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RESPONSE OF STRAWBERRY (*FRAGARIA ANANASSA*)TO THE APPLICATION OF MICROBIAL INOCULANTS AND ORGANIC FERTILIZERS

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ABSTRACT:

The present study was carried out during growing season of 2018-2019, in the wooden canopy of the College of Agricultural Engineering Sciences, University of Duhok, Kurdistan Region of Iraq, to investigate the influence of foliar spray of four concentrations of Urea (0, 0.5, 1 and 1.5 g.L^{-1}) and inoculation the soil with Azotobacter at two concentrations (0 and 10 m.L^{-1}) and their interaction on the vegetative growth properties and quality of strawberry plant cv. Rubygem. The results indicated that Urea and Azotobacter significantly increased vegetative growth (chlorophyll, fresh weight, leaf area, leaf number and dry weight) as well as fruit quality (fruit weight, fruit length and number of fruits) (15.4g, 5.58cm and 10.67) respectively as compared with untreated plants. The interaction between the studies factors varied in their effect on the traits. The best interaction was the interaction of Urea at concentration (1g.L^{-1}) and Azotobacter at (10 m.L^{-1}) which gave the highest values (45.17 SPAD, 15.84 g and 5.38g) respectively as compared with other plants.

KEY WORD: Bio stimulants, Growth, yield Chemical composition, Strawberry

1. INTRODUCTION:

Strawberry (*Fragaria* × *ananassa* Duch.) is the most refreshing and delicious fruit crop which belong to the family of "Rosaceae". It is a rich source of vitamins and minerals with delicate flavors (Sharma, 2002). It also contains a higher percentage of other components including phenolics and flavonoids (Hakkinen and Torronen, 2000). Being a non-climacteric, only it matures on plant (Cordenunsi, *et al.*, 2003). And has a wide range of climates from tropics to the near of Arctic Circle (Barney, 1999 and Ayesha, *et al.* 2011). The cultivated strawberries are native to North America and originated in Europe in early 18th century. USA is the biggest strawberries producer n(FAO, 2013).

It is a perennial herbal plant, the name of which is derived from the Latin word "Fragrant" or "Fragrance", and it spreads between latitudes 28 and 60 north of the equator. There are about 1000 varieties of strawberry, 125 varieties are distributed in the world as commercial (A-lsaidi, 2000, and Al-Baiati, 2011). Some varieties are also distributed in the countries of the east coast of the Mediterranean Sea, since the plant has the ability to adapt under different conditions and it constantly renews itself. The ideal temperature of vegetative growth is between 20 and 22^{o}C, while the best temperature for flowers is 15-17^{o}C (Al-saidi, 2000; Hassan, 2003).

Fruit yields of strawberry cultivars depend on soil fertility and water availability during growing season. Therefore, to obtain uniform high yield of good quality fruits it is essential to provide adequate nutrients for proper plant nourishment (Sharma, 2002). Abo Sedera *et al.*, (2009) found that using mineral N fertilizer alone or with compost at the recommended dose (2000 kg N/fed.) had better effect on the studied strawberry vegetative growth, total yield, average fruit weight and fruit firmness compared with the other combinations.

Biofertilizers are some non-symbiotic and symbiotic microbes like *Azospirillum,Bacilluspolymyxa, Pseudomanas*striataand. *Azotobacter*, in the soil (Saxena, 1993) that stimulate plant growth and contribute to the improvement of ecosystem. They also play an active action in biologic control of plant pathogens, (Tilk *et al*., 2005).

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Azotobacter and Azospirillumalso release growth regulators like gibberellin, biotin and auxin.

Nitrogen is one of the major nutrients required by the plant for sufficient growth (Grapevine Nutrition Literature Review, 2006).

Moreover, nitrogen is a key part of many plant cell functions because it is important in the synthesis of amino acids, protein build, which are used to make the enzymes responsible for much of the work done in plants as well as making structural components (Keller *et al.*, 1998).

Foliar sprays of fertilizers have been one of the approaches to achieve an improvement in the yield and quality of different fruit crops including grapevines and to optimize the use of chemical fertilizers (Moustafa *et al.*, 1986,, Crespan *et al.*, 2000).

Urea, when properly applied, results in crop yield increases equal to other forms of Nitrogen (Curtis *et al.*, 1991). Urea can also be applied as a foliar spray on some crops, it is highly water soluble. At normal atmospheric temperatures, approximately 1 pound of Urea can be dissolved in 1 pound of water (Curtis *et al*., 1991).

Nutrition studies have been considered to be the most effective factor in improving the growth, fruit yield and their quality, owing to the role of various minerals in the physiological metabolism of plant (Havlin *et al.* 2005 and Bal, 2005).

The aim of this study is the effect of inoculation soil with microbial (Azotobacter) and Urea on growth and qualitative properties of strawberry cv. Rubygem

2. MATERIALS AND METHODS

This study was carried out during growing season of 2018-2019, in the wooden canopy of the College of Agricultural Engineering Science, University of Duhok. In order to study the effect of inoculation soil with microbial (Azotobacter) and Urea on growth and qualitative properties of strawberry cv. Rubygem, grown in plastic bags (21.5 cm diameter), therefore, the experiment consisted of eight treatments, the treatments were arranged in a factorial experiment in a Randomized Complete Block design (RCBD) with two factors, first (with azotobacter and without azotobacter)and four concentration of urea (0,0.5,1and 1.5 $g.L^{-1}$) the experiment consist (2*4), it means we will have 8 treatments with 3 replication. SAS program were used to analysing all data (Anonyme, 2005).

The strawberry plants that used in this investigation were obtained from the nursery of agricultural institute of Zakho/ Duhok/ Iraq. At first all transplants were pruned by removing excess and damaged leaves and remained three leaves on each plant as well as pruning roots to get the balance between roots and vegetative growth.

Experimental characters were as shown as follow.

A. Vegetative growth parameters, that include:

Chlorophyll content (SPAD, fresh weight Leaf area,) dry weight and leaf number.

B. Quality parameters of fruits that include:

Fruit diameter (cm), fruit length (cm), fruit weight ($g.fruit^{-1}$) and Number $fruit.plant^{-1}$

3: RESULTS:

Results in table (1) indicated that there was significantly affect of inoculation the soil with azotobacter and spraying of urea on vegetative growth characters (chlorophyll content SPAD, fresh weight, leaf area and leaf number per plant). Treated plants with (10 $m.L^{-1}$) azotobacter were significantly affected as compared with untreated plants. Plant treated with (1$m.L^{-1}$) urea gave highest value in all vegetative growth characters as compared with other concentration that recorded lower value especially untreated plant. The interaction between microbial urea shows significant effected among all vegetative characters, which gave high chlorophyll, fresh weight, dry weight and highest number of leaves.

Regarding the fresh and dry weight of vegetative growth of strawberry it was indicated that treated plant with concentration (1m. L^{-1}) of urea and (10m. L^{-1}) of azotobacter gave significantly increased in fresh and dry weight of vegetative growth that recorded (15.84and 5.38g) respectively as compared with untreated plant that gave lower weight of fresh and dry weight (7.88and 2.89g). Concerning the leaf area it was showed that there were significantly increased in the leaf area. (cm^2) as compared to untreated plant, Furthermore plant treated with urea gave the highest value of the leaves area (52.57 cm^2) as compared with control (46.49cm^2). Plant treated with (1.5$g.L^{-1}$) of urea and (10$m.L^{-1}$) with azotobacter recorded high

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value leaf area (54.53 cm^2) as compared with untreated plant (46.54 cm^2)

Table (1) also showed significantly increased in leaf number, where Plant treated with (10m. L^{-1}) of azotobacter gave highest value (14.58) of leaf number as compared with untreated plant (10.36). Regarding interaction between urea (1.5m. L^{-1}) and azotobacter (10m. L^{-1}) gave highest value of leaf number (19.00) as compared with untreated plans (8.67).

Results in the table (2) showed that the fruit weight, fruit length and fruit number of treated plants were significantly different increased as compared with untreated plant Regarding fruit weight of treated plant with azotobacter recorded highest weight of fruit (13.4g) as compared with untreated plant that gave lower value of weight (11.5g).The interaction between urea (1m. L^{-1}) and azotobacter (10m.L^{-1}) gave highest value of fruit weight of treated plant (15.4g) as compared with lowest value of untreated plant (11.1g) respectively.

Concerning fruit length it were showed that treated plant with Azotobacter obtained higher length of fruit as compared with untreated plant that gave lowered length (5.31 and 4.83cm) respectively, while the fruit number per plant it were seems that plant treated with Azotobacter (10m.L^{-1}) gave highest number of fruits (8.62) per plant as compared lowest value of untreated plant (6) per plant respectively. The interaction between urea (1.5m.L^{-1}) and Azotobacter (10m.L^{-1}) recorded high number of fruit per plant (10.67) as compared with untreated plant that gave lowered number of fruit per plant (4.33).

Table (1):- Effect of inoculation of microbial and urea on vegetative growth characters of strawberry cv. Rubygem.

Bacteria	**Chlorophyll (SPAD)**				**Bacteria**	**Fresh weight**				**Bacteria**
	Urea($g.L^{-1}$)					Urea($g.L^{-1}$)				
	0	0.50	1.00	1.50		0	0.5	1	1.5	
0	42.57c	44.10b	45.13a	43.77b	43.89b	9.22d	15.26	15.84 a	12.68b	13.25b
10	43.73 b	43.37b	45.17a	44.23a	44.13a	10.36c	7.88e	15.84 a	12.68b	11.69a
Urea	43.15 b	43.73ab	45.15a	44.00ab		9.79c	11.57 b	15.84 a	12.68a b	Bacteria
bacteria	Leaf area				Bacteria	Dry weight				
	0	0.5	1	1.5		0	0.5	1	1.5	
0	46.54c	49.92 b	50.12b	50.61b	49.30b	3.58c	5.38a	5.34a	4.16b	4.62a
10	46.44c	46.77 b	54.33a	54.53a	50.52a	3.68c	2.89d	5.38a	5.34a	4.32b
Urea	46.49 b	48.35 b	52.23a	52.57a		3.63c	4.14b	5.36a	4.75ab	

Bacteria	Leaf number				Bacteria
	0	0.5	1	1.5	
0	8.67f	10.10e	11.00d	11.67c	10.36b
10	11.67c	10.00e	17.67b	19.00a	14.58a
Urea	10.05 b	10.17b	14.33a	15.33a	

Means within a column, row and their interactions followed with the same letters are not significantly different from each other according to Duncan multiple ranges test at significant level of 5%.

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Table (2):- Effect of inoculation of microbial and urea on quality characters of Strawberry cv. Rubygem.

Bacteria	Fruit weight (g)				Bacteria	Fruit length(cm)				Bacteria
	Urea($g.L^{-1}$)					Urea($g.L^{-1}$)				
	0	0.5	1	1.5		0	0.5	1	1.5	
0	11.1d	11.9c	10.2d	12.9b	11.5ab	4.27bc	4.72bc	5.22b	5.10b	4.83b
10	12.8b	12.8b	15.4a	12.5b	13.4a	5.12b	5.22b	5.58a	5.32b	5.31a
Urea	11.9a	12.3ac	12.8a	12.7a		4.69b	4.97ab	5.40ab	5.21a	
Bacteria	Fruit number.$plant^{-1}$				Bacteria					
	0	0.5	1	1.5						
0	4.33e	6.50c	6.60c	6.57c	6.00b					
10	5.33c	9.07bc	10.67a	9.40b	8.62a					
Urea	4.83b	7.78a	8.63a	7.98a						

Means within a column, row and their interactions followed with the same letters are not significantly different from each other according to Duncan multiple ranges test at significant level of 5%.

DISCUSSION:

Tables (1& 2) reveled that there are significant difference in vegetative growth parameters, increasing vegetative growth components by the effect of urea and Azotobacter may be goes to the action of Azotobacter on improving soil fertility and enhanced biological processes and consequently growth characteristics would be improved (Jianguo *et al* 1998).

Production of growth regulators by the Azotobacterinthe root zone which gets absorbed by the plant roots has been reported by Cordenunsi BR *et al* ,(2003). Antipchuk *et al*. (1982) who reported that inoculation of different Azotobacterstrains to soil resulted in higher vitamin C in tomato.

That enhances the plant to grow well, faster and early maturity leading to high plant productivity. (Potter, 2005) which consider the main problem facing crop cultivation in the world. (Calapietra and Alexander, 2006, Sivasankari, *et al*., 2006). (Al- Saaberi., 2005). The enhanced in vegetative growth could be attributed to the positive effect of nitrogen on the single leaf area (table 3) of the plant which was reflected in more carbohydrates production through photosynthesis processes for the physiological view.

The significant effect of foliar spraying of Urea may be due to the role of nitrogen in plant cell, the synthesis of protein and enzymes which are important compounds in the synthesis of chlorophyll and cytochrome and their role in the processes of photosynthesis and respiration that lead to increase cell division and elongation (Beniwal *et al.*, 1992; Usha and Singh 2002; Mohammed Abdul-Qader, 2007).The leaf contents of N, P and K increases as a results of Urea spraying, these may be assigned to the role of Urea in the increasing vegetative growth that led to stimulating the root and vegetative growth to realize growth requirement, then in turn increasing absorption of these elements and increasing its concentration in leaves**(**Gobara *et al.* 2000 and Andreas 2009) those results are the same found out by Abou Sayed-Ahmad *et al.* (2000); Andreas (2009) and Porro *et al.* (2010), who measured that nitrogen fertilizer rates had a significant effect on the concentration of N, P and K in the leaves.

The obtained results explained to the role of the Urea as a constituent of pyridines which are, in turn, constituents of chlorophyll and cytocromes (Mansour, 1998; Joo *et al.* 1999; Magada 2002 and Fawzi *et al*., 2010).

Role of nitrogen in the physiological process and its effect on transportation of carbohydrate products and other materials from the leaves (Mohammed, 1991; Al-Emam, 1998; Mohammed and Abdul- Qader, 2007).

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شیانا رووکی ستراوبیری (Fragaria ananassa) بو ئەزوتوبکتر و زبلی ئورگانیکی

پوختە:

ئەف ڤەکولینە هاتیە ئەنجامدان ل وەرزێ گەشێ 2018-2019 ل خانیێ داری ل کولیژا زانستێن ئەندازیاریا چاندنێ زانکویا دهوك ل هەرێما کوردستانا عیراقێ ژ بو تاقیکرنا کارتێکرنا رەشانا بەلگا ب چار تیراتیێت یوریایێ (0 و0.5 ,1و 1.5 غم.لتر-1) دگەل لێدانا ئەزوتوبەکتەری د ئاخێ دا ب تیراتیا (0 و 10 مل.لتر-1) ولێکدانا وان دگەل ئێك ل سەر ساخلەتێن شینکاتی و کوالتیا فێقیێ زووەکێ فراولێ ژ جورێ روبیجیم. ئەنجامدا دیار بوو کو یوریا و ئێك تیراتیا ئەزوتوبەکتەری زێدەبونەکا بەرچاف هەبوو ل سەر شینکاتی (کلوروفیل, کێشەیا تەر, پانیا بەلگی, ژمارا بەلگا و کێشەیا هشك) هەروەسا ل سەر کوالتیا فێقی (کێشەیا فێقی, دریژاهیا فێقی و ژمارا فێقی) (15.4غم , 5.58 سم و 10.67) دیڤێکدا بەراورد دگەل رووەکێن کونترولێ. لێکدان دناڤبەرا ساخلەتێن خاندی دا جیاواز بوو دکارتێکرنێ دا. گرنکترین لێدان ئە و لێکدان بوو یا دناف بەرا یوریایا ب تیراتیا (غم.لتر-1) و ئەزوتوبەکتەرێ بتیراتیا (10 مل.لتر-1) ئەنجامێن بلند تر دان (45.17 15.84 ,SPAD غم و5.38 غم) دیڤێکدا بەراورد دگەل رووەکێت دی.

استجابة نبات الشليك (Fragaria× ananassa) للحقن بالازوتوبكتر والسماد العضوي

الخلاصة:

أجريت الدراسة خلال موسم النمو (2018-2019) داخل الظلة الخشبية لكلية علوم الهندسة الزراعية في جامعة دهوك، أقليم كوردستان العراق لإختبار تأثير الرش الورقي باربعة تراكيز من اليوريا (0 و0.5 ,1و 1.5 غم.لتر$^{-1}$) مع حقن التربة بالازوتوبكتر بتراكيز (0 و10 مل.لتر$^{-1}$)والتداخل بينهما في الصفات النمو الخضري والنوعي لنبات الشليك الصنف روبيجيم. أظهرت النتائج بأن اليوريا واحدى تراكيز الازوتوبكتر لها زيادة معنوية على النمو الخضري (الكلوروفيل، الوزن الرطب، المساحة الورقية، عدد الاوراق والوزن الجاف) وكذلك في الصفات النوعية للثمرة (وزن الثمرة وطول الثمرة وعدد الثمار) (15.4غم, 5.58 سم و 10.67) على التوالي مقارنةً مع النباتات غير المعاملة وقد تباين تأثير التداخل بين العوامل المدروسة على الصفات المسجلة. أفضل تداخل كان التداخل بين اليوريا بتركيز (غم.لتر$^{-1}$) والازوتوبكتر بتركيز (مل.لتر$^{-1}$) والذي أعطى أعلى النتائج (SPAD 45.17 , 15.84 غم و5.38غم) على التوالي بالمقارنةً مع النباتات الاخرى.

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