International Journal of Psychosocial Rehabilitation, Vol. 24, Issue 06, 2020
ISSN: 1475-7192

THE RESPONSE OF TWO POTATO CULTIVARS TO ORGANIC AND BIO FERTILIZATION AND THEIR INTERACTION WITH CHEMICAL FERTILIZATION ON SOME GROWTH AND YIELD TRAITS

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***ABSTRACT**--This study was conducted in a field of potato farmers in Babylon province, Al-Dabla region south of Al-Hilla city during the autumn season (2018-2019). This study aimed to study two factors: First factor: the cultivars (Riviera and Arizona) class A resulting from cultivation of class E imported and cultivated in spring season 2018. The second factor: the effect of fertilizer combinations, the Arizona cultivar was significantly excelled in most of the measured traits compared to the Rivera cultivar. Significant differences were observed between the treatments of fertilizer combinations, Where the treatment (organic fertilizer + bio-fertilizer + 25% chemical fertilizer) was significantly excelled compared to the control treatment in the study indicators. Bi-interaction treatment (Arizona cultivar + organic fertilizer + bio-fertilizer + chemical fertilizer 25%) achieved the highest values for the number of Aerial stems amounted to (3.374 stems.plant^{-1}) and the total yield for tubers (43.24 tons.ha^{-1}).*

***Key words**-- Potato cultivars, Soil salinity, Bio fertilizers, chemical fertilizers, Organic compost, Nutrients availability*

I. INTRODUCTION

The potato (*Solanum tuberosum* L.) is considered one of the most important vegetable crops in the world in terms of production and cultivated area, it belongs to the Solanaceae family, which includes about 90 genera and about 2000 species (Hassan, 2003; Al-Juthery, *et al*,2018 b). The cultivated areas of the potato crop in Iraq is increasing, however, that the produced quantities do not meet the requirements of the Iraqi consumer, this is due to many of the problems facing the cultivation of the crop in Iraq, the most important of which is the salinity of the soil, which plays an important role in determining productivity(AL-Taey and Saadoon,2012 ; AL-Taey,2017), where the crop's exposure to salt stress causes a decline the production in most vegetables. Therefore, research has recently tended to study raising the average of growth and production in such , improving the reality of

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Received: 22 Feb 2019 | Revised: 13Mar 2019 | Accepted: 05 Apr 2020

cultivation of this crop in Iraq requires attention to the various agricultural service operations and Providing plants with the necessary nutrients (AL-Taey, *et al*, 2018).

Organic fertilizers are an important way to provide plants with the necessary nutrient requirements but do not adversely affect the environment (Al-Safir,2006) , where the addition of organic fertilizers to the soil improves their synthetic traits and increases the activity and numbers of microorganisms (Burhan and AL-Taey ,2018). Biofertilizers also play a role in improving the physical, chemical and biological traits for the soil. Biofertilizers are one of the used materials in this field. which are natural preparations containing a group of beneficial microorganisms that have an active and effective role in improving soil fertility and supplying plants with part of their nutritional needs (AL-Taey and Majid,2018) ; where It maintains the equilibrium of the elements in the agricultural lands and converts the elements to the soluble and available form suitable for plant nutrition, It is also involved in the biological resistance for some pests and plant diseases (Al - Haddad, 2003; Al-Badawi, 2008). The concept of integrated fertilization has emerged, which is a combination of chemical, organic and bio-fertilization in order to rationalize the use of chemical fertilizers and compensating them with natural fertilizers for the purpose of increasing the yield and improving the quality (Al-Juthery, *et al* ,2018b). This study aims to know the response of two potato cultivars to organic and bio fertilization and their interaction with chemical fertilization for the traits of growth and yield in saline-affected soils.

II. MATERIALS AND METHODS

The experiment was conducted in a private vegetable field in Al-Dabla region, south of Babylon province, located on longitude 44.39 E and latitude 32.3 N during the autumn growing season (2018). Soil samples were taken from different locations of the experiment field at a depth of (30 cm) for the purpose of conducting some physical and chemical analyzes before cultivating as shown in Table (1). The maximum and minimum temperatures and rainfall were recorded during the duration of the study from the meteorological station in Babylon province as shown in Table (2).

Table 1: illustrates some of the physical and chemical traits for the soil of the experiment field before cultivating.

Traits and units	**Autumn Season (2018)**
pH	7.5
EC ($dS.m^{-1}$)	6.23
Organic matter (%)	1.25
Nitrogen (%)	0.33
Phosphorus (%)	0.12
Potassium (%)	1.07
Sand (%)	22
Silt (%)	54
Clay (%)	24
Texture	Silty loam

The land was prepared , and divided into plots and each plot divided into experimental units. Potato seed for the two cultivars (Arizona and Riviera) class (A) was obtained from a farmer, which taken from the harvest of the spring season for the agricultural season (2018), which was cultivated with the class (E) and stored at 4 °C in refrigerated warehouses. The seed was cultivated at 10/9/2018 on a furrows where the length of the furrow was (2 m), the distance between the furrow and another is (75 cm), with rate of two furrows for each experimental unit, thus the area of the experimental unit amounted to (3 m^2), leaving a distance of 1 m between the experimental units and plots. The experiment involved the study of two factors with three replicates. The first factor included the cultivars (Arizona and Riviera), which is one of the early maturing cultivars that is symbolized by (V1, V2), respectively. The second factor: the combinations of fertilizer, with eight levels (corn cobs wastes, Organic fertilazers + bio-fertilizer, Organic fertilazers + chemical fertilizer 50% of recommended fertilizer, Organic fertilazers + chemical fertilizer 25% of recommended fertilizer, Organic fertilazers + bio-fertilizer + chemical fertilizer 50% of recommended fertilizer, Organic fertilazers + bio-fertilizer + chemical fertilizer 25% of recommended fertilizer, Chemical fertilizer 100% full recommended fertilizer, the control without fertilization), which are symbolized by (F1, F2, F3, F4, F5, F6, F7, F8), respectively. Organic fertilizers were added to the specified experimental units and It was well mixed with soil before cultivating and according to the recommendation of the fertilizer (20 tons.ha^{-1}). As for the equivalent NPK fertilizer (15:15:15) which was added in two batches before cultivating and after 45 days of emerging according to specified rates (25% from the recommendation of fertilizer, 50% from the recommendation of fertilizer, 100% from the recommendation of fertilizer at a rate of (600 kg.ha^{-1} N, P, K)). As for the biofertilizers, a mixture of (Bacillus megaterium + Azotobacter chroococcum + Fluorescent Pseudomonas was added before cultivating according to a recommendation by adding (200 g from biofertilizer to 5 L of water, the tubers were then immersed and then cultivated directly. Bio-fertilizer was obtained from the Ministry of Science and Technology, Laboratories of the Agricultural Research Department in Al-Zafaraniya. The experiment was applied according to the split-split system with two factors, the first factor is the cultivars that are symbolized by (V), which is the Main-plots, the second factor is fertilizer combinations that are symbolized by (F), which is the sub-plots, with three replicates and the number of treatments in each replicate was 16 treatments (8 × 2) and the total of experimental units are (48). The significant differences between the treatments were calculated at significant level of (0.05) for the least significant difference (LSD) using Genstat program.

III. RESULTS AND DISCUSSION

Plant Height (cm)

Table (2) shows that there was a significant effect between the two cultivars, where the Arizona cultivar was significantly excelled by recording it the highest average amounted to (48.38 cm) compared to the Riviera cultivar which gave the lowest average amounted to (34.82 cm). The results of the same table indicated that there were significant differences in the treatments of fertilizer combinations where the treatment (organic fertilizer + bio-fertilizer + 25% chemical fertilizer) achieved the highest average of plant height amounted to (45.87 cm) compared to the control treatment which amounted to (37.79 cm). As for the Bi-interaction between cultivars and fertilizer combinations as shown in Table (3), the treatment (Arizona cultivar + 100% chemical fertilizer) has excelled by

recording it the highest average amounted to (53.61 cm) which did not significantly differ from the treatment (Arizona cultivar + organic fertilizer + bio-fertilizer + 25% chemical fertilizer), which amounted to (50.45 cm), while the treatment (Rivera cultivar + organic fertilizer + bio-fertilizer) recorded the lowest average amounted to (30.26 cm).

Leaf Area ($cm^2.plant^{-1}$)

Table (2) shows that the Arizona cultivar recorded the highest average of leaf area amounted (7842.88 $cm^2.plant^{-1}$), thus the Rivera cultivar was significantly excelled by giving it the lowest average for leaf area amounted to (7681 $cm^2.plant^{-1}$). The effect of fertilizer combinations had a significant effect on the treatment (organic fertilizer + bio-fertilizer + 25% chemical fertilizer) which recorded the highest average amounted to (9448 $cm^2.plant^{-1}$) and the lowest average at the control treatment which amounted to (5158 cm). In the bi-interaction between cultivars and fertilizer combinations, Table (3) treatment (Arizona cultivar + Organic Fertilizer + Bio-fertilizer + 25% Chemical Fertilizer) achieved the highest average of leaf area amounted to (9454 $cm^2.plant^{-1}$). As for the treatment (Rivera + control) recorded the lowest average amounted to (5030 $cm^2.plant^{-1}$).

The leaves content of chlorophyll (SPAD):

Table (2) shows that the Arizona cultivar was significantly excelled by giving it the highest average of the leaves content of chlorophyll amounted to (38.21 SPAD) compared to the Rivera cultivar which recorded the lowest chlorophyll content in leaves amounted to (35.51 SPAD). There was significant effect in fertilizer combination on the treatment (organic fertilizer + bio-fertilizer + 25% chemical fertilizer) which recorded the highest average amounted (38.70 SPAD) while, there was no significant differences in the bi-interaction between cultivars and fertilizers combinations.

The percentage of dry matter in leaves

Table (2) shows that the Arizona cultivar was significantly excelled by giving it the highest average of the percentage of dry matter in leaves amounted to (14.98%) compared to the Rivera cultivar which recorded the lowest the percentage of dry matter in leaves amounted to (14.01%). The results indicated that there were significant differences between the treatments of fertilizer combination, where the treatment (organic fertilizer + 25% chemical fertilizer) recorded the highest average amounted to (15.56%) which did not differ significantly from the treatment (organic fertilizer + bio-fertilizer + 25% chemical fertilizer) which amounted to (15.09%). As for the treatment (organic fertilizer + bio-fertilizer) recorded the lowest average amounted to (13.50%). Although there were differences between the bi-interaction treatments, they did not reach a significant level.

The total yield of tubers ($tons.ha^{-1}$)

Table (2) indicates the significant superiority for Arizona cultivar by recording it the highest total yield of tubers amounted to (35.49 $tons.ha^{-1}$) compared to the Rivera cultivar which recorded the lowest average of total yield for tubers amounted to (31.21 $tons.ha^{-1}$). In the effect of fertilizer combinations, it was noted that the highest total yield of tubers was recorded in the treatment (organic fertilizer + bio-fertilizer + 25% chemical fertilizer) which amounted to (40.58 $tons.ha^{-1}$), while the control treatment recorded the lowest average amounted to (21.55

Received: 22 Feb 2019 | Revised: 13Mar 2019 | Accepted: 05 Apr 2020

tons.ha^{-1}). Table (3) shows that the treatment (Arizona cultivar + Organic Fertilizer + Bio-Fertilizer + 25% Chemical Fertilizer) recorded the highest total yield for tubers between the bi-interaction treatments which amounted to (43.24 tons.ha^{-1}) compared to the treatments (Arizona cultivar + control) and (Rivera cultivar + control), which recorded the lowest yield amounted to (21.55 tons.ha^{-1}) for both treatments.

Table 2: Effect of cultivar and fertilizer combinations on the traits of growth and yield for potato plant.

Treatments / LSD 0.05	Plant height	Leaf area for the plant	The leaves content of chlorophyll	Percentage of dry matter in the leaves	Total yield Ton.ha^{-1}
V1	48.38	7842.88	38.21	14.98	35.49
V2	34.82	7681	35.51	14.01	31.21
LSD 0.05	**2.734**	**0.311**	**1.858**	**0.823**	**1.553**
F1	39.39	6351.50	36.77	14.10	35.62
F2	37.90	5876.50	33.19	13.50	28
F3	41.17	8079.50	37.37	14.76	33.80
F4	45.74	9218.50	37.66	15.56	36.20
F5	40.42	8911.50	37.79	14.40	37.56
F6	45.87	9448	38.70	15.09	40.58
F7	44.50	9052	36.80	14.85	33.50
F8	37.79	5158	36.62	13.67	21.55
LSD 0.05	**2.885**	**1.642**	**1.576**	**1.147**	**1.112**

Table 3: Effect of interactions on the traits of yield and growth for potato plant.

Treatments / LSD 0.05	Plant height	Leaf area for the plant	The leaves content of chlorophyll	Percentage of dry matter in the leaves	Total yield for tuber
V1 F1	46.17	6543	37.63	14.27	37.50
V1 F2	45.54	5965	35.67	14.17	29.65
V1 F3	49.73	8043	38.90	15.35	37.24
V1 F4	49.89	9369	38.41	15.82	39.62
V1 F5	47.31	9056	39.33	15.14	41.35
V1 F6	50.45	9454	40.63	15.33	43.24
V1 F7	53.61	9027	37.40	15.68	33.79
V1 F8	44.31	5286	37.73	14.06	21.55
V2 F1	32.62	6160	35.90	13.94	33.75
V2 F2	30.26	5788	30.70	12.84	26.35
V2 F3	32.60	8116	35.83	14.18	30.35
V2 F4	41.59	9068	36.90	15.3	32.78
V2 F5	33.54	8767	36.25	13.66	33.76

Received: 22 Feb 2019 | Revised: 13Mar 2019 | Accepted: 05 Apr 2020

V2 F6	41.29	9442	36.77	14.85	37.92
V2 F7	35.38	9077	36.20	14.03	33.21
V2 F8	31.27	5030	35.50	13.28	21.55
LSD 0.05	**4.024**	**2.177**	**Non-Significant**	**Non-Significant**	**1.662**

The results showed Arizona cultivar was achieved the best values compared to the Rivera cultivar. This is due to the variation of genetic traits among the cultivars as well as to the response of Arizona cultivar to the factors and conditions of the soil where the study conducted as shown in Table (1) and its response to climatic conditions during the growing season. The superiority of the Arizona cultivar in the trait of plant height, as well as the number of Aerial stems, caused an increase in the number of leaves and this increase in the number of leaves led to an increase in the leaf area of the plant and the leaves content of chlorophyll, which led to an increase in the surface of the leaves exposed to sunlight and increasing chlorophyll pigment in the leaves, thus Increasing the carbon metabolism, increasing the accumulation of carbohydrates and securing the amino acids needed to build proteins, which increases the percentage of dry matter in the total vegetative. This increase in dry matter was reflected in the plant yield and the total yield of tubers. It may be due to the process of mixing organic fertilizer (compost) and bio-fertilizer that cause the increase of nitrogen availability for plant growth, this encouraged the growth of microorganisms and increasing their numbers, where this increase in microorganisms is accompanied by raising the rate of organic phosphorus mineralization and then an increase of phosphorus availability, which has the effect of stimulating co-enzymes in forming chlorophyll (Al-Zoghbi et al., 2007). The integrated fertilization positively affects the traits of vegetative growth for potatoes. As well as Abed et al., (2018) showed that the mineral and bio-fertilizers have a positive role in improving the vegetative traits, plant height and the number of Aerial stems. As well as we note that organic fertilization has an effect on the traits of the quantitative yield, where this is due to the organic fertilization provided by the elements necessary for plant growth and development, which contributes to increasing photosynthesis process, thus increasing manufactured carbohydrates, which is reflected in the transport of these carbohydrates and stored in tubers. These results agree with (Al-Bayati**,** 2010; Al-Sharifi, 2015; AL-Taey and Majid ,2018; Bashi and Zaki ,2018) they found that organic fertilizers have a role in increasing some of the traits of the quantitative yield. This may also be due to the role of bio-fertilizers and mineral fertilizers because they contain nutrients such as K, P, N, where they are available to absorption after mineralizing it in the soil due to soil revitalization and this leads to improving vegetative growth, thus an increase in the quantitative yield (Abed et al., 2018) .

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