD at 5%** | | 0.29 | | | 0.08 | |

However, the great influence was obtained on plant traits due to supplying plants with potassium sulphate at 150 kg/fad., as soil application combined with 6 $cm^3$/l potassium silicate as foliar spray in both seasons. These results are in line with those reported by **Abou El-Khair and Mohsen (2016)** on Jerusalem artichoke.

Generally, as mentioned just before, both potassium fertilization levels and potassium silicate concentration treatments (each alone) increased plant growth of garlic plant, in turn, they together might maximize their effects leading to better results in this connection.

## Yield and Some Chemical Constituents

### Effect of potassium sulphate levels

Clear differences in total yield/fad. (ton) were detected due to supplying plants with different levels of potassium sulphate as presented in Table 5. The two levels of potassium sulphate (150 and 120 kg/fad.) were the best treatments used in raising total yield of garlic per faddan without significant differences between them compared with the lowest level in both seasons. Additionally, enhance translocation of sugar and carbohydrates through plant organs, increases protein synthesis and different metabolic

Table 5. Effect of potassium sulphate levels on yield and some chemical constituents of garlic plants during 2015/2016 and 2016/2017 seasons

| Potassium sulphate (kg/faddan) | Yield/fad. (ton) | TSS (Brix°) | Nitrogen (%) | | Phosphorus (%) | | Potassium (%) | |
|---|---|---|---|---|---|---|---|---|
| | | | Bulb | Leaves | Bulb | Leaves | Bulb | Leaves |
| | | | | **2015/2016 season** | | | | |
| **60** | 5.88 | 35.67 | 2.51 | 1.18 | 0.56 | 0.50 | 1.61 | 3.05 |
| **90** | 6.87 | 36.23 | 2.56 | 1.45 | 0.57 | 0.49 | 1.71 | 3.24 |
| **120** | 7.32 | 37.10 | 2.76 | 1.61 | 0.63 | 0.49 | 2.00 | 3.65 |
| **150** | 7.71 | 37.77 | 3.50 | 1.72 | 0.66 | 0.49 | 1.85 | 4.04 |
| **LSD at 5%** | 0.47 | 0.24 | 0.08 | 0.03 | 0.02 | NS | 0.06 | 0.03 |
| | | | | **2016/2017 season** | | | | |
| **60** | 6.63 | 35.81 | 2.55 | 1.23 | 0.54 | 0.49 | 1.63 | 3.17 |
| **90** | 7.14 | 36.23 | 2.52 | 1.47 | 0.55 | 0.48 | 1.69 | 3.36 |
| **120** | 7.29 | 36.14 | 3.14 | 1.58 | 0.63 | 0.49 | 1.79 | 3.54 |
| **150** | 8.01 | 37.91 | 3.49 | 1.72 | 0.66 | 0.49 | 2.05 | 4.03 |
| **LSD at 5%** | 0.34 | 0.20 | 0.06 | 0.02 | 0.02 | NS | 0.05 | 0.13 |

processes (**Csirzinsky, 1999**). Results revealed that potassium sulphate at 150 kg/faddan significantly increased total soluble solid, total nitrogen percentage in bulb and leaves, total phosphorus percentage in bulb and potassium percentage in both bulb and leaves (Table 5). These results are in harmony with those obtained by **Abdel Fattah *et al.* (2002), El Sayed and El Morsy (2012), Ali (2013)** on garlic, **Anjaiah and Padmaja (2006), Hossain *et al.* (2009)** and **Shikha *et al.* (2016)** on carrot and **Bartaseviciene and Pekarskas (2007)** on vegetables crops.

The increase in total yield was directly due to the increase in plant growth (Tables 1 and 4), and high N, P and K in leaves and bulbs (Table 6). These increases might be ascribed to the favorable role of the used potassium in pigments formation, photosynthesis activation and carbohydrates assimilation diverted to the bulbs which represented the economic part of plant **(Hilman and Asandhi, 1987)**.

**Effect of potassium silicate concentrations**

Results outlined in Table 6 show that the application of different concentrations of potassium silicate had significant effect on total yield of garlic per faddan, TSS and NPK percentage in bulb and leaves compared to control (untreated plants). Also, the highest values in this regard were recorded by the highest concentration of potassium silicate especially 6 $cm^3/l$, in most cases, in the two seasons.

In addition, foliar spray with potassium silicate increased N, P and K contents in leaves and yield and its components as found by **Kamal (2013)** on sweet pepper, **Salim *et al.* (2014)** on potato and **Abdelkader *et al.* (2016**) on roselle.

**Effect of the combination between potassium sulphate levels and potassium silicate concentrations**

With regard to the combination between potassium sulphate and potassium silicate it is evident from tabulated results in Tables 7 and 8, that all combination treatments caused an increment in total yield per faddan, nitrogen, phosphorus and potassium percentages comparing with that recorded from untreated plants with potassium silicate when combined with potassium sulphate at 60 kg/fad., in both seasons, in most cases.

Table 6. Effect of potassium silicate concentrations on yield and some chemical constituents of garlic plants during 2015/2016 and 2016/2017 seasons

| Potassium silicate ($cm^3/l$) | Yield/fad. (ton) | TSS (Brix°) | Nitrogen (%) | | Phosphorus (%) | | Potassium (%) | |
|---|---|---|---|---|---|---|---|---|
| | | | Bulb | Leaves | Bulb | Leaves | Bulb | Leaves |
| **2015/2016 season** | | | | | | | | |
| **Control** | 5.46 | 36.00 | 2.88 | 1.46 | 0.59 | 0.48 | 1.73 | 3.43 |
| **3** | 6.93 | 36.53 | 3.04 | 1.46 | 0.61 | 0.49 | 1.79 | 3.46 |
| **6** | 8.40 | 37.55 | 2.93 | 1.55 | 0.61 | 0.51 | 1.86 | 3.59 |
| **LSD at 5%** | 0.28 | 0.16 | 0.05 | 0.02 | NS | 0.01 | 0.04 | 0.02 |
| **2016/2017 season** | | | | | | | | |
| **control** | 6.57 | 36.27 | 2.88 | 1.46 | 0.58 | 0.48 | 1.74 | 3.27 |
| **3** | 7.47 | 36.45 | 2.97 | 1.45 | 0.60 | 0.48 | 1.79 | 3.43 |
| **6** | 7.74 | 36.75 | 2.93 | 1.58 | 0.60 | 0.51 | 1.84 | 3.87 |
| **LSD at 5%** | 0.19 | 0.24 | 0.05 | 0.04 | 0.01 | 0.04 | 0.04 | 0.12 |

Table 7. Effect of the combination between potassium sulphate levels and potassium silicate concentrations on yield and some chemical constituents of garlic plants during 2015/2016 and 2016/2017 seasons

| Potassium sulphate (kg/faddan) | Potassium silicate ($cm^3/l$) | | | | | |
|---|---|---|---|---|---|---|
| | Control | 3 | 6 | Control | 3 | 6 |
| | 2015/2016 season | | | 2016/2017 season | | |
| **Yield/faddan (ton)** | | | | | | |
| **60** | 4.17 | 6.15 | 7.35 | 5.49 | 7.20 | 7.23 |
| **90** | 5.22 | 7.02 | 8.34 | 6.75 | 7.29 | 7.41 |
| **120** | 6.03 | 7.23 | 8.67 | 6.72 | 7.50 | 7.62 |
| **150** | 6.51 | 7.35 | 9.30 | 7.35 | 7.86 | 8.79 |
| **LSD at 5%** | | 1.13 | | | 0.55 | |
| **Total soluble solids TSS (Brix°)** | | | | | | |
| **60** | 35.80 | 35.00 | 36.20 | 35.23 | 34.93 | 36.07 |
| **90** | 35.50 | 36.90 | 36.90 | 35.67 | 36.30 | 36.73 |
| **120** | 36.00 | 36.30 | 37.40 | 35.73 | 36.13 | 36.57 |
| **150** | 36.70 | 37.90 | 39.70 | 38.47 | 37.63 | 37.63 |
| **LSD at 5%** | | 0.36 | | | 0.43 | |
| **Nitrogen (%) in bulb** | | | | | | |
| **60** | 2.15 | 2.88 | 2.51 | 2.36 | 2.81 | 2.48 |
| **90** | 3.54 | 3.08 | 2.46 | 2.12 | 3.02 | 2.42 |
| **120** | 2.29 | 3.09 | 2.91 | 3.45 | 3.03 | 2.95 |
| **150** | 3.54 | 3.12 | 3.84 | 3.58 | 3.03 | 3.87 |
| **LSD at 5%** | | 0.12 | | | 0.10 | |
| **Nitrogen (%) in leaves** | | | | | | |
| **60** | 1.20 | 1.24 | 1.11 | 1.27 | 1.25 | 1.17 |
| **90** | 1.36 | 1.53 | 1.45 | 1.42 | 1.51 | 1.47 |
| **120** | 1.41 | 1.56 | 1.85 | 1.40 | 1.53 | 1.82 |
| **150** | 1.87 | 1.52 | 1.78 | 1.77 | 1.51 | 1.88 |
| **LSD at 5%** | | 0.04 | | | 0.07 | |

**Table 8. Effect of the combination between potassium sulphate levels and potassium silicate concentrations on phosphorus and potassium percentages of garlic plants during 2015/2016 and 2016/2017 seasons**

| Potassium sulphate (kg/faddan) | Potassium silicate ($cm^3$/l) | | | | | |
|---|---|---|---|---|---|---|
| | control | 3 | 6 | Control | 3 | 6 |
| | 2015/2016 season | | | 2016/2017season | | |
| | | | Phosphorus (%) in bulb | | | |
| **60** | 0.58 | 0.56 | 0.55 | 0.53 | 0.53 | 0.55 |
| **90** | 0.56 | 0.58 | 0.58 | 0.59 | 0.55 | 0.55 |
| **120** | 0.59 | 0.65 | 0.65 | 0.58 | 0.65 | 0.65 |
| **150** | 0.64 | 0.67 | 0.67 | 0.64 | 0.67 | 0.67 |
| **LSD at 5%** | | 0.03 | | | 0.03 | |
| | | | Phosphorus (%) in leaves | | | |
| **60** | 0.49 | 0.50 | 0.51 | 0.49 | 0.49 | 0.51 |
| **90** | 0.48 | 0.49 | 0.50 | 0.48 | 0.48 | 0.49 |
| **120** | 0.47 | 0.49 | 0.53 | 0.46 | 0.48 | 0.53 |
| **150** | 0.48 | 0.49 | 0.50 | 0.47 | 0.50 | 0.51 |
| **LSD at 5%** | | 0.01 | | | 0.09 | |
| | | | Potassium (%) in bulb | | | |
| **60** | 1.56 | 1.67 | 1.59 | 1.61 | 1.68 | 1.59 |
| **90** | 1.52 | 1.74 | 1.87 | 1.61 | 1.67 | 1.80 |
| **120** | 2.07 | 2.04 | 1.90 | 1.72 | 1.74 | 1.90 |
| **150** | 1.77 | 1.71 | 2.08 | 2.00 | 2.07 | 2.09 |
| **LSD at 5%** | | 0.09 | | | 0.08 | |
| | | | Potassium (%) in leaves | | | |
| **60** | 2.87 | 3.06 | 3.21 | 2.80 | 2.89 | 3.81 |
| **90** | 3.06 | 3.43 | 3.23 | 3.03 | 3.30 | 3.75 |
| **120** | 3.86 | 3.30 | 3.80 | 3.32 | 3.49 | 3.80 |
| **150** | 3.94 | 4.05 | 4.12 | 3.94 | 4.04 | 4.11 |
| **LSD at 5%** | | 0.05 | | | 0.24 | |

Furthermore, the best combination treatment was 120 or 150 kg/fad., with the high concentration of potassium silicate at 6 $cm^3$/l compared to control.

## Conclusion

Potassium sulphate at 120 or 150 kg/ faddan contributed to an increase in total garlic yield per feddan without significant differences between them under study. Also, foliar spray with potassium silicate at the rate 6 $cm^3$/l led to stimulate growth, increasing yield and enhancing some biochemical constituents of garlic plant.

From the above mentioned results it could be concluded that foliar application of potassium silicate (6 $cm^3$/ l) could be successfully used in addition to fertilization application of potassium sulphate with rate of 120 kg/fad., to obtain the highest vegetative growth characters, total yield, and significantly enhanced bulb quality of garlic plants under similar field conditions.

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## تأثير طرق إضافة البوتاسيوم علي نباتات الثوم النامية تحت ظروف الأراضي الرملية

**هاني جمال زيادة – إيناس عبد الله برديسي**

قسم البساتين - كلية الزراعة - جامعة الزقازيق - مصر

أُجريت تجربتان حقليتان خلال موسمي شتاء ٢٠١٦/٢٠١٥ و ٢٠١٧/٢٠١٦ بمزرعة التجارب بالخطارة، كلية الزراعة، جامعة الزقازيق، مصر لدراسة تأثير سلفات البوتاسيوم (٦٠، ٩٠، ١٢٠ و ١٥٠ كجم/ للفدان) كإضافة أرضية والرش الورقي بسيليكات البوتاسيوم (صفر، ٣ و ٦ سم$^3$/لتر ماء) والتفاعل بينهما علي قياسات النمو، والوزن الجاف للنبات، والمحصول الكلي وجودة رؤوس الثوم صنف بلدي النامي في أرض رملية تحت نظام الري بالتنقيط، وكانت أهم النتائج المتحصل عليها على النحو التالي: كان تسميد الثوم بسلفات البوتاسيوم بمعدل ١٢٠ أو ١٥٠ كجم/فدان أفضل المستويات المستخدمة لزيادة ارتفاع النبات، وعدد الأوراق، وقطر البصلة والعنق، والوزن الجاف للأوراق، والجذور، والمحصول الكلي للفدان، ونسبة المواد الصلبة الكلية ومحتوي الأبصال والأوراق من النتروجين والفوسفور والبوتاسيوم بالمقارنة بالمستويات المنخفضة من البوتاسيوم، أعطي الرش بسيليكات البوتاسيوم بتركيز ٦ سم$^3$/لتر أعلى القيم بالنسبة للنمو، ومحتوي الأوراق والأبصال من النتروجين والفوسفور والبوتاسيوم، والمحصول الكلي في كلا الموسمين، يوصى بتسميد الثوم البلدي المنزرع تحت ظروف الأراضي الرملية بسلفات البوتاسيوم بمعدل ١٢٠ كجم /فدان والرش بسيليكات البوتاسيوم بتركيز ٦ سم$^3$/ لتر لزيادة المحصول الكلي للفدان.

**المحكمـــــون:**

**١- أ.د. السيد السيد محمد أبو الخير** أستاذ الخضر – مركز البحوث الزراعية.

**٢- أ.د. داليا أحمد ســامي نـــــوار** أستاذ الخضر – كلية الزراعة – جامعة الزقازيق.