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Effect of Humic acid and potassium sulfate spraying on growth and yield of strawberry (*Fragaria x ananassa* Duch.)

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Abstract

This study was carried out in the green house of the Agricultural-Research and Experiment>Station, College of Agriculture, University of Kirkuk, Sayada area, Kirkuk, Iraq during the season 2021-2022 to study the effect of humic and potassium sulfate spraying on the growth and yield of Rubegym strawberries. The experiment was-included two factors, the first being three levels of sulfate Potassium (0, 1000 and 20000) mg L-1, and the second factor was three concentrations of humic, which is (0, 2 and 4) g L-1, using the randomized complete block design (R.C.B.D.) as a factorial experiment, using 10 seedlings per experimental unit, and the data were analyzed statistically using the (SAS V 9.0) program, and the averages were compared according to Dunkin's multinomial test at the probability level (0.05). Total. Soluble. Solids and vitamin C compared to control treatment.

Key words: humic acid, strawberry, potassium sulfate, vitamin C.
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Introduction

Strawberry Fragaria x ananassa Duch, which belongs to the Rosaceae family, is one of the most important fruits, with small and widespread fruits in different regions of the world due to a large number of its varieties and its ability to adapt. and grow in different environmental conditions [1], from the arctic to the tropics. Strawberry may be grown practically anywhere [2]. Adding subtropical regions like the northern part of Iraq After apples, oranges, and bananas, strawberries are among the top four fruits consumed worldwide. The strawberry plant is a herbaceous perennial with a short life of three to five years. Reaching a height of about 30 cm above the soil surface. In the axils of the leaves are buds that may grow, give

inflorescences, outriggers, or crowns, or remain dormant [3]. Strawberry has great nutritional value because its fruits contain many substances and nutrients such as proteins, carbohydrates, fats, calcium, magnesium, phosphorus, potassium, copper, and zinc, as well as vitamin C,thiamine, and riboflavin [4]. Its fruits are used in many food industries, such as making jams, ice cream, and pastries, as well as having medical and therapeutic value in eliminating types of bacteria and treating many diseases [5]. Although strawberries are often grown in colder climates, particularly in the north, the country's climate is conducive to the production of good-quality fruit. The technology for growing strawberries is relatively new in the northern part of Iraq, although the area under cultivation is growing gradually. In the northern part of Iraq, strawberries can be produced from October through April. For dependable output from one year to the next, a sustainable variety is required. In order to find a strawberry variety that is suited for continuous production, some varieties have undergone screening. Today, practically all nations in the world produce strawberries, but Iran, Turkey, and the United States stand out. This widespread range shows that both the strawberry plant and the genus as a whole are well suited. Although a lot [6]. Studies have revealed that there is a trend toward increasing strawberry cultivation and chemical and biological soil [7]. Traditions in agriculture: farmers employed synthetic fertilizers to increase production [8]. However, the addition of organic fertilizer is one of the most important factors in increasing the soil's content of organic matter [9]. Humic acid is an important part of the organic matter in the soil that has been identified as amorphous, dark-colored chemical compounds (polymers) that have been collected from the components of biomass or metabolites, biochemically or chemically, in the environment [10]. Another component of the humic material is humic acid. But it is less active than fulvic acid (FA). It has been called polydisperse because of its variable chemical profiles [11]. [12] It is indicated that humic acid is one of the organic and mineral fertilizers used in complement to chemical fertilizers. Thus, organic fertilizers, in their various sources, contain a wide range of water-soluble organic compounds like sugars, proteins, amino acids, and humic and non-humic organic acids, and all these compounds contribute directly or indirectly to plant growth and development. They contain nutrients needed by the plant, or they increase the readiness of nutrients already present in the soil or added to it, increasing production and improving its quality [13]. Potassium is a positive ion (monovalent) that plants need in large quantities, although it is not included in any organic compound. It is a highly mobile element that moves when it is required within the tissues of the plant, so symptoms of its deficiency appear first on the lower or older leaves than on the new leaves [14]. Potassium affects the vital processes in the plant, especially respiration and photosynthesis, and one of the most important roles that potassium plays in the plant is in the process of transpiration and the opening and closing of stomata [15]. Potassium is an essential activator for enzymes, in addition to its role as a stimulant for protein metabolism. It also affects the formation of chlorophyll and the water content of leaves [16]. Potassium also works to regulate the osmosis of plant cells, which is the aim of this study under Iraqi ecological conditions. To the effect of humic acid and potassium sulfate spraying on the growth and yield of Rubegym strawberries using the experiment.

Materials and methods

This experiment was carried out in the greenhouse of the Agricultural Research Institute. Experiment Station: Agriculture College, University of Kirkuk, Sayada area Kirkuk-Iraq during the season 2021-2022, The study included two factors, the first being three concentrations of sulfate potassium. (0.1000.2000) mg L-1 The second factor has three concentrations of humic acid, which is (0.2.4) g L-1 of humic acid. The experiment was carried out using the randomized complete block design (R.C.B.D.) as a factorial experiment and using 10 seedlings for the experimental unit. The results were analyzed statistically using the program (SAS V 9.0, 2002), and averages were compared according to Duncan's tests at the probability level

(0.05). The following characteristics were studied:

1-Leaves content of chlorophyll (SPAD):
using a field device (502 - Chlorophyll Meter SPAD) [17].

2-Leaf area (cm^2):
The leaves area was measured with an electric device (0.1 sensitivity)
area of one sheet is cm2 =
average weight of the leaf format is (g) * the area of the copy paper (A4) cm2
Copy paper weight (A4) g

3- Average Number of fruit. Plant-1:
The Number of fruit per plant was taken at the start of harvesting

4- Average weight of the fruit (g):

5- Fruit volume (cm^3):

6- Total soluble .Solids (TSS):

7-Vitamin C content of fruits (mg.100ml-1 .juice): Oxalic acid (2% concentration) was used as a preservative and used to measure the vitamin C content of fruit juice during all experimental conditions. Ascorbic acid alone has the ability to decrease the dye (2, 6-Dichlorophenol Indophenol), which changes color from blue to pink in the acidic medium.

Results

In Table (1), the results indicate that humic was a significant effect on the growth and yield characteristics of the strawberries, as it led to a significantly effect in the characteristics of leaves area, leaf chlorophyll content, the number of fruits, as it recorded the highest rate (34.32 SPAD, 46.06 cm2 , 22.76 fruits Seedlings-1) compared to the control treatment, which recorded (32.96 SAPD, 44.98 cm2, 19.98 fruits. Seedlings-1). It is also clear from the results that potassium led to a significant effect in the growth and yield of the strawberries, as it led to Significant effect in the leaf area, leaf chlorophyll content and fruits number, as it recorded the highest rate (34, 94 SPAD, 46, 93 cm2, 25, 25 fruits. Seedlings-1) compared to the control treatment, which recorded (32, 24 SPAD, 44, 17 cm2, 17, 64 fruits. Seedlings-1).

As for the binary overlap, we note the superiority of the binary overlap in the traits, leaf-area, leaf chlorophyll content, and fruits number.

Table (1) effect of humic and-potassium spraying on growth and yield of strawberry (Fragaria x ananassa Duch.)

Humic Acid g L^{-1}	Putassium Mg L^{-1}	Leave Clorophyl contnet (SPAD)	leave area cm^2	Fruit nomber
0	0	31.19 f	43.76 g	16.44 i
	1000	32.37 e	44.25 f	17.79 h
	2000	33.17 d	44.50 f	18.70 g
2	0	33.34 d	44.97 e	19.59 f
	1000	33.52 d	45.54 d	20.84 e
	2000	34.06 c	45.65 d	22.52 d
4	0	34.36 c	46.22 c	23.91 c
	1000	34.74 b	46.73 b	24.80 b
	2000	35.72 a	47.86 a	27.05 a
humic acid effect g L-1	0	32.96 c	44.98 c	19.98 c
	2	33.54 b	45.50 b	21.14 b
	4	34.32 a	46.06 a	22.76 a
Putassium effect Mg L^{-1}	0	32.24 c	44.17 c	17.64 c
	1000	33.64 b	45.40 b	20.98 b
	2000	34.94 a	46.93 a	25.25 a

We note from the results shown in Table (2) that humic was significant affected on the characteristics of fruit weight, fruit size, T.S.S, and vitamin C content of fruits, which recorded (17,68gm, 18, 68cm3 , 8,78%, 16,19 mg.100ml-1) compared to the control treatment, that recorded thelowest value (16,32 gm, 17,34 cm3, 8,19%, 15,07 mg.100ml-1). Potassium at the level of 2000 mg.L-1 was significantly superior in the studied traits, fruit weight, fruit size, total soluble solids ratio, and vitamin C content of fruits, as it recorded the highest value, which amounted to (18.98 gm, 19.72 cm3, 9.34%, 16.99 mg.100ml-1)

compared to With the comparison treatment, which recorded the lowest value, which amounted to (15.42 gm, 16.41 cm3, 7.60%, 14.14 mg.100ml1). As for the interaction, we note that the interaction was superior to 4 gm.L1 of humic acid and 4000 mg.L-1 of enteric potassium over the control treatment.

Table (2) effect of humic and potassium spraying on growth and yield of strawberry (Fragaria x ananassa Duch.)

Humic Acid g L^{-1}	Putassium Mg L^{-1}	Fruit weight g	Fruit volume Cm^3	T.S.S	Vitamine c
0	0	14.55 h	15.62 g	7.40 f	13.33 g
	1000	15.66 g	16.53 f	7.62 ef	14.32 f
	2000	16.07 fg	17.09 e	7.77 e	14.77 e
2	0	16.22 ef	17.37 de	8.37 d	15.33 d
	1000	16.62 e	17.75 d	8.67 cd	15.61 d
	2000	17.60 d	18.55 c	8.74 c	16.07 c
4	0	18.21 b	19.05 c	8.80 c	16.58 b
	1000	18.79 b	19.71 b	9.39 b	16.70 b
	2000	19.39 a	20.40 a	9.83 a	17.72 a
humic acid effect g L-1	0	16.32 c	17.34 c	8.19 c	15.07 c
	2	17.02 b	17.99 b	8.56 b	15.54 b
	4	17.68 a	18.68 a	8.78 a	16.19 a
Putassium effect Mg L^{-1}	0	15.42 c	16.41 c	7.60 c	14.14 c
	1000	16.81 b	17.89 b	8.59 b	15.69 b
	2000	18.98 a	19.72 a	9.34 a	16.99 a

Discussion:

From the results in Table (1,2), It was noted that humic led to significant superiority in characteristics such as leaf area, leaf content of chlorophyll, number of fruits studied, fruit weight, fruit size, total soluble solids ratio, and vitamin C in fruit. This is attributed to the role of humic acid in the processes of growth and stimulation of cell division as well as the activation of some enzymes that stimulate the growth of plant parts and increase the efficiency of the process of photosynthesis by increasing the leaf area in order to increase the number of materials manufactured in the leaves of carbohydrates and proteins needed to build plant tissues [20] as well as the role that The plant's metabolic activities are increased as a result of this acid and an increase in the activation of enzymes that manufacture chlorophyll necessary in the process of photosynthesis and the formation of sugars, proteins and energy compounds, which all affect the increase in plant growth and size, and thus lead to an increase in the studied vegetative growth characteristics [21] and thus led to superiority Moral in all studied traits [22].

There was noted that potassium led to superiority in the characteristics of leaf-area, total chlorophyll, and the number of fruits studied, the weight of fruits, the size of fruits, the percentage of TSS, and the content of vitamin-C in fruits. This is due to the positive role that potassium plays in increasing the process of photosynthesis and increasing cell-division. Increasing their numbers and sizes [23] and assisting in the transfer of carbohydrates between parts of the plant where they are needed, as well as the role of potassium in creating low osmosis in the cell vacuole, which enables it to withdraw water and fill the cell through its roles in the movement of stomata in the leaves. Potassium may also contribute To plant development growth as a result of its role in increasing protein representation and activating various physiological processes [24], which led to an increase in chlorophyll, vegetative growth, leaf area and metabolism, and thus an increase in the fruits number, fruit weight and volume, and an increase in TSS, as well as vitamin C in the fruit.

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تأثير الرش بحامض الهيوميك و كبريتات البوتاسيوم على نمو وحاصل الشليك (Fragaria x ananassa Duch)

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• تاريخ استلام البحث 2023/08/24 وتاريخ قبوله 2023/08/23.

الملخص

نفذت هذه الدراسة في البيت البلاستيكي التابع لمحطة البحوث والتجارب الزراعية، كلية الزراعة ،جامعة كركوك/ منطقة الصيادة، أثناء موسم النمو(2021–2022) لدراسة تأثير الهيوميك و الرش بالبوتاسيوم في نمو وحاصل الشليك صنف Rubegym باستخدام وتضمنت التجربة عاملين هي العامل الأول ثلاثة تراكيز من كبريتات البوتاسيوم (0،1000،2000) ملغم لتر−1 والعامل الثاني ثلاثة تراكيز من الهيوميك هي (0،2،4) غم لتر−1 وتم تنفيذ التجربة باستخدام تصميم القطاعات العشوائية الكاملة (RCBD) كتجربة عاملية باستخدام 10 شتلات للوحدة التجريبية وحللت النتائج احصائيا باستخدام برنامج (SAS V9.0) الجاهز وقارنت المتوسطات وفق اختبار دنكن متعدد الحدود عند مستوى احتمال (0.05)، أدت المعاملة الهيوميك والبوتاسيوم الى تفوق معنوي في الصفات المدروسة، المساحة الورقية، محتوى الكلوروفيل من الأوراق، عدد الثمار، وزن الثمار، حجم الثمار، نسبة المواد الصلبة الذائبة الكلية محتوى الثمار من فيتامين سي مقارنة بمعاملة المقارنة.

الكلمات المفتاحية: حامض الهيوميك ، شليك ، كبريتات البوتاسيوم ، فيتامين سي.