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THE ROLE OF ORGANIC FERTILIZER (TICAMIN MAX) AND POTASSIUM SULFATE IN THE QUANTITATIVE AND QUALITATIVE YIELD OF POTATO (SOLANUM TUBEROSUM L.)

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Abstract

The experiment was carried out in College of Agriculture and Forestry / Mosul University during spring season 2021, to investigate the effect of spraying organic acid (Ticamin Max) at a concentrations (1.5, 3, 4.5 and 6 ml L-1) and potassium sulfate at a concentrations (1.5, 3 , 4.5 and 6 gm l-1) in addition to the control treatment in potato plants ,Arizona cultivar, grade E. The experiment was designed according to the randomized complete block design (RCBD) with three replications. The results showed :
Spraying Ticamin Max at 6 ml l-1 concentration gave the highest significant values in the number of total and marketable tubers per plant, tubers hardness and the percentage of total soluble solids (TSS) in tubers, with a value of 12.88, 11.10, and 12.45 kg cm2 and 6.03%, respectively. The treatment of potassium sulfate at 3 gm l-1 concentration gave the highest significance values in the average marketable tubers weight, marketable plant yield, marketing yield of tubers, percentage of dry matter and starch in tubers, and the specific weight of the tubers, with a value of 93.12 g and 960.89 gm 51.247 tons ha-1 and 19.67%, 13.13% and 1.1920, respectively.

Keywords: Ticamin Max, Potassium Sulfate, Potato, Tuber.

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Introduction

Potato (*Solanum tuberosum* L.) belonging to the Solanaceae family is important vegetable crops in Iraq and the world in terms of productivity and cultivated area. It has a high nutritional value because it contains many nutrients such as phosphorous, calcium, iron, potassium and magnesium, and also contains ascorbic acid, protein, vitamins, carbohydrates. , Fibers, sugars and organic acids (Hassan, 2003). It is also rich in amino acids, especially lysine, which gives it a high nutritional value (Hamdan et al., 2006). Humic acid is one of the main components of organic matter, which positively affects plant growth (Pettit, 2003). Potassium has an important role in enhancing the activity of enzymes, especially the nitrate reductase enzyme , and also stimulating many important biological processes such as the process of opening and closing stomata (Krauss, 1993). Potassium also stimulates the absorption of CO_2 gas through the stomata and the formation of ATP, which is necessary to fill the sieve tubes with materials resulting from the photosynthesis process. It has a role in converting light energy into chemical energy in the form of ATP in the process of photophosphorylation, biological processes in plant cells such as the synthesis of proteins, carbohydrates and fats (Mengle, 1997). Al-Mohareb (2011) showed that spraying potassium sulfate at 5 gm l^{-1} on potato plants of Desiree cultivar caused a significant increase in the number of marketable tubers, the marketing yield of tubers and the total yield of tubers. Al-Ajil and Al-Hasnawi (2011) observed that spraying humic acid at 50, 75 and 100 ml L^{-1} on two potato cultivars caused a significant increase in the percentage of dry matter and starch in tubers.

Sarhan (2011) found that spraying potato plants Desiree cultivar with humic acid at 3 ml L^{-1} led to a significant increase in the number of tubers per plant, average tuber weight, plant and total yield of tubers. Al-Alousi (2013) mentioned that spraying potato plants with potassium sulfate at 5 gm l^{-1} caused a significant increase in the total yield of tubers, the number of tubers per plant, and the percentage of starch in tubers. Al-Bayati et al. (2013) observed when spraying two potato cultivars plants with humic acid (Bau-Humes) at concentrations 1, 2, 3, 4, and 5 gm l^{-1}, that 5 gm l^{-1} gave the highest significant values in the number of tubers per plant and plant yield, and marketing and total yield of tubers compared to others concentrations Al-Sultani (2015) found that spraying potato plants with humic acid at 0, 1.5 and 3 ml L^{-1} increase significantly the number of tubers per plant, average tuber weight, yield per plant, total and marketing yield of tubers and the percentage of the dry matter , starch and (TSS) in tubers compared to other concentrations. Merhej and Jassim (2018) reported that spraying potato plants with high-potash fertilizer at a concentration of 10 ml L^{-1} increase significantly plant yield, marketing and total tubers yield Kahlel and Sultan ,2019 revealed that applying Ticamin Max compounds to the soil at 3 ml.l^{-1} increased significantly dry weight of whole plant, total chlorophyll in leaves, tuber average weight, tuber volume, plant tubers yield, and total tubers yield, percentage of NPK in leaves . Noora et al. (2020) found that spraying potato plants (Sylvana cultivar) with potassium sulfate at of 5 gm l^{-1} , increase significantly the number of tubers per plant and the total yield of tubers compared to the control treatment. AL-Bayati and AL-Dulaimi (2020) showed that spraying potassium sulfate at of 3 gm l^{-1} on two potato cultivars Arizona and Laperla caused a significant increase in the number of tubers per plant, plant and total yield of tubers in comparison with concentrations 0 and 6 g l^{-1}. Najem (2020) noticed when spraying potato plants (Sylvana cultivar) with potassium sulfate at concentrations 0, 2.5 and 5 gm l^{-1}, that the concentration of 5 gm l^{-1} caused a significant increase in the number of marketable tubers of the plant, the average marketable tuber weight, the marketing yield of the plant and the marketing yield of tubers per unit area and percentage of dry matter, starch and TSS in tubers.

The study aims to demonstrate the effect of spraying different concentrations of humic acid (Ticamin Max) and potassium sulfate on the quantitative and qualitative yield tubers of potato Arizona variety.

Materials and Methods:

The experiment was conducted in the vegetable field / Department of Horticulture and Landscape / College of Agriculture and Forestry / University of Mosul during spring season 2021, to investigate the effect of spraying of humic acid (Ticamin Max) and potassium sulfate in potato plants Arizona cultivar E grad imported from Holland . Samples of field soil were taken from the soil surface to a depth of 30 cm and analyzed in the central laboratory / College of Agriculture and Forestry / University of Mosul to determine the physical and chemical properties of field soil as shown in Table 1

Table 1. Some physical and chemical properties of field soil:

H	EC (ds.m^{-1})	Organic matter%	Total N (mg.kg^{-1})	Available P (mg.kg^{-1})	Exchangeable K (mg.kg^{-1})	Sand (gm kg^{-1})	Silt (gm kg^{-1})	Clay (gm kg^{-1})	Texture class
.2	0.9	1.1	25.2	8.5	118	575.5	277.5	147	Sandy loam

Analysis conducted in the Central Laboratory/ College of Agriculture and Forestry / University of Mosul.

NPK 0-46-18, fertilizer with an amount of 600 kg ha^{-1}, was added to the soil, and. The tubers of Arizona variety, grade E, were planted in 35-55 mm size , at a depth of 12-15 cm, and at a distance of 25 cm on 17 Feb. 2021. The following treatments were used by spraying on the plants:

1- Control (water spray only).

2- Humic acid (Ticamin Max) 1.5 ml L^{-1}.

3- Humic acid (Ticamin Max) 3 ml L^{-1}.

4- Humic acid (Ticamin Max) 4.5 ml L^{-1}.

5- Humic acid (Ticamin Max) 6 ml L^{-1}.

6- Potassium sulfate 1.5 g l^{-1}.

7- Potassium sulfate 3 gm l^{-1}.

8- Potassium sulfate 4.5 g l^{-1}.

-9 Potassium sulfate 6 gm l^{-1}.

The study was conducted in simple experiment in Randomized Complete Block Design (RCBD) with three replications.

Humic acid (Ticamin Max) and potassium sulfate were sprayed three times during the season, the first one after a week of tubers emergence complete , the second after 20 days from the first (tuber development phase), the third after 20 days from the second (tuber formation phase) .

After 110 days of planting the tubers were harvested on 7/6/2021 and the following characteristics were recorded:

1- Number of total tubers per plant .

2- Number of marketable tubers per plant .

3- Average weight of the marketing tuber (gm).

4- Marketable plant yield (gm).

5- Marketable yield of tubers (ton ha-1).

6- Tuber hardness (kg. cm. ^{2}).

7- Percentage of total soluble solids (TSS) in tubers.

8- Percentage of dry matter in tubers.

9- Percentage of starch in tubers..

10- Specific gravity of tubers

The results were statistically analysis according to the statistical analysis system (SAS) and compared with the means by Duncan multiple rang test at 0.05 level (Al-Rawy, & Khalaf-Allah,2000).

Results:

It was noted from the results of table (2) that spraying of humic acid (Ticamin Max) at a concentration of 6 ml L^{-1} gave the highest significant value in number of total and marketable tubers per plant, (12.88 and 11.10) respectively, while spraying Potassium sulfate at a concentration of 3 g l^{-1} gave the highest significant values in the average marketable weight of the tuber, the marketable plant yield and the marketable yield of tubers, which were (93.12 g, 960.89 g and 51.247 tons ha^{-1}) respectively, and the lowest values for these traits were found in the control treatment, which reached (7.55 and 6. 22 tuber $plant^{-1}$, 74.13 g, 461.01 g, and 24.587 ton ha^{-1}) respectively.

Table.2. Effect of humic acid (Ticamine Max), potassium sulphate spraying on some quantity yield characteristics of potato.

Treatments	Number. of tubers per plant	Number . of marketable tubers per .plant-	Average wighty of marketable tuber (gm)	Marketable yield per plant (gm)	Marketable yield of tubers (t ha^{-1})
Control	7.55 d	6.22 d	74.13 c	461.01 e	24.587 e
H.A.1.5 (ml. l^{-1})	8.10 cd	6.66 d	87.35 abc	582.88 de	31.087 de
H.A 3 (ml. l^{-1})	9.74 bc	8.55 c	75.85 bc	651.40 cd	34.742 cd
H.A.4.5 (ml.$l.^{-1}$)	11.44 ab	9.08 bc	82.82 abc	742.27 bc	39.588 bc
H.A. 6 (ml. l^{-1})	12.88 a	11.10 a	83.04 abc	921.62 a	49.153 a
P.S. 1.5 (g. l^{-1})	12.66 a	10.32 ab	86.72 abc	837.17 ab	44.649 ab
P.S. 3 (g. l^{-1})	11.77 ab	9.66 abc	93.12 a	960.89 a	51.247 a
P. S. 4.5(g. l^{-1})	12.50 a	8.55 c	88.49 abc	755.59 bc	40.298 bc
P.S. 6 (g. l^{-1})	12.00 a	8.66 c	89.15 ab	769.88 bc	41.060 bc

The average with same letter for each factor is non-significant according to Duncan's multiple range tests under level 0.05.

Tabl 3 illustrated the effect of humic acid (Ticamine Max), potassium sulphate on some quality yield characteristics of potato. It was found that spraying potato plants by Ticamine Max at 6 ml. l^{-1} concentration increase significantly tubers firmness (12.45 kg. cm^2) and TSS (6.03 %) .while spraying potassium sulphate at 3.0 g.l^{-1} gave the highest values of dry matter (19.67%), starch percentage (13.13 %) and specific gravity (1.1920) of tubers . The lowest values of the five characteristics was from the control treatment which recorded (8.81 kg cm^2, 4.80 , 17.48%, 10.99 %, 1.1816) respectively.

Table.3. Effect of humic acid (Ticamine Max), potassium sulphate concentrations spraying on some quality yield characteristics of potato.

Treatments	Tuber firmness (kg cm^2)	TSS%	dry matter Percentage in tubers	Starch Percentage in tuber	Specific gravity of tubers
Control	8.81 d	4.80 b	17.48 d	10.99 d	1.1816 d
H.A. 1.5 (ml.l^{-1})	9.96 cd	4.80 b	18.48 cd	11.77 cd	1.1854 cd
H. A. 3 (ml. l^{-1})	12.32 ab	4.90 b	19.06 abc	12.53 abc	1.1891 abc
H.A.4.5 (ml. l^{-1})	11.50 ab	4.83 b	19.20 abc	12.67 abc	1.1898 abc
H. A. 6 (ml. l^{-1})	12.45 a	6.03 a	18.85 abc	12.32 abc	1.1881 abc
P. S. 1.5 (g. l^{-1})	12.43 a	5.01 ab	19.29 ab	12.75 ab	1.1902 ab
P. S. 3. (g.l^{-1})	10.96 bc	4.93 ab	19.67 a	13.13 a	1.1920 a
P. S. 4.5(g. l^{-1})	12.15 ab	5.53 ab	18.56 bc	12.04 bc	1.1867 bc
P. S. 6 (g. l^{-1})	11.15 abc	5.00 ab	19.35 ab	12.82 ab	1.1905 ab

The average with same letter for each factor is non-significant according to Duncan's multiple range tests under level 0.05.

It was found from the results in tables 2 and 3 that spraying humic acid (Ticamin Max) at 6 ml. l^{-1} concentration gave the highest values in the number of total and marketable tubers of the plant (Table 2) and the tuber firmness and TSS (Table 3) This may be due to the mineral elements that organic fertilizer contains which important for

plant growth, as well as containing many amino acids and plant hormones such as gibberellins, auxins and cytokines, as well as containing proteins, carbohydrates and .

organic nitrogen and its role in increasing the activity of enzymes and thus stimulating the growth of roots and stolons which is the origin of the tubers and thus increase tubers number. The superiority of spraying potassium sulfate at a concentration of 3 g l^{-1} in increasing the rate of tuber weight, marketable yield of the plant and marketable yield of the tubers per hectare Table 2), the percentage of dry matter and starch, and the pecific weight of the tubers (Table 3) may be attributed to the important role that potassium plays in increasing the opening of stomata which increasing the concentration of CO_2 gas in plant cells, increasing the efficiency of the photosynthesis process, and processed of carbohydrates and helping it to transfer the sugars from leaves (Sources) to tubers (Sinks) and increasing their size (Trehan and Greweal, 1990). Also, the presence of sulfur when spraying potassium sulfate, which is a necessary nutritional element for plants, and thus led to an increase in the size of tubers and an increase in yield (Rao and Rao, 2000). The high concentration of potassium may have a negative effect on the absorption of other mineral elements such as nitrogen and phosphorous (Al-Sahhaf, 1989), and as a result it led to a lack of tubers yield and its components, also potassium increases the rate of tuber bulging and the syntheses of carbohydrates and protein and helps in its transfer from the leaves to the tuber (Imas and Bansal, 1999). and thus leads to the accumulation of carbohydrates and proteins in the tubers and leads to an increase in the percentage of dry matter, starch and the specific weight of the tubers.

Conclusions:

It can be concluded from this study that spraying humic acid at a concentration of 6 ml L^{-1} caused an increase in the number of total and marketable tubers of the plant, tuber firmness and TSS in tubers, and spraying potassium sulfate at a concentration of 3 g L^{-1} caused a significant increase in the average weight of tuber , plant yield, marketable yield of tubers and the proportion of the Percentage of dry matter and starch in tubers and specific weight of tubers.

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