Effect of spraying with Biozyme and bacterial fertilizers on the yield and vegetative traits of two potato cultivars

Mohammed Abrahem Abbas AL shammary Hussein Awad Adday AL Zobaai
Department of Horticulture and landscaping Gardening, College of Agriculture, University of Anbar.

ABSTRACT

A field experiment was conducted in the fields belonging to College of Agriculture, Abu Ghraib on January/ 29/ 2017 to study the effect of nine treatments of two microorganisms: *Azotobacter vinilandi* and *Pseudomonas fluoresces*, spraying with the Biozyme on two potato cultivars (Everest and Riviera), with Elite order. The treatment included (the control treatment, treatment of whole Recommended chemical fertilizer), as well as (treatment of *Pseudomonas* only, treatment of *Azotobacte*r only, treatment of both types of bacteria, treatment of Biozyme only, the bi-interaction treatment between *Pseudomonas* and Biozyme, the bi-interaction treatment between *Azotobacter* bacteria and Biozyme, treatment of both types of bacteria with the Biozyme) plus half of the Recommended fertilizer. The experiment was conducted as a factorial experiment according to the Randomized Complete Block Design (RCBD), The averages were compared at a 5% probability level, and the results of the following experiment showed:

The treatment of T8 (inoculation with *A.vinlandii* Bacteria and *P. fluorescens* Bacteria with Biozyme + half of the Recommended fertilizer) gave the highest percentage of vegetative growth Where it worked to increase the dry weight of the plant, the number of leaves and leaf area compared to the control treatment, It also gave the highest value in the number of tubers, the yield of one plant and the total yield compared with the control treatment. Everest cultivar is characterized by the dry weight of one plant, number of leaves and leaf area.

أثر الرش بالبايوزيم والمخصبات البكتيرية في صفات النمو الخضري والحاصل لصنفين من البطاطا

محمد ابراهيم عباس الشمري حسين عواد عداي الزوبعي
قسم البستنة وهندسة الحدائق كلية الزراعة – جامعة الانبار

الخلاصة

نُفذت تجربة حقلية في الحقول التابعة لكية الزراعة –أبي غريب في 29 كانون الثاني للعام 2017 لدراسة تأثير تسعة معاملات مؤلفة من نوعين الأحياء المجهرية هي بكتريا *Azotobacter vinilandi* وبكتريا *Pseudomonas fluoresces* مع الرش بالمحفز البايوزيم على صنفين من البطاطا إيفرست (Everest) وريفيرا (Riviera) رتبة Elite. شملت التجربة (معاملة المقارنة، معاملة توصية السماد الكيمياوي كاملة)، كذلك (معاملة بكتريا *Pseudomonas* فقط، معاملة بكتريا *Azotobacter* فقط، معاملة كلا النوعين من البكتريا، معاملة البايوزيم فقط، معاملة البايوزيم مع بكتريا *Pseudomonas*، معاملة البايوزيم مع بكتريا *Azotobacte*r، معاملة كلا النوعين من البكتريا مع البايوزيم) مضافاً لها نصف التوصية السمادية. نُفذت التجربة كتجربة عاملية وفق تصميم القطاعات العشوائية الكاملة (RCBD)، وقورنت المتوسطات عند مستوى احتمالية 5%، وأظهرت نتائج التجربة التالي.

أعطت المعاملة T8(التلقيح ببكتريا *A.vinlandii* وبكتريا *P.fluorescens* مع البايوزيم + نصف التوصية السمادية) أعلى قيمة في صفات النمو الخضري حيث عملت على زيادة الوزن الجاف للنبات وعدد الاوراق والمساحة الورقية مقارنة بمعاملة المقارنة، كذلك أعطت أعلى قيمة في عدد الدرنات وحاصل النبات الواحد والحاصل الكلي بالقياس مع معاملة المقارنة. تميز الصنف إيفرست Everest في الوزن الجاف للنبات وعدد الأوراق والمساحة الورقية. بينت نتائج التداخل تفوق المعاملة V2T8(التلقيح ببكتريا *A.vinlandii* وبكتريا *P.fluorescens* مع البايوزيم + نصف التوصية السمادية) مع الصنف Riviera (V2) الذي كان أكثر استجابة للمعاملات من الصنف Everest (V1) حيث اعطى أعلى قيمة في حاصل النبات الواحد والحاصل الكلي. بينما تفوقت نفس المعاملة مع الصنف Everest في جميع صفات النمو الخضري المدروسة.

1. INTRODUCTION

Potato (*Solanum tuberosum* L.) belongs to Solanasceae family, It is one of the most widely consumed vegetable crops in the world because it contains many nutrient elements, high protein content, vitamins, minerals and

energy as well as cheap prices. It is the fourth crop after wheat, yellow corn and rice in the main global crop sequence [32]. The cultivated area of this crop in the world amounted of (19463041 tons.ha^{-1}) with a global production of (362368096 tons.ha^{-1}) [10]. The foliar spraying is a fast method of processing the plant with nutrients compared to soil fertilization, as well as being effective in nutrient transport within the plant [15]. Foliar nutrient is an effective way to treat micro-nutrient deficiencies. Where It provides plant requirements in critical periods which the roots cannot provide the needs of plants for these elements or because of inappropriate soil conditions, particularly in the early stages of its growth [20]. Due to the importance of this crop to humans and the need for nutrient elements, therefore, must meet the needs of the plant from elements necessary for growth, Most of the fertilization process depends on the traditional method of quality and quantity of fertilizer, which depends on the chemical fertilizer, which solved the problems of farmers in terms of the provision of nutrients to the plant, but the excessive use of chemical fertilizers has led to the emergence of environmental and health problems to the consumer so turned attention only the use of bio-fertilizers to avoid harm and to improve the quality traits of the agricultural product [38], which solved many problems, including the provision of nutrient elements to the plant and reduce the productivity of agricultural crops and reduce the use of chemical fertilizers and it is considered environmentally friendly [36]. The organism used in bio-fertilization are *Azotobacter*, Phosphobacterira, *Pseudomonas* and *Bacillus*, which improve soil properties and increase agricultural production to meet nutrient requirements for plant [31]. Bio-fertilizers can be added directly or mixed with seeds. Some of these are used to stabilize atmospheric nitrogen in soil by at least 35% and others dissolve phosphates or organic phosphorus metals, where 50% of phosphorus is available [21]. Increasing the nutrient availability of the plant through its secretion of organic acids in the soil and reduce the pH of the soil, thus works to dissolving the nutrient elements available in non-availability form to availability form for the plant, for example conversion of Tricalcium phosphate to Monocalcium phosphate as well as its role in the secretion of some growth regulators and plant hormones that have a role in the plant's bioprocesses [37]. Potatoes are cultivated in Iraq with many cultivars. These cultivars differ in their traits and their ability to resist diseases and insects. It also differs in its productivity, which is affected by several factors, including genetic and nutrition, and are grown on two cultivars so prefer the early cultivars maturity and abundance yield, cultivar is considered an important and influential factor in the productivity of this crop [33]. Genotypes affect if they interact with genetic factors effectively in the tuberous yield of the potato and its components as well as on the speed of plant growth [16, 25].

2. MATERIALS AND METHODS

The field experiment was conducted in College of Agriculture, Abu Ghraib, the alternative location of Anbar University in the fields belonging to Department of Horticulture and landscaping Gardening. The agricultural operations were conducted including plowing and settling. The land was divided to furrows with a width of 75 cm, Samples of field soil were taken at a depth of 30 cm from several random places. They were mixed and a quantity was taken to the laboratory for analysis as shown in Table (1). Bio-vaccine isolates (*Azotobacter vinlandii* and *Pseudomonas fluorescens*) added to the peat moss were equipped with biomass 810 from the Agricultural Research Department of the Abu Ghraib Soil Research Department. The experiment was conducted in the field on 29/1/2017 by cultivating two cultivars of certified potato seeds (Elite order) by the Ministry of Agriculture during the spring season. The Everest cultivar was used by the Dutch Stet Holland company and the second cultivar (Riviera) was from the Dutch company also, which was cultivated on a furrows, with a

dimensions of 6 m x 0.75 m per furrow, Which represents one experimental unit with distance of 25 cm between the plant and another, depth of 10-15 cm, A fixed quantity of 1,700 g per experimental unit was added from an organic substance called Italian Italpollina, which is the origin of all bacterial processes to improve the action of bacteria after the work of incision in the furrow and mixing it with the soil. Drip irrigation system was adopted in the irrigation process of the experiment. One half of the Recommended fertilizer for T2-T8 treatments was added from K.P.N as recommended by Al-Fadhli (240 kg $N.ha^{-1}$, 120 kg $P.ha^{-1}$, 400 kg $k.ha^{-1}$) and a whole Recommended fertilizer for T1 treatment [11]. The process of Biozyme spraying that product from seaweed extract was conducted with a concentration of (0.5 $ml.L^{-1}$) Which consists of Auxins (IAA) and Gibberelins with ratio of (32.2 ppm), Cytokinins with ratio of (82.2 ppm) and nutrient elements (Mg, S, B, Fe, Mn, Zn) with ratios of (0.14, 44, 0.3, 0.49, 0.12, 0.37%), respectively at 29/3/2017 for first spraying and on 14/4/2017 for the second spraying at the tubers formation stage.

Experiment treatments,

The first factor is the cultivars which are symbolized by V1 for Everest cultivar and V2 for the Riviera cultivar. The second factor is the treatment which are symbolized by (T), which includes the microorganisms (*Azotobacte*r, *Pseudomonas* and Biozyme), with the interaction between them as following:

T0: control Treatment.

T1: Whole Recommended Treatment.

T2: Treatment of (*Pseudomonas* bacteria + half of the Recommended fertilizer).

T3: Treatment of (*Azotobacter* bacteria + half of the Recommended fertilizer).

T4: Treatment of (*Pseudomonas* bacteria + *Azotobacter* bacteria + half of the Recommended fertilizer).

T5: Treatment of (spraying with Biozyme at concentration of 0.5 $ml.L^{-1}$ + half of the Recommended fertilizer).

T6: Treatment of *(Pseudomonas* bacteria + spraying with Biozyme at concentration of 0.5 $ml.L^{-1}$).

T7: Treatment of (*Azotobacter* bacteria + spraying with Biozyme at concentration of 0.5 $ml.L^{-1}$ + half of the Recommended fertilizer).

T8: Treatment of (*Pseudomonas* + *Azotobacter* bacteria + spraying with Biozyme at concentration of 0.5 $ml.L^{-1}$ + half of the Recommended fertilizer).

The Randomized Complete Block Design (RCBD) was used in the conducting of the experiment and was conducted as a factorial experiment, with three replicates and each replicate consisting of 18 treatments. Thus, the experiment included 54 experimental units, with 24 plant for each experimental unit, with a unit area of 4.5 m. The treatments were distributed randomly on each replicate. Gensta Discovery Edition was used in the statistical analysis of the experimental data. The averages were compared for all the traits of the study according to the least significant difference test (L.S.D) at the 5% probability level [23].

Analyzes were conducted in the Department of Agricultural Research, Department of Soil Research on 16/1/2017

Studied traits:

1. Traits of vegetative growth

1-1 Number of leaves per plant (leaf.plant^{-1})

It is calculated by counting the leaves of one plant for ten plants which randomly selected and calculating the average and extracting the average number of leaves per treatment in the replicate.

1-2 leaf area (dm^2.plant^{-1})

Three leaves were taken from each plant (top, middle and bottom) representing for plant from five randomly selected plants. It was scanned using the scanner and then inserted the images into the Digimizer program. It extracts the leaf area of each leaf and multiply by the number of leaves of each plant. The final average of the leaf area is then extracted to obtain the leaf area for the one experimental unit or treatment [28].

1-3 Dry weight of vegetative growth (g. plant^{-1})

The total vegetative of ten randomly selected plants was taken during tubers extraction, placed in large paper bags, dried in an air and then dried in oven at 70 °C until the weight was fixed. The dry weight of each plant was calculated and then the average was calculated [6].

2-Yield traits:

2-1 Number of tubers for plant (tuber.plant^{-1})

The total number of tubers were calculated and then dividing the total number of tubers on the number of selected plants.

2.2 Plant yield per plant (g.plant^{-1})

It was calculated by dividing the yield of selected plants on the number of these plants within the experimental unit.

2.3 Total yield (tons.ha^{-1})

It was calculated after calculating the yield of the one plant and calculate the yield of the experimental unit through the following equations.

The yield of the experimental unit = the yield of one plant × the number of plants emerging in the experimental unit.

Total yield (tons.ha^{-1}) = $\frac{\text{The yield of experimental unit} \times 1000}{\text{The area of experimental unit}}$

Table 1: Results of chemical and physical analysis for the soil of the field before cultivating.

Traits	Values	Units
pH	8.0	
EC 1:1	3.4	ds.m^{-1}
N availability	42.0	mg.kg^{-1} soil
P availability	19,16	
K availability	398	
Mg	17.0	meq.L^{-1}
Ca	L 12.5	
Na	9.68	
SO4	2,6	
Cl	L 12.5	
HNO3-	2.0 l	
CEC	14.44	cmol.kg^{-1}
O.M	1.18	g.kg^{-1}
Percentage of sand	46.8	%
Percentage of silt	38.4	
Percentage of clay	14.8	
Soil texture	loamy	

3. RESULTS AND DISCUSSION

1- Effect of cultivars, Bio-vaccine treatments, Biozyme and the interaction between them on the traits of vegetative growth for potato plant

1-1- Number of leaves (leaf.plant^{-1})

Table (2) shows that the T8 treatment (Inoculation with *A.vinlandii* Bacteria, *P. fluorescens* bacteria and Biozyme + half of the Recommended fertilizer) was excelled by giving it the highest average number of leaves reached (79 leaf.plant^{-1}) compared with the control treatment T0, which gave the lowest value amounted of (35.5 leaf.plant^{-1}), It also excelled with percentage of 52.24% on the complete fertilization treatment with the recommended fertilizer T1. As for cultivar, the results showed that Everest cultivar V1 was significantly excelled on Riviera cultivar V2 by giving it the number of leaves amounted of (73.30 leaf.plant^{-1}) compared to V2 cultivar, which amounted to (47.26 leaf.plant^{-1}). For bi-interaction treatments, the bi-interaction treatments (V1T8) has showed an excelling by giving it the highest average number of leaves

amounted of (103 leaf.plant^{-1}) compared with the control treatment V1T0 which gave a value of (42 leaf.plant^{-1}), It also excelled with percentage of 113.12% on the interaction treatment with complete fertilization by the recommended fertilizer V2T1.

1-2- leaf area (dm^2.plant^{-1})

Table (2) shows that T8 treatment is excelled by giving it the highest leaf area amounted of (177 dm^2.plant^{-1}) compared to the control treatment T0, which gave the lowest value of (48.5 dm^2.plant^{-1}), It also excelled with percentage of 79% on the complete fertilization treatment with the recommended fertilizer T1. The results showed that Everest cultivar V1 was excelled on Riviera cultivar V2 for the same trait by giving it the highest average of leaf area amounted of (141.6 dm^2.plant^{-1}) compared to the cultivar V1, which gave (123.6 dm^2.plant^{-1}). As for the interaction, the treatment V1T8 showed a significant excelling in this trait amounted of (196.3 dm^2.plant^{-1}) compared to the control treatment V1T0, which gave a value of (50.1 dm^2.plant^{-1}), It also excelled with percentage of 93% on the interaction treatment with complete fertilization by the recommended fertilizer V2T1.

Table 2: shows the number of leaves (Leaf.plant^{-1}), leaf area (dm.plant^{-1}) and the dry weight of the plant (g.plant^{-1}).

The number of leaves (Leaf.plant^{-1})				**Leaf area (dm.plant^{-1})**				**The dry weight of the plant (g.plant^{-1})**			
V / T	**V1**	**V2**	**T**	**V / T**	**V1**	**V2**	**T**	**V / T**	**V1**	**V2**	**T**
T0	42.00	29.00	35.50	**T0**	50.1	47	48.5	**T0**	158.3	75.0	116.7
T1	55.33	48.33	51.83	**T1**	94.6	103	98.9	**T1**	211.7	170.0	190.8
T2	80.67	40.00	60.33	**T2**	152.4	103	128	**T2**	280.0	208.3	244.2
T3	74.33	55.33	64.83	**T3**	171.8	156	164	**T3**	328.3	247.0	287.7
T4	75.00	47.67	61.33	**T4**	157.7	143	150	**T4**	341.7	210.0	275.8
T5	72.33	47.33	59.83	**T5**	140	125	133	**T5**	338.3	223.3	280.8
T6	72.33	47.67	60.00	**T6**	137.1	124	130	**T6**	306.7	233.3	270.0
T7	84.67	55.00	69.83	**T7**	174.4	154	164	**T7**	358.3	242.7	300.5
T8	103.00	55.00	79.00	**T8**	196.3	158	177	**T8**	366.7	236.0	301.3
V	**73.30**	**47.26**	**7.72**	**V**	**141.6**	**123.6**	**14.1**	**V**	**298.9**	**205.1**	**27.9**
L.S.D 0.05	**3.64**			**L.S.D 0.05**	**6.7**			**L.S.D 0.05**	**13.1**		
L.S.D 0.05 for interaction	**10.92**			**L.S.D 0.05 for interaction**	**20.0**			**L.S.D 0.05 for interaction**	**39.4**		

Table (2) shows there is a positive effect for treatments in the traits of the vegetative growth for the potato plants. The positive effect of bio-fertilization treatments on the dry weight of the total vegetative, the number of leaves and the leaf area may be attributed to the role of the bio-fertilizers of the nitrogen-fixing *Azotobacter*, which work on increase the percentage of nitrogen which absorbed by the plant [4] or is attributed to the organisms that dissolving phosphate and released for the phosphorus element represented by *Pseudomonas*, Where works on dissolving and converts phosphate to the available form and absorption availability of by the plant by the release of organic acids that dissolve the mineral phosphate or mineralizing of organic phosphate and change the soil pH allows the plant optimal absorption of elements not available for absorption [9]. Perhaps due to the joint action of the two types of bio-fertilization bacteria, This is evidenced by the results of the superiority of treatments that use the two species together of bio-fertilization bacteria (*Azotobacter* and *Pseudomonas*) as well as half of added recommended fertilizer constantly for all the treatments and all these work to increase the proportion of nutrient elements in the soil in addition to the work of organisms in increasing the bioactivity of the soil in terms of the Configure of nutrient elements and make them sustainable for growth and plant production [3]. Nitrogen is an important component of the plant for its role in the manufacture of amino acids [19]. Its entry into the synthesis of enzymes, chlorophyll, hormones, nucleic acids, RNA and DNA, as well as in the formation of Porphyrin that forming the chlorophyll molecule, it has important in the formation of proteins. Phosphorus has no less importance than nitrogen. It is a component of RNA and DNA. It plays a role in the enzymatic reactions of carrier RNA and ribosomes. It also plays a role in the energy reactions required for carbon construction and respiration and enters into the co-enzymatic NAD and NADP that important in oxidation, reduction, respiration and carbonate reactions, and the abundance of phosphorus reduces the harmful effects of inorganic nitrogen and promotes the building of fibrous and lateral roots [12, 34]. Therefore, the increase in concentrations of nitrogen and phosphorus by the organisms increases the plant content of absorbed nutrient elements which reflected positively on the biological and physiological processes of plant cells and the process of construction of carbon, which increases the produced carbohydrates, and occurring of the division, elongation and evolution of plant cells, reflected on vegetative growth indicators [26], this results agree with [1, 30]. The increase in vegetative growth indices is due to the secretions of bio-fertilizers from stimulants, vitamins, hormones (Auxins, Gibberellins and cytokinines) [29], as well as the components of the used stimulators (Biozyme) from nutrient elements and growth regulators, which have an important effective in the conservation of plant growth. Where Auxins work in combination with other plant hormones in affect the phytochemical processes such as elongation, expansion of cells and the growth of the total vegetative. The Gibberellins role in the cellular division, which lead to elongation of the aerial stems and has an important role in delaying Senescence and thus prevents the breakage of chlorophyll in the leaves, In addition, cytokinines promote cell division in branches and roots, chloroplast formation and chlorophyll accumulation [14]. Therefore, the growth regulators have an effective role in increasing the leaf area and number of leaves as well as the number and length of roots and its composition, which is reflected on the absorption of nutrient elements by the plant, which is reflected positively on the representation of carbon and traits of vegetative growth in general [18]. It may be attributed to the content of Biozyme from nutrient elements (Zinc, iron, manganese, magnesium, sulfur, boron) and their active role in vegetative growth, where zinc is considered an essential element in the formation of chlorophyll and amino acid (Tryptophan), The sulfur is also used in the formation of amino acids and vitamin B1. Magnesium is considered an

essential element in the chlorophyll molecule and is an active promoter of metabolism enzymes for carbohydrate. Manganese is also important in the synthesis of chlorophyll and the synthesis of oxidation and reduction enzymes. Boron also plays a role in the synthesis of sugars and hormones and transported through cellular membranes [34, 12], which has a positive effect on the production of carbohydrate materials manufactured carbonate process and reflected positively on the density of the vegetation mass. This result agrees with [7]. The same table showed the effect of Everest cultivar in the traits of dry weight for plant, number of leaves and leaf area. This effect may be attributed to the genetic variation of the different species, which is the result of genetic factors affecting the traits of vegetative growth. In addition, the cultivars differ in size of the root system and the distribution of roots in the soil [8]. There is a positive relationship between root size and total vegetative [27]. The effect may be attributed to the suitability of the environmental condition of the species such as temperature, humidity and sun brightness, which is also reflected positively on the growth traits. This results agree with [17].

Effect of cultivars, Bio-vaccine (Biozyme) and interaction between them on the traits of yield and its components of potato plant

2.1 Number of tubers for the total yield (tuber.plant^{-1})

Table (3) shows the excelling of T8 treatment by giving it the highest average number of tubers for the total yield amounted of (9.75 tuber.plant^{-1}), and did not differ significantly from T4, T7, T6 and T2 treatments compared to T0 treatment, Which gave the lowest value of (7.58 tuber.plant^{-1}), It was also excelled with percentage of 8.7% on the recommended fertilizer T1. The results showed that Riviera cultivar (V2) was significantly excelled on the Everest cultivar (V1), with an average amounted of (10.23 tuber.plant^{-1}) compared with V2 cultivar, which gave (8.25 tuber.plant^{-1}). For bi-interaction treatment, the V2T4 treatment (*A.vinlandii* and *P. fluorecens* with half of the Recommended fertilizer) with Riviera V2 showed an excelling by giving it the highest average number of tubers amounted of (11.13 tuber.plant^{-1}) compared with the control treatment V2T0, which gave a value of (8.27 tuber.plant^{-1}), It was also excelled with percentage of 41.4% on the interaction treatment of V2T1 complete fertilization treatment with the recommended fertilizer.

2.2 Plant yield per one plant (g.plant^{-1})

Table (3) The T8 treatment was excelled by giving it the highest value of the plant yield of (1245.60 g.plant^{-1}), which did not differ significantly from the T7 treatment compared with the control treatment T0, which gave the lowest value of (817.4 g.plant^{-1}), It also excelled with a percentage of (10.77%) on the recommended fertilizer of T1. The results of the same table showed no significant effect for the cultivar. For bi-interaction, Treatment V2T8 showed by giving it the highest plant yield of (1259.30 g.plant^{-1}). It were not significantly different from V2T7, V1T8, V2T6 and V2T2 treatments compared

to the V2T0 treatment, which gave the lowest value of 788 g and It also excelled with percentage of 9.6% on the interaction treatment with complete fertilization by the recommended fertilizer V1T1.

2.3 Total yield (tons.ha^{-1})

Table (3) shows a significant effect for the total yield, the T8 was excelled by giving the highest value amounted of (66.43 tons.ha^{-1}) and it did not differ significantly from the treatment T7 compared with the control treatment T0, which gave the lowest value of (43.60 tons.ha^{-1}), It also excelled with percentage of (10.77%) the complete fertilizer treatment T1. The results of the same table showed no significant effect for the cultivar. As for bi-interaction, the treatment of V2T8 showed a significant excelling in the total yield amounted of (67.16 tons.ha^{-1}) and it did not differ significantly from the treatments of V2T7, V1T8, V2T2 and T6V2 compared with the control treatment of V2T0, which gave the lowest value (42.03 tons.ha^{-1}) and It also excelled with percentage of 9.6% on the interaction treatment with complete fertilization by the recommended fertilizer V8T1.

Table 3: shows the number of tubers (tuber.plant^{-1}), the yield of one plant (g.plant^{-1}) and the average of total yield (tons.plant^{-1}).

The number of tubers (tuber.plant^{-1})				**The yield of one plant (g.plant^{-1})**				**The dry weight of the plant (g.plant^{-1})**			
V / T	**V1**	**V2**	**T**	**V / T**	**V1**	**V2**	**T**	**V / T**	**V1**	**V2**	**T**
T0	6.90	8.27	7.58	**T0**	846.70	788.10	817.40	**T0**	45.16	42.03	43.60
T1	7.87	10.07	8.97	**T1**	1149.10	1099.90	1124.50	**T1**	61.28	58.66	59.97
T2	8.63	10.53	9.58	**T2**	1106.00	1218.80	1162.40	**T2**	58.99	65.00	61.99
T3	7.83	10.17	9.00	**T3**	1175.00	1182.70	1178.90	**T3**	62.67	63.08	62.87
T4	8.33	11.13	9.73	**T4**	1199.80	1185.10	1192.50	**T4**	63.99	63.21	63.60
T5	8.77	9.63	9.20	**T5**	1137.30	1142.90	1140.10	**T5**	60.66	60.96	60.81
T6	8.87	10.47	9.67	**T6**	1176.50	1217.70	1197.10	**T6**	62.75	64.95	63.85
T7	8.40	10.93	9.67	**T7**	1211.60	1235.80	1223.70	**T7**	64.62	65.91	65.26
T8	8.63	10.87	9.75	**T8**	1231.90	1259.30	1245.60	**T8**	65.70	67.16	66.43
V	**8.25**	**10.23**	**0.59**	**V**	**1137.10**	**1147.80**	**31.65**	**V**	**60.65**	**61.22**	**1.69**
L.S.D 0.05	**0.28**			**L.S.D 0.05**	**N.S**			**L.S.D 0.05**	**N.S**		
L.S.D 0.05 for interaction	**0.84**			**L.S.D0.05 for interaction**	**44.76**			**L.S.D 0.05 for interaction**	**2.39**		

Table (3) indicates to the positive effect for the treatments on the yield and its components, This is due to the effect of bio-fertilization and its positive effects mentioned above, as well as the spraying with Biozyme on the traits of vegetative growth as shown in Table (2) of (the dry weight of the total vegetative, the number of leaves and leaf area), Which may be attributed to the positive reflection on the yield components as shown in table (3), which reflected on the improving the total yield, number of tubers and plant yield, where the number of tubers increases with the increase in the number of leaves, especially the leaf area, which increases the light absorption of the plant and improve the representation of carbon and the product of carbohydrates and manufactured materials [35]. The increase in the number of tubers was attributed to the increase in the number of stems, as well as the accumulation of nutrient elements, water and carbohydrates, which helped to increase the average weight of the tuber. All this is reflected on the total yield of the tubers. The yield increase may be due to equilibrium in nitrogen, phosphorus and potassium absorption due to bio-fertilization and foliar spraying with the Biozyme [24]. This means that the increase in tuberous yield is dependent on the increase in the average traits of vegetative growth as well as the absorption of nutrient elements from the plant [26]. This results agree with [31, 18, 7]. Increase the average of metabolic is considered a significant factor in increasing the average of plant production [2]. The Riviera cultivar showed a significant effect in the traits of the number of tubers. This is due to the predominance of the genetic factor responsible for these traits for each cultivar of the mentioned cultivars. Consequently, it is reflected in the variation of the cultivars among them in terms of their effect on the yield components [22] or it is due to the effect of environmental conditions on the genotypes of the species and their adaptability to the environmental situation, this results agree with [5].

REFERENCES

1- Abou-Hussein,S.D.,I.EL-Oksh,T.EL-Shorbagy,and M.Gomaa. (2002). Effect of cattle manure,bio fertilizers and reducing mineral fertilizer on nutrient content and yield of potato plant .Egyptian Journal of Horticulture,29(1):99-115.

2-Agrawal, L., Narula, K., Basu, S., Shekhar, S., Ghosh, S., Datta, A. (2013). Comparative proteomics reveals a role for seed storage protein Am A1 in cellular growth, development, and nutrient accumulation. Journal of Proteome Research, 1: 4904–4930.

3-Ahemad, M., Khan, M.S., Zaidi, A., Wani, P.A. (2009). Remediation of herbicides contaminated soil using microbes. In: Khan, M.S., Zaidi, A., Musarrat, J. (Eds.), Microbes in Sustainable Agriculture. Nova Science Publishers, New York, USA.

4-Ahemad, Munees and Mulugeta Kibret .(2014). Mechanisms and applications of plant growth promoting rhizobacteria: Current perspective. University – Science, 26:1–20.

5-Akhtar , P.; Abbas ,S .J .; Aziz ,M .; Shah , A . B . and Ali , N .(2010). Effect growth behavior of Potato mini tubers on quality of seed potatoes as influenced by different cultivars . Pak . J. Pl . Sci, 16 (1) : 1-9

6-Al-Sahaf, Fadel Hussein. (1989). Applied Plant Nutrition. Baghdad University. Ministry of Higher Education and Scientific Research, Iraq. (In arabic)

7-Baske ,Raju., Mohapatra, P. P., Tarique Aslam., Manna, D., Sarkar, A., Maity, T. K. (2017). Efficacy of biozyme on yield and yield attributing traits in potato (Solanum tuberosum L.). Journal article . Environment and Ecology,35(2):1575-1579.

8-Battilani A., Plauborg F.L., Hansen S., Doleżal F., Mazurczyk W., Bizik J. (2008). Root development model for potato management. In Proceedings of the Vth IS on Irrigation of Horticulture Crops ISHS Acta Horticulturae,1(84): 792.

9-Bhattacharyya, P.N., Jha, D.K. (2012). Plant growth-promoting rhizobacteria (PGPR): emergence in agriculture. World J. Micro-biol. Biotechnol, 28, 1327–1350.

10-Central Bureau of Statistics. (2016). Potato production rate in Iraq. Republic of Iraq, Ministry of Planning.(In arabic)

11- Al - Fadli, Jawad Taha Mahmoud. (2006). Effect of NPK addition to soil and spray on potato growth, yield and components.

Master Thesis, Faculty of Agriculture, University of Baghdad. (In arabic)

12-Hassan, Ahmed Abdel Moneim. (2016). Fertilizing vegetable crops (Edition1). Scientific Publishing House for Publishing and Distribution. Faculty of Agriculture, Cairo. (In arabic)

13-Jahanian, A., Chaichi, M.R., Rezaei, K., Rezayazdi, K., Khavazi, K. (2012). The effect of plant growth promoting rhizobacteria (pgpr) on germination and primary growth of artichoke (Cynara scolymus). Int. J. Agric. Crop Sci, 4:923–929.

14- Al-Khafaji, Makki Alwan. (2014). Plant growth regulators. Faculty of Agriculture, University of Baghdad. (In arabic)

15-Kuepper,G. (2003). Foliar fertilization appropriate technology transfer for rural areas (ATTRA).National sustainable agriculture.t.service .ww.attra. ncat.org.

16-Kumar, D. and R. Ezekiel. (2006). Effect of physiological and biochemical attributes of potato cultivars Kufri Lauvkar and Atlantic on their chipping quality. Potato J. 33, :50-55.

17-Kumar, P., S.K. Panedy, S.V. Singh andD. Kumar. (2007). Irrigation requirement of chipping potato cultivars under west-central indian plains. Potato J, 34(3-4) 193-198.

18-Kumar, Rajesh., Avtar Singh., Vikash Hooda., R. K. Singh and Mainpal Singh. (2015). Effect of organic manures, biofeltilizer and mulching on Growth and yield of potato (solanum tuberosum L.). an internation Quarterly Jornal of life Seinces . (Supplement on Agronomy) ,10(1): 403-406.

19-Leegood,RC., Sharkey,TD and von Caemmerer,S. (2000). Photosynthesis: Physiology and Metabolism. Advances in Photosynthesis and Respiration. Springer, Dordrecht, 9:115-136

20-Martin, P. (2002). Micro – nutrient deficiency in Asia and the pacific Borax Europe Limited, UK, AT, 2002. IFA. Regional Conference for Asia and the Pacific, Singapore, 18-20 Nove. 2002.

21-Mekhemer, Jamal Abdel Fattah Ahmed. (2008). The importance of using bio-fertilizers in agriculture. Land, Water and Environment Research Institute. Shams Magazine, Issue (91) July - August The Arab Republic of Egypt. (In arabic)

22-Minhas, J.S., D. Kumar; T.A. Joseph., B.T. Raj., S.M.P. Khurana, S.K.Pandey, S.V. Sindh, B.P. Singh and P.S. Naik. Kufri Surya. (2006). A new heat-tolerant potato variety suitable for early planting in North-western plains, peninsular India and processing into French fries and chips. Potato J, 33(1-2): 35-43.

23-Al-Mohammedi, Shaker Musleh, and Fadel Musleh Al-Mohammadi. (2012). Statistics and design experiments. Dar Osama Publishing & Distribution. Ammaan, Jordan. (In arabic)

24-Mondal, S.S., Saha, M., Acharya, D., Patra, D. And Chatterjee, S. (2007). Integrated effect of nitrogen and potassium with or without sulphur and and farm yard manure on potato tuber yield, storage quality and soil fertility status. Potato Journal, 34 (1-2): 89-92.

25-Patel, C.K; P.T. Patel and S.M. Chaudhari. (2008). Effect of physiological age and seed size on seed production of potato in North Gujarat. Potato Journal, 35(1&2): 85-87.

26-Ram, Brijesh., B. N. Singh and Hitesh Kumar. (2017). Impact of Various Organic Treatments on Growth, Yield and Quality Parameters of Potato. Int. J. Pure App. Biosci, 5 (3): 643-647 .

27-Rykaczewska, K. (2015). Morphology and anatomy of the root system of new potato cultivars. Part I. Morphology of the root system. Biuletyn Instytutu Hodowli I Aklimatyzacji Roślin, 275: 99–109.

28-Sadik,S.K.,AL-Taweel,A.A.,Dhyeab,N.S. (2011). New Computer Program for Estimating Leaf Area of Several Vegetable Crops. American-Eurasian Journal of Sustainable Agriculture, 5(2):304-309.

29-Safak, K., Nilfer A. (2006). Some optimal cultural pa- rameters for gibberellic acid biosynthesis by *Pseudomonas* sp. Turk J Biol, 30: 81-85.

30-Sheng,Kuang. Wei. (2008). Effect of rice straw mulch and adding plastic membrane on agronomic performance and quality of potato with no- tillage. J. Guangxi Agricultural and Biological Science, 27(2):130- 133.

31-Singh Jai. (2017). Effect of Organic and Inorganic Sources of NPK and Bio-fertilizer

on Growth, Yield and Quality of Sweet Potato (Ipomoea batatas Lam.). Thesis MSc in Agriculture (Horticulture). College of Agriculture. Unvirsity of Jobner.

32-Sulaiman, Nasr Sheikh and Janan Osman .(2014). Study the effect of the genetic characteristics of the variety in the size and quality of tubers five varieties of potatoes newly introduced to Syria. Tishreen Folder for Research and Scientific Studies Series of Biological Sciences. 36 (3): 146-134. (In arabic)

33-Taha, Farouk Abdel Aziz. (2007). Effect of Potassium Fertilizer and Soil Covering in Three Potatoes (Solanum tuberosum L.) Cultivated in Basrah Governorate. Master Thesis. Faculty of Agriculture, University of Basra. Iraq. (In arabic)

34-Taiz, L. and E. Zeiger. (2006). Plant Physiology. 4th. Edition. Sinauer Associates, Inc. publisher Sunderland, Massachus- AHS. U.S.A.

35-White , PJ ., Broadley , MR ., Greenwood , DJ and Hammond , JP .(2005). Proceedings of The International Fertiliser Society 568 . Genetic modifications to improve phosphorus acquisition by roots . IFS : York, UK . ISBN 0853102058.

36-Yazdani, M., Bahmanyar, M.A., Pirdashti, H., Esmaili, M.A. (2009). Effect of phosphate solubilization microor- ganisms (PSM) and plant growth promoting rhizobacte- ria (PGPR) on yield and yield components of corn (Zea mays L.) Proceding of world academy science. J Engin technol 2070-3740.

37-Youssef, Reza Abdel-Zaher. (2011). Biological fertilizers (types, classification, marketing). Publications of King Saud University, Saudi Arabia, p:2011-335.(In arabic)

38-Zakaria,A. A. (2009). Growth Optimization of potassium solubilizing bacteria isolated fromiofertilizer. A thesis submitted in fulfillment of the requirements for the award of the degree of Bachelor of Chemical Engineering (Biotechnology), A thesis submitted in fulfillment of the requirements for the award of the degree of Bachelor of Chemical Engineering (Biotechnology).