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EFFECT OF MEDIA, BENZYL ADENINE, AND NPK FERTILIZER ON THE GROWTH AND DEVELOPMENT OF OXALIS (*Oxalis triangularis*) PLANT.

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ABSTRACT

The present study was conducted in a plastic house in the campus of Duhok university, Kurdistan region, Iraq, during the growing year 2021, to investigate the effect of different factors includes growing media (river soil, peatmoss and river soil + peatmoss 1:1), Benzyl Adenine (BA) (0 and 500 mg.l^{-1}), NPK fertilizer (0, and 200 mg.l^{-1}) per pots on the growth of oxalis plant (*Oxalis triangularis*). The results showed that the peatmoss significantly improved all the studied parameters compared with mixture and river soil. Similarly, benzyl adenine at (500 mg.l^{-1}) increases most study characters except rhizomes number, single rhizome volume and single rhizome fresh weight. However, NPK fertilizer at concentration (200 mg.l^{-1}) per pot improved leaf length. The interactions between peatmoss and (500 mg.l^{-1}) BA recorded significantly entire growth measurements exclude rhizomes number, single rhizome volume and single rhizome fresh weight. Whereas, the interactions between peatmoss and without NPK fertilizer, positively enhanced leaf number, vegetative dry weight, rhizomes number, and single rhizome volume, also the interactions of (500 mg.l^{-1}) BA plus (200 mg.l^{-1}) NPK leading to encourages most parameters in the research. And the triple interaction among peatmoss, (200 mg.l^{-1}) NPK and (500 mg.l^{-1}) BA recorded best results of most studied parameters.

KYEWORDS: *Oxalis triangularis*, Growing Media, Benzyl Adenine, NPK Fertilizer.

INTRODUCTION

Oxalis triangularis commonly known as purple shamrock or purple clover in Oxalidaceae family is an edible perennial plant but the plant is often grown as an ornamental, which is easily cultivated and propagated by bulbs, it is perfect for cultivating in pots or containers (Rosna, *et al.,* 2013). However, oxalis is believed to be native to North America and is found in most of the Eastern and Central United States and is also present in Europe, Africa, and Asia (Lollar and Marble, 2015). Oxalis is a wonderfully long-lived houseplant with attractive purple foliage, the leaves develop from the base of the plant and have three leaflets with tiny white blooms, the leaflet may have a heart-shaped, these leaves open and close in response to light, closing up at night. (Illinois Department of Natural Resources, 2021). *Oxalis* needs bright light indoors to look its best and the plant has intensely purple leaves with a monomeric anthocyanin content (Pazmino-Duran *et al.,* 2001).

Many factors should be considered during cultivation of oxalis particularly media, fertilizers, irrigation, growth regulators and environmental conditions. Therefore, the most important success factors for growing oxalis are soil that drains well and keeping them evenly moist (Vermeulen and Rosenfleld, 1998). *Oxalis* performs well when grown in standard potting mixes that drain well like loam or peatmoss, the bulbs will rot if planted in soils that are too heavy and retain too much water, many types of potting soil are too heavy and do not drain properly, which can lead to problems with rot, hence most substrate mixes used in the greenhouse industry do not contain mineral soil as a component, instead they are usually peat based and combined with other organic materials (Miller, *et al.,* 2011).

Selecting the appropriate fertilizer composition is important to ensure adequate and not deficient or toxic amounts of nutrients for growing oxalis. So, fertilization recommendations for oxalis are limited, greenhouse fertilization of ornamental plants typically uses fertilizers dissolved in and delivered through the irrigation water (Miller, 2011). However, De Hertogh and Le Nard (1993) recommend using NPK no rate specified after visible growth or a weekly liquid application of NPK in the irrigation water and Bar-Tal *et al.,*

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(2001) reviewed that the N form and availability may affect plant growth and development, leaf area, plants size, and availability of other nutrients due to its influence on root-zone pH.

On the other hand, benzyl adenine belongs to the class of cytokinin type of plant growth regulators and has been used by non-organic growers for many years as active ingredient in promoting shoot growth as a non-toxic and environmental safer alternative to a synthetic insecticide used to protect crops (Kim, *et al.*, 2004). Benzyl adenine is enhancing the lateral shoot growth and leading to improved branching in fruit trees, as well as it causes an increase in the number of calla lily flowers (Kamenetsky, and Okubo, 2013). The objectives of this experiment were to determine the effects of different media, fertilizers (NPK), benzyl adenine and their interactions on the growth and development of oxalis plant.

MATERIALS AND METHODS

The research was conducted inside plastic house in the campus of Duhok University at the Duhok governorate during the period of 1st May, 2021 to 1st November, 2021, in order to investigate the effect of three different factors include growing media, BA and NPK fertilizer on the growth of oxalis plants (*Oxalis triangularis*). The experiment was arranged in a factorial and in Randomized Complete Block Design (RCBD) with three factors, **the first factor** was the different growing media (river soil, peatmoss and river soil + peatmoss 1:1 by volume) and placed under uniform climate inside plastic house, about 1 - 2 bulbs of oxalis plant were planted in each plastic pots which sized 12 cm. **The second factor** was two levels (0, and 500) $mg.l^{-1}$ of Benzyl adenine (BA), were sprayed two times, the first one after fifteen days from planting and the second sprayed a mounts after the first spray. **The third factor** was NPK fertilizer with two concentrations (0, and 200) $mg.l^{-1}$ that added as Liquid Fertilization (200) ml per pots for each month, However, the experiment contains 12 treatments with 3 replications and 6 pots per experimental units. After six months the data of experiment were recorded, that includes (leaves number, leaves length, vegetative dry weight, rhizome number, rhizome volume, rhizome fresh weight and growth index). The statistical analysis of data with means comparison was done by the use of Duncan's Multiple Ranges Test under 5% (SAS, 2003).

RESULTS

1. Leaf Number

Table (1) shows the effect of media on the leaves number, which significantly recorded (35 and 33.08) leaves / plant in peatmoss and mixture respectively compared to river soil (17.25). However, the number of leaves / plant was significantly increased (32.78) leaf / plant when plant sprayed with (500 $mg.l^{-1}$) BA concentration compared to control. But no significant variations were recorded among the levels of NPK fertilizer as shown in table (1) while the highest number of leaves (29.00) leaf / plant recorded when add (200 $mg.l^{-1}$) NPK.

Regarding the interaction between media and BA showed that high significant (38.33) leaves / plant found in peatmoss with (500 $mg.l^{-1}$) of BA. The interaction between media and NPK was also valuable on the improving of leaf number, when oxalis grown in mixture and treated by NPK fertilizer at (200 $mg.l^{-1}$) significantly increased (37.50) leaf / plant and the lowest value found in treatment of river soil with both levels of NPK. Relating to the interaction between BA and NPK, it has a favourable effect to improving leaf number, where (500 $mg.l^{-1}$) BA and control of NPK gave (35.11) leaf / plant it considered the highest number of leaves than other treatments. The significant interaction effect which increased leaf number among three factors found in peatmoss, without using NPK and (500 $mg.l^{-1}$) BA conc., this interaction recorded maximum value (48) leaf / plant, and the minimum (11) leaf / plant recorded in river sand, with control of NPK fertilizer and BA.

Table 1: Effect of different media, BA concentrations, level of NPK fertilizer and their interactions on the leaf number in *Oxalis triangularis.*

level NPK mgl^{-1}	conc. BA mgl^{-1}	Leaf Number (No.)			NPK* BA	NPK Effect
		Peatmoss	Mixture	River Soil		
0	0	23.00 bc	28.00 b	11.00 d	20.67 c	27.89 a
	500	48.00 a	29.33 b	28.00 b	35.11a	
200	0	40.33 a	30.33 b	12.00 d	27.56 b	29.00 a
	500	28.67 b	44.67 a	18.00 cd	30.44 ab	
NPK * Media	0	35.50 a	28.67 b	19.50 c	BA Effect	
	200	34.50 ab	37.50 a	15.00 c		
BA * Media	0	31.67 bc	29.17 cd	11.50 e	24.11 b	
	500	38.33 a	37.00 ab	23.00 d	32.78 a	
Media Effect		35.00 a	33.08 a	17.25 b		

* Means with same letter for each factor and interaction are not significantly different at 5% level based on Duncan's Multiple Rang Test.

2. Leaf Length (cm)

The data illustrated in the table (2) showed the highly significant (24.58 cm) leaf length which obtained in peatmoss as compared to river soil (13.08 cm). In contrast of that, when oxalis plant treated by BA at concentration (500 $mg.l^{-1}$) increased significantly leaf length (21.11 cm) and the lowest length of leaves was obtained in control treatment reached (16.78 cm). On the other hands, the single effect of NPK significantly improved leaf length, the highest value (20.06 cm) recorded in (200 $mg.l^{-1}$) NPK and the lowest value (8.58 cm) obtained in untreated plants.

Referring to the interaction of different media and BA concentrations, the maximum significant of leaf length noticed in the peatmoss when pots sprayed with (500 $mg.l^{-1}$) BA compared with the river soil plus control. However, the dual interaction between media and NPK fertilizer at (200 $mg.l^{-1}$) significantly improved leaf length (26.17 cm) while the minimum results (12.33 cm) recorded in river soil with (200 $mg.l^{-1}$) NPK. Concerning the interaction between BA and NPK, the best significant value (22.44 cm) was shown at the interaction between (500 $mg.l^{-1}$) BA with (200 $mg.l^{-1}$) NPK and plants which untreated by BA and NPK recorded the lowest elongation of leaves (15.89 cm). According to the table (2), it is indicated that the highest (27.33 cm) leaf length was recorded by the interaction among peatmoss, (200 $mg.l^{-1}$) NPK fertilizer, and (500 $mg.l^{-1}$) BA, and the lowest value (11.33 cm) leaf length obtained in river sand, with (200 $mg.l^{-1}$) NPK and control of BA.

Table 2: Effect of different media, BA concentrations, level of NPK fertilizer and their interactions on the leaf length (cm) in *Oxalis triangularis.*

level NPK mgl^{-1}	conc. BA mgl^{-1}	Leaves Length (cm)			NPK* BA	NPK Effect
		Peatmoss	Mixture	River Soil		
0	0	20.00 b	15.00 c-e	12.67 de	15.89 c	17.83 b
	500	26.00 a	18.33 bc	15.00 c-e	19.78 b	
200	0	25.00 a	16.67 b-d	11.33 e	17.67 bc	20.06 a
	500	27.33 a	26.67 a	13.33 de	22.44 a	
	0	23.00 b	16.67 c	13.83 cd		

NPK * Media	200	26.17 a	21.67 b	12.33d	**BA Effect**
BA * Media	0	22.50 b	15.83 c	12.00 d	16.78 b
	500	26.67 a	22.50 b	14.17 cd	21.11 a
Media Effect		24.58 a	19.17 b	13.08 c	

* Means with same letter for each factor and interaction are not significantly different at 5% level based on Duncan's Multiple Rang Test.

3. Dry Wight (g)

There were significant differences appear between three media on the vegetative dry weight as in the table (3) shown that the significant result of dry weight between the different media recorded on peatmoss reached (2.58) g followed by (1.89 g) in mixture and (1.23 g) in river soil. Concerning the effect of benzyl adenine on the vegetative dry weight, significantly the highest value (2.33 g) found in (500 $mg.l^{-1}$) BA compared to (1.65 g) which recorded in control. The vegetative dry weight of oxalis plant was not response significantly (1.88 and 2.10 g) to NPK fertilizer.

The same table demonstrated that the interaction between peatmoss and both concentrations of BA (0 and 500 $mg.l^{-1}$) obtained significantly higher (2.60 and 3.09 g) vegetative dry weight respectively on oxalis plant, while the treatment of river soil medium without BA conc. Gave the lowest (0.94 g) dry weight. Regarding the interaction between media plus NPK fertilizer significantly found in many treatments while the highest value recorded in peatmoss plus control of NPK which recorded (3.01 g), and the lowest vegetative dry weight (1.05 g) obtained in river soil with (200 $mg.l^{-1}$) NPK fertilizer. The interaction between BA and NPK was also effective on the improving vegetative dry weight, when oxalis treated with both concentrations of BA and NPK lead positively increased vegetative dry weight compared to plant that untreated with BA and NPK fertilizer as shown in table (3). The significant result (4.20 g) dry weight was obtained from interaction among peatmoss, control of NPK with (500 $mg.l^{-1}$) BA, and the lowest (0.53 g) recorded in river sand, without using NPK and BA.

Table 3: Effect of different media, BA concentrations, level of NPK fertilizer and their interactions on the vegetative dry weight (g) in *Oxalis triangularis.*

level NPK mgl^{-1}	**conc. BA mgl^{-1}**	**Vegetative Dry Weight (g)**			**NPK* BA**	**NPK Effect**
		Peatmoss	**Mixture**	**River Soil**		
0	0	1.81 d-f	0.97 d-f	0.53 f	1.10 b	1.88 a
	500	4.20 a	1.48 d-f	2.31 b-d	2.66 a	
200	0	3.40 ab	1.86 d-f	1.34 d-f	2.20 a	2.10 a
	500	1.98 c-e	3.25 a-c	0.76 ef	2.00 a	
NPK * Media	0	3.01 a	1.23 b	1.42 b	**BA Effect**	
	200	2.69 a	2.56 a	1.05 b		
BA * Media	0	2.60 a	1.42 c	0.94 c	1.65 b	
	500	3.09 a	2.37 ab	1.53 bc	2.33 a	
Media Effect		2.85 a	1.89 b	1.23 c		

* Means with same letter for each factor and interaction are not significantly different at 5% level based on Duncan's Multiple Rang Test.

4. Number of Rhizome

The data of rhizome number in the table (4) observed that the peatmoss significantly gave a higher (12.00) number of rhizomes compared to mixture and river soil (6.50 and 4.58) respectively. While increased was not significant between two differences concentration of BA but the highest number of rhizomes recorded (8.39) rhizome / plant between two concentrations of BA on the number of rhizomes. Similarly, the effect of NPK fertilizer on the rhizomes number did not increase significantly but the highest number of rhizomes obtained (8.22) rhizome / plant as shown in the table (4).

Also, when the oxalis plant grown in peatmoss and applied (500 $mg.l^{-1}$) BA recorded significantly maximum (14.00) rhizome / plant compared with other treatments and the interactions between river soil with control of BA has the minimum (4.50) rhizome / plant. Significant differences were shown in many treatments of the rhizomes number between the interactions of media plus NPK fertilizer while the higher rate (12.67) rhizome / plant recorded in peatmoss with untreated plant by NPK fertilizer, and the lower rate (3.33) rhizome / plant recorded in mixture plus control of NPK. For the double interaction effect of BA and NPK on the number of rhizomes there were no significant differences appeared between all treatments as observed in the table (4). The significant interaction of three factors observed in many treatments while the highest value (15) rhizomes number recorded in peatmoss, without using NPK fertilizer plus (500 $mg.l^{-1}$) BA, and the lower (3.00) number of rhizome observed in river sand, (200 $mg.l^{-1}$) NPK, and untreated with BA.

Table 4: Effect of different media, BA concentrations, level of NPK fertilizer and their interactions on the number of rhizomes in *Oxalis triangularis.*

level NPK mgl^{-1}	conc. BA mgl^{-1}	Rhizome Number (No.)			NPK* BA	NPK Effect
		Peatmoss	Mixture	River Soil		
0	0	10.33 ab	3.00 d	6.00 b-d	6.44 a	7.17 a
	500	15.00 a	3.67 cd	5.00 b-d	7.89 a	
200	0	9.67 ab	10.00 ab	3.00 d	7.56 a	8.22 a
	500	13.00 a	9.33 a-c	4.33 b-d	8.89 a	
NPK * Media	0	12.67 a	3.33 b	5.50 b	BA Effect	
	200	11.33 a	9.67 a	3.67 b		
BA * Media	0	10.00 b	6.50 bc	4.50 c	7.00 a	
	500	14.00 a	6.50 bc	4.67 c	8.39 a	
Media Effect		12.00 a	6.50 b	4.58 b		

* Means with same letter for each factor and interaction are not significantly different at 5% level based on Duncan's Multiple Rang Test.

5. Single Rhizome Volume (cm^3)

As shown in the data available in table (5) the higher volume of rhizome (1.20 and 0.99 cm^3) was obtained from planted oxalis in river soil and peatmoss respectively, in contrast, those which were planted in mixture provided minimum volume (0.56 cm^3). While non-significant differences were found from effect of both BA concentrations and NPK fertilizers (0.96 and 0.92) cm^3 respectively on single rhizome volume.

Concerning the interaction between growing media and BA, it is shown that the significantly best rhizome volume was recorded from planted oxalis rhizome in both river soil and peatmoss and treated with both concentrations of BA (0 and 500 $mg.l^{-1}$) when compared with lowest volume for those planted in mixture and treated with both concentration of BA. Whereas, from interaction effect of planted oxalis rhizome in river soil and sprayed with (200 $mg.l^{-1}$) NPK fertilizer (1.23 cm^3) as highest rhizome volume were obtained comparison with minimum volume (0.54 cm^3) which recorded from those planted in mixture and sprayed without NPK fertilizer. Regarding the dual interaction between BA and NPK, non-significant differences were found from effect of

various interactions between them. Concerning the triple interaction, the plants which cultivated in the river sand and treated without using NPK fertilizer and BA had the highest significant increases (1.67 cm^3) of rhizome volume compared with most other interactions, while the lowest rate (0.34 cm^3) was found in the mixture, (200 $mg.l^{-1}$) NPK and without sprayed BA.

Table 5: Effect of different media, BA concentrations, level of NPK fertilizer and their interactions on the single rhizome volume (cm^3) in *Oxalis triangularis.*

level NPK mgl^{-1}	conc. BA mgl^{-1}	Single Rhizome Volume (cm^3)			NPK* BA	NPK effect
		Peatmoss	Mixture	River Soil		
0	0	1.15 a-c	0.71 cd	1.00 bc	0.95 a	0.92 a
	500	0.96 bc	0.36 d	1.35 ab	0.89 a	
200	0	0.86 b-d	0.34 d	1.67 a	0.96 a	0.91 a
	500	0.99 bc	0.84 b-d	0.78 b-d	0.87 a	
NPK * Media	0	1.05 a	0.54 c	1.17 a	BA effect	
	200	0.93 ab	0.59 bc	1.23 a		
BA * Media	0	1.01 a	0.53 b	1.33 a	0.96 a	
	500	0.97 a	0.60 b	1.06 a	0.88 a	
Media effect		0.99 a	0.56 b	1.20 a		

* Means with same letter for each factor and interaction are not significantly different at 5% level based on Duncan's Multiple Rang Test.

6. Single Rhizome Fresh Weight (g)

As related to the data presented in table (6) it is realized that the maximum fresh weight of rhizome (1.28 g) was found from planted oxalis in peatmoss media followed by those planted in river soil while minimum weight (0.70 g) was showed from those that were planted in mixture media and augmentation was significantly of the fresh weight of rhizomes from the mixture and river soil. While, both other two factors BA and NPK provided non-significant differences on the rhizome fresh weight.

Regarding to the dual interaction of growing media with BA, it is clear that the significantly highest value of rhizome fresh weight (1.55 g) was registered from planted oxalis in peatmoss and sprayed with (500 $mg.l^{-1}$) of BA compared to lower value of all other interactions especially those planted in mixture and sprayed with the same concentration of BA which recorded (0.64 g). As for the interaction between growing media and NPK is it revealed that (1.36 g) as maximum fresh weight of rhizome were obtained from that oxalis which were planted in peatmoss and (200 $mg.l^{-1}$) NPK fertilizer comparison with the minimum weight (0.62 g) to the oxalis which obtained from mixture media and without treated NPK fertilizer. Non-significant differences were showed from effect of dual interaction between BA concentrations and NPK fertilizer (Table 6). The best triple interaction occurred among peatmoss with (200 $mg.l^{-1}$) NPK plus (500 $mg.l^{-1}$) BA that gave the highest (1.77 g) rhizome fresh weight, this value was significantly higher than all other interactions, on the other hand, the lowest (0.52 g) rhizome fresh weight recorded in mixture, control of NPK and (500 $mg.l^{-1}$) BA.

Table 6: Effect of different media, BA concentrations, level of NPK fertilizer and their interactions on the single rhizome fresh weight (g) in *Oxalis triangularis.*

level NPK mgl^{-1}	conc. BA mgl^{-1}	Single Rhizome Fresh Weight (g)			NPK* BA	NPK effect
		Peatmoss	Mixture	River Soil		
0	0	1.08 bc	0.71 bc	0.78 bc	0.86 a	0.91 a
	500	1.33 ab	0.52 c	1.06 bc	0.97 a	

200	0	0.96 bc	0.81 bc	1.20 ab	0.99 a	1.07 a
	500	1.77 a	0.76 bc	0.93 bc	1.15 a	
NPK * Media	0	1.21 ab	0.62 c	0.92 bc		
	200	1.36 a	0.79 bc	1.07 ab	**BA effect**	
BA * Media	0	1.02 b	0.76 b	0.99 b	0.92 a	
	500	1.55 a	0.64 b	1.00 b	1.06 a	
Media effect		1.28 a	0.70 c	0.99 b		

* Means with same letter for each factor and interaction are not significantly different at 5% level based on Duncan's Multiple Rang Test.

7. Growth Index (cm^3)

The presented data in table (7) show that there were significant differences on the growth index from the effect of different growing media used, and it appear that the best growth index was shown in planted oxalis in peatmoss media which obtained (3602.30 cm^3) followed by mixture and the lowest value were found in river soil media with value (422.66 cm^3). Likewise, there was a significant difference of growth index from plants sprayed with (500 $mg.l^{-1}$) of BA which registered (2620.50 cm^3) comparison with lower value (1319.72 cm^3) which showed from control treatment (0 $mg.l^{-1}$) BA. In contrast, no significant variation was found on growth index from effect of NPK factor.

Also, the interaction effect between growing media and BA, reveal that the significantly highest value of growth index was appeared from grown plants in peatmoss media and sprayed with (500 $mg.l^{-1}$) BA which recoded (4464.69 cm^3) while this value reduced to minimum (180.03 cm^3) when plants were grown in river soil and without BA conc. Whereas the interaction of media with NPK show that the effect of interaction of peatmoss with 0 ml NPK on plants provided best growth index (3769.57 cm^3) in contrast when plants were grown in river soil and treated with (200 $mg.l^{-1}$) NPK recorded minimum value (285.48 cm^3). The last interaction between NPK and BA when happened between both level of NPK (0 and 200 $mg.l^{-1}$) with (500 $mg.l^{-1}$) BA provided best growth index in comparison with lowest value for the other two interactions. The significantly highest growth index (5254.79 cm^3) was from triple interactions among the peatmoss, without NPK fertilizer and with (500 $mg.l^{-1}$) BA, whereas the minimum value (165.90 cm^3) of growth index recorded in the river soil plus without using NPK and BA.

Table 7: Effect of different media, BA concentrations, level of NPK fertilizer and their interactions on the growth index (cm^3) in *Oxalis triangularis.*

level NPK mgl^{-1}	conc. BA mgl^{-1}	Growth Index (cm^3)			NPK* BA	NPK effect
		Peatmoss	Mixture	River Soil		
0	0	2284.35 cd	953.78 e	165.90 e	1134.67 b	1812.96 a
	500	5254.79 a	1265.16 de	953.78 e	2491.24 a	
200	0	3195.47 bc	1124.64 de	194.16 e	1504.76 b	2127.26 a
	500	3674.59 b	4197.92 ab	376.80 e	2749.77 a	
NPK * Media	0	3769.57 a	1109.47 c	559.84 c		
	200	3435.03 ab	2661.28 b	285.48 c	**BA effect**	
BA * Media	0	2739.91 b	1039.21 c	180.03 d	1319.72 b	
	500	4464.69 a	2731.54 b	665.29 cd	2620.50 a	
Media effect		3602.30 a	1885.37 b	422.66 c		

* Means with same letter for each factor and interaction are not significantly different at 5% level based on Duncan's Multiple Rang Test.

DISCUSSIONS

The best superior results for leaf number, leaf length, vegetative dry weight, rhizome number, rhizome fresh weight and growth index from effect of all studied factors were obtained from peatmoss media, (500 $mg.l^{-1}$) BA concentration and (200 $mg.l^{-1}$) NPK level fertilizer may be due to the positive effect of peatmoss is the most accepted and widely used substrate worldwide for potted plant production, and it accounts for a significant portion of growing substrates used for potted plants (Ribeiro, *et.al*, 2007). It has high water holding capacity with good consistency, low strength, and excellent porosity (Eudoxie, and Alexander, 2011). And contains organic matter, beside it contains up to 3 percent nitrogen but contain a few of other nutrients (Williams, 2013). All these factors provide significant role in growth of plant.

And the influence of NPK causes may be attributed to the influence of N at specific concentration on the plant growth which led to new cells formation, consequently, increased chlorophyll amount in the leaves and finally induced leaf length, because Nitrogen has a special role in the formations of chlorophyll structure which related to the improving photosynthesis process. These results are in accordance (El-Naggar, and El-Nasharty, 2009) revealed that NPK fertilizer at 5g/plant affected to increasing leaf length in *Hippeastrum vittatum*. However, these results are in agreement with those of (Pal and Biswas, 2005) with *Polianthes tuberosa.*

However, benzyl adenine (BA) increases most study characters as followed growth index, leaf number, leaf length, and vegetative dry weight, may be due to the positive effect of BA on promoting of protein synthesis, increasing cell division, number and enlargement of cells (Cheema and Sharma, 1982) and this ultimately cause an increase in plant growth characteristics. Or might be increase in the installation of photosynthesis process, that act as food manufacture in plant leaves and later its translocation inside plant (Saleh, 1987). However, Kamenetsky, and Okubo, (2013) reported that benzyl adenine could increased the flower number of (*Zantedeschia aethiopica*) bulbs and improved lateral shoot growth, which flowers and leaves rise directly from rhizomes as consistent to oxalis plants.

CONCLUSIONS

In conclusions, according to study results the best media which significantly recorded whole study parameters was peatmoss, followed by mixture and river soil. Whereas for single effect, the higher concentration of BA and level NPK fertilizer improved most characters in this research, similarly, that is correct for double interactions. Also, when oxalis plant grown in peatmoss and treated NPK at (200 $mg.l^{-1}$) per pot or sprayed (500 $mg.l^{-1}$) BA recorded significantly maximum number of growth parameters for double interactions. Whereas, the triple interactions for many parameters recorded among peatmoss, (200 $mg.l^{-1}$) NPK fertilizer and (500 $mg.l^{-1}$) BA concentrations.

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کارتێکرنا جورێن ئاخێ، بێنزیل ئەدینین، و پەینێ کیمیایی NPK لسەر گەشا رووەکێ ئوکزالس (Oxalis triangularis)

پوختە

ئەڤ ڤەکولینە هاتە ئەنجامدان ل ناڤا خانیێ پلاستیکی و ل کەمپەسا زانکویا دهوك، هەرێما کوردستانا عیراقێ ل سالا (2021). ژبو دیارکرنا چەندین فاکتەرێن جوراوجور ژوان جورێن ئاخێ (پیتموس، وئاخا رویباری وتێکەلێ وان) و رەشا بێنزیل ئەدینینی و پەینێ کیمیایی (NPK) لسەر گەشەکرنا رووەکێ ئوکزالس (Oxalis triangularis). لدویف ئەنجامێن ڤەکولینێ پیتموس بو ئەگەرێ زێدەبونەکا بەرچاڤ یا هەمی ساخلەتێن ڤەکولینێ. هەروەسا بێنزیل ئەدینین ژی ب ریژا (500 mg.l-1) بو ئەگەرێ زێدەبونا هەمی ساخلەتان ژبلی ژمارا رایزوما. وفاکتەرێ (NPK) ب خەستیا (200 mg.l-1) بو ئەگەر درێژیا بەلگی زێدەببیت. وکارتێکرنا دوو قولی دنافبەرا پیتموسی و بێنزیل ئەدینی دا ب ریژا (500 mg.l-1) پتریا خەسلەتێن ڤەکولینێ زێدەکرن ژبلی ژمارا رایزوما، قەبارێ کتەکا رایزوما، و کێشا تەر یا کتەکا رایزوما. بەلێ کاریگەریا دوو قولی دنافبەرا پیتموسی و بێ بکارئینانا پەینێ (NPK) ب شێوەکێ بەرچاڤ ژمارا بەلگا، کێشا هشکا رووەکی، ژمارا رایزوما، وقەبارێ کتەکا رایزوما زێدەکرن. هەروەسا کاریگەریا (500 mg.l-1) یا بێنزیل ئەدینینی دگەل (200 mg.l-1) یا (NPK) بو ئەگەرێ باشترکرنا پتریا ساخلەتێن هاتینە وەرگرتن د ڤێ ڤەکولینێ دا. هەروەسا گاریگەریا سێ قولی د نافبەرا پیتموسی و هەردوو خەستیێن بلند یێن بێنزیل ئەدینینی وپەینێ کیمیایی (NPK) پتریا ساخلەتان بەرچاڤ زێدەکرن د ڤێ ڤەکولینێ دا.

پەیڤێن دەستپێکی: (Oxalis triangularis)، پیتموس، ئاخا رویباری، تێکەلێ وان، بێنزیل ئەدینین، فێرتیلایزەرێ NPK.

تأثير الأوساط الزراعية، البنزيل أدنين، و NPK على نمو نبات أوكزاليس *(Oxalis triangularis)*

الخلاصة

أجريت هذه الدراسة في البيت البلاستيكي التابع الى مشتل جامعة دهوك اقليم كوردستان العراق لموسم النمو 2021، لدراسة تأثير الاوساط الزراعية (البيتموس والرمل النهري + البيتموس والرمل النهري 1:1) بالإضافة الى البنزيل أدنين، وسماد NPK وتأثيرهما على نمو نبات الأوكزاليس (*Oxalis triangularis*). تظهر النتائج بوضوح أن البيتموس أدى إلى تحسين جميع الصفات الدراسية مقارنة بالرمل النهري والخليط. وكذلك زاد البنزايل ادنين بتركيز (500) ملغم. لتر$^{-1}$ من معظم هذه الصفات باستثناء عدد الرايزومات وحجم و وزن الطري لكل رايزوم. كذالك أظهرت الدارسة إن سماد NPK بتركيز (200) ملغم. لتر$^{-1}$ لكل سندان أدى إلى زيادة في طول الورقة. سجلت التداخل الثنائى بين البيتموس و البنزين ادنين تأثيرا معنويا كبيرا على صفات النمو لكل من عدد الرايزومات وحجم و وزن الطري للرايزوم. كذالك أظهرت النتائج لتداخل الثنائي للبيتموس بدون استخدام سماد NPK، تحسناً ايجابياً لكل من عدد الأوراق والمادة النباتية الجافة وعدد وحجم الرايزومات، وكذلك ادى التداخل بين البنزيل ادنين وNPK إلى تحسين اغلب صفات النمو في البحث. وبالنسبة لمعاملات التداخل الثلاثي بين العوامل الثلاثة (البيتموس، و البنزايل ادنين 500 ملغم. لتر$^{-1}$ و سماد NPK 200 ملغم لتر$^{-1}$) فقد سجلت أعلى المعدلات مقارنة بغير المعاملة لمعظم الصفات المدروسة.

الكلمات المفتاحية: *(Oxalis triangularis)*، بيتموس، رمل، خليط، بنزيل أدنين، سماد NPK.