



Effect of potassium and biological fertilization on yield quantitative characteristics of two potatoes cultivars (*Solanum tuberosum* L.)

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Abstract

This experiment was carried out during the spring growing season 2021 in the research field of the College of Agriculture and Forestry/Mosul University/Tourist Forest Area, to study the response of three factors in the characteristics of the quantitative yield of the two potato cultivars. The first factor included two cultivars of potatoes (Taurus and Universa), the second factor included bio-fertilizer (*Trichoderma* fungus) at two levels and for one time only (5 g.m², without addition), and the third factor included potassium fertilizer as potassium sulfate at four levels (0, 100, 200, (300 kg. ha⁻¹). The results were as follows: The treatment of the cultivar Universa gave the highest significant values in the number of total tubers, the average marketing weight of the tuber, the yield of one plant and the total yield of tubers, with a value of 15.63 tubers.plant⁻¹, 87.19 g.tuber⁻¹ and 965.08 g.Plant⁻¹ and 43.972 ton. ha⁻¹, respectively. The bio-fertilization treatment at a concentration of 5 g. m² gave the highest significant values in the total number of tubers, the yield of one plant and the total yield of tubers with a value of 15.29 tubers.plant⁻¹, 900.92 g. plant⁻¹, 40,819 ton. ha⁻¹, respectively, and potassium fertilization treatment (300 kg. ha⁻¹) gave the highest significant values in the average weight of the tuber and the average weight of the marketing tuber with a value of 65.30 g.plant⁻¹

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Introduction

Potato (*Solanum tuberosum* L.) is one of the plants of the Solanaceae family. It is an important tuber crop locally and globally. It is considered the daily food for more than 75-90% of the world because it contains food and energy (Van Gijessel, 2005). Each 100 gm of potato tubers contains 79.8 g of water, 76 calories, 2.1 g protein, 0.1 g fat, 17.1 g carbohydrates, 0.5 g fiber, 0.9 g ash and 7 mg calcium (Hassan, 2003). The production of the

potato crop is affected by several factors, including the suitability of the variety to the area, which in turn affects the yield, both quantitatively and qualitatively (Hassan et al, 2002). Bio-fertilizers are one of the topics that have received great attention in recent years, either by adding them to the soil or spraying them on the vegetative total of vegetable crops. (Ghamriny et al, 1999) and that *Trichoderma* fungus is one of the most biological control agents, as it works to combat pathogenic plant



fungal pests and works on colonizing the root perimeter of the plant and therefore it provides protection for the plant (Anand, Reddy, 2009). Many noted that potassium fertilization is of great importance for the potato crop and an important role in enhancing enzyme activity and protein synthesis, as potassium fertilization leads to an increase in vegetative growth (Paufetti, 2004) and potassium deficiency negatively affects the growth and yield of plants (Hassan, 1988), and many researchers emphasized that adding potassium fertilizers to the soil Or spraying the vegetative system with it reflects positively on the growth and yield of the plant, especially for crops that need this element in a high degree, such as the potato crop (Bahia, 2001).

The study aims to show the effect of potassium and biological fertilization on the quantitative yield characteristics of two potato cultivars.

Materials and methods

The experiment was carried out in the research field of the College of Agriculture and Forestry/Mosul University/Tourist Forest Area during the spring growing season 2021, to show the response of potato cultivars (Taurus and Universa) to potassium and bio-fertilization. The soil of the field was plowed using a triple plow, two orthogonal plows, smoothed, leveled and cut into three blocks. The number of experimental units in each blocks was 16 experimental units, and in the experiment contain 48 experimental units (16 * 3), urea fertilizer was added (46% N) at a rate of 400 kg. ha⁻¹ and super triple phosphate (48%) p₂o at a rate of 600 kg.ha⁻¹ (Al-Obaidi, 2005). The tubers of Taurus and Universa were planted at a depth of 12-15 cm, and at a distance of 30 cm between one tuber and another. The tubers were planted on 24/2/2021, and the number of tubers for each plant was 7 tubers and in the experimental unit 21 tubers. The experiment was designed according to the Randomized Complete Block Design (RCBD) in a system of split –split plots cultivars where placed in the main plots, bio-fertilizer in subplots and Potassium in sub sub plots and in three

replications. The experiment included the following factors:

First factor: (cultivars) Taurus and Universa.

Second factor: included the bio-fertilizer *Trichoderma* fungus at two levels and for one time only (ground addition) the first level is 5 g.m² and the second level without addition.

The third factor: Potassium fertilizer as potassium sulfate at four levels (ground addition) The first level is 100 kg. ha⁻¹ The second level is 200 kg. ha⁻¹ third level is 300 kg. ha⁻¹ The fourth level compared to without potassium sulfate.

Bio-fertilization and potassium fertilization were added in the first stage, a week after the completion of germination on 7/4/2021. As for the second stage, the plants were treated with potassium fertilizers with the beginning of the flowering phase on 20/4/2021, after 115 days of planting the tubers, the harvest was done on 9/9 6/2021 and study the characteristics of the following quantitative product.

- 1 -Total number of tubers (tuber. plant-1).
- 2-Average tuber weight (gm. tuber-1).
- 3-The average weight of the marketing tuber (gm. tuber-1).
- 4-The yield of one plant (gm.plant-1.)
- 5-The total yield of tubers (ton. hectares 1).

The data were statistically analyzed according to the SAS system, 2017, according to the design used by Duncan's polynomial test under the probability level of 0.05 (Al-Rawi and Khalaf Allah, 2000).

Results and discussion

The results of Table (1) show the significant superiority of the plants of the cultivar Universa over the plants of the cultivar Taurus in the characteristic of the total number of tubers (15.63 tubers). For the average effect of bio-fertilizer at 5 g.m² highest value (15.29 tuber.plant⁻¹) in the number of tubers which differed significantly compared to control treatment , and in the potassium fertilization treatments, the plants fertilized for the three levels were significantly superior to the control treatment, while the treatment fertilized with potassium fertilization (200 kg.ha⁻¹) did not



differ significantly with the other two fertilization treatments at levels (100 and 300). kg. ha^{-1} (where the difference between them did not reach the level of significance, and in the bilateral interaction between cultivars and bio-fertilizer, the treatment of the cultivar Universa and bio-fertilized (5 g. m^2) was significantly superior to the rest of the other treatments (16.25 tuber. plant^{-1}). As for the interaction between cultivars and potassium fertilizer, the treatments of the cultivar Universa at all levels were superior to the treatments of the variety Taurus, and in the interaction between the bio-fertilizer and potassium, the bio-fertilization

treatment (5 g. m^2) with the potassium fertilization at the level (100 kg ha^{-1}) gave the highest values of (16.00 tuber. plant^{-1}) differed significantly with the bio-fertilization treatment (5 g. m^2) and the comparison treatment for potassium fertilization (13.83 tuber. plant^{-1}), the biological fertilization without addition, and the levels of potassium fertilization at (100 and 300 kg. ha^{-1}). The treatments of the triple interaction varied, where the treatment of the cultivar Universa and fertilized with bio-fertilizer (5 g. m^2) and potassium fertilizer at the level (100 kg. ha^{-1}) was significantly superior (17.33 tuber).

Table (1) Effect of cultivar, bio-fertilizer and potassium and the interference between them on the total number of tubers (tuber. plant^{-1})

Cultivar	Bio-fertilizer levels g. m^2	Potassium levels kg. ha^{-1}				cultivarX Bio-fertilizer	Average effect of cultivar
		without addition	100	200	300		
Taurus	without addition	13.00 de	12.00 e	14.33 c-e	13.00 de	13.08 c	13.71 b
	Addition 5 g. m^2	13.33 de	14.67 b-d	14.33 c-e	15.00 a-d	14.33 b	
Universa	without addition	15.33 a-d	14.33 c-e	15.33 a-d	15.00 a-d	15.00 b	15.63 a
	Addition 5 g. m^2	14.33 c-e	17.33 a	17.00 ab	16.33 a-c	16.25 a	
cultivar X potassium	Taurus	13.17 d	13.33 cd	14.33 b-d	14.00 cd	Average effect of bio-fertilizer	
	Universa	14.83 a-c	15.83 ab	16.17 a	15.67 ab		
bio-fertilizer X potassium	without addition	14.17 b-d	13.17 d	14.83 a-c	14.00 cd	14.04 b	
	Addition 5 g. m^2	13.83 cd	16.00 a	15.67 ab	15.67 ab	15.29 a	
Average effect of potassium		14.00 b	14.58 ab	15.25 a	14.83 ab		

* The averages that share the same alphabetic letter for each factor and each interference do not differ significantly among themselves

according to Duncan's polynomial test at the probability level ($P \leq 0.05$).

The results of Table (2) indicate that there are no significant differences between the two cultivars under study and the level of biological fertilization in the tuber weight rate, while the potassium fertilization treatment at the level (300 kg. ha⁻¹) showed a significant superiority over the rest of the fertilization treatments (65.30 g.tuber⁻¹) In the bilateral interaction between cultivars and biological fertilization, the treatment of the cultivar Universa with bio-fertilized (5 g.m²) (63.26 g.tuber⁻¹) was significantly superior to the treatment of the variety Taurus for the same fertilization treatment (56.4 g.tuber⁻¹). In the interaction between cultivars and potassium fertilizer, the treatment of potassium fertilization at the level (300 kg.ha⁻¹) of the cultivar Universa showed significant superiority over all treatments of this interaction (65.57 g.tuber⁻¹) except for the treatment of the same cultivar at the level (200

kg.ha⁻¹). The treatment of cultivar Taurus at the level (300 kg.ha⁻¹), which did not differ significantly with it in the average weight of the tuber. In the interaction between the levels of bio-fertilization and potassium, the treatments of biological (without addition) and potassium at the level (300 kg.ha⁻¹) showed a significant superiority (65.62 g. tuber⁻¹) On all treatments of this overlap except for the treatment of potassium and bio-fertilizer (5 g.m²) (64.98 gm. tuber⁻¹). As for the triple interaction of the three study factors, the biological fertilization treatment (without addition) and at the potassium fertilization level (300 kg.ha⁻¹) for Taurus cultivar showed a significant superiority over all treatments of this interaction (71.73 g.tuber⁻¹) at the level of potassium fertilization (300 kg.ha⁻¹) (71.63 g. tuber⁻¹) in the average tuber weight.

Table (2) Effect of cultivar, bio-fertilizer and potassium and the interference between them on total tuber weight (.g. tuber⁻¹)

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Cultivar	Bio-fertilizer levels g. m ²	Potassium levels kg. ha ⁻¹				cultivarX Bio-fertilizer	Average effect of cultivar
		without addition	100	200	300		
Taurus	without addition	52.40 de	53.43 de	56.38 c-e	71.73 a	58.49 ab	57.46 a
	Addition 5 g. m ²	59.64 b-d	51.46 e	56.27 c-e	58.33 b-e	56.43 b	
Universa	without addition	53.54 de	58.70 b-d	61.32 bc	59.50 b-d	58.27 ab	60.77 a
	Addition 5 g. m ²	61.02 bc	56.48 c-e	63.91 b	71.63 a	63.26 a	
cultivar X potassium	Taurus	56.02 bc	52.45 c	56.33 bc	65.03 a	متوسط تأثير التسميد الحيوي	
	Universa	57.28 b	57.59 b	62.62 a	65.57 a		
bio-fertilizer X potassium	without addition	52.97 c	56.07 bc	58.85 b	65.62 a	58.38 a	
	Addition 5 g. m ²	60.33 b	53.97 c	60.09 b	64.98 a	59.85 a	
Average effect of potassium		56.65 bc	55.02 c	59.47 b	65.30 a		



* The averages that share the same alphabetic letter for each factor and each interference do not differ significantly among themselves according to Duncan's polynomial test at the probability level ($P \leq 0.05$).

From the results of Table (3) that both cultivars differed significantly in the average marketing weight of tuber, cultivar Universa significantly outperformed the variety Taurus and gave a marketing weight of the tuber of (87.19 g.tuber⁻¹). The treatment of potassium fertilization at the high level (300 kg. ha⁻¹) was superior to all the fertilization treatments in this trait with a value of (82.04 g. tuber⁻¹). In the interaction between cultivars and biological fertilization, the highest rate of marketable tuber weight was in the cultivar Universa, which was significantly superior to the other cultivar and at both levels (with and without addition). And potassium fertilization had the highest rate of marketable tuber weight in the cultivar Universa at the level of (200 kg.ha⁻¹), which was

significantly superior to most of the treatments of this interaction (91.43 g.tuber⁻¹). In the interaction between the levels of biological and potassium fertilization, the highest rate of marketing tuber weight was between the biological fertilization without addition with the high level of potassium fertilization (300 kg.ha⁻¹) with a value of (83.41 g.tuber⁻¹), which differed significantly with some treatments of this interaction. And the highest rate of marketing tuber weight through the results of the triple interaction in the cultivar Universa, bio-fertilized and level of potassium fertilization (200 kg.ha⁻¹) (92.50 g.tuber⁻¹), and thus this treatment significantly outperformed most of the treatments of this interaction.

Table (3) Effect of cultivar, bio-fertilizer and potassium and the interference between them on marketable tuber weight (g. tuber⁻¹)

Cultivar	Bio-fertilizer levels g. m ²	Potassium levels kg. ha ⁻¹				cultivarX Bio-fertilizer	Average effect of cultivar
		without addition	100	200	300		
Taurus	without addition	70.85 de	62.96 ef	66.31 ef	79.23 b-d	69.84 b	68.48 b
	Addition 5 g. m ²	60.06 f	66.08 ef	66.02 ef	76.32 cd	67.12 b	
Universa	without addition	78.55 b-d	90.91 a	90.37 a	87.59 ab	86.86 a	87.19 a
	Addition 5 g. m ²	89.35 a	83.22 a-c	92.50 a	85.03 a-c	87.53 a	
cultivar X potassium	Taurus	65.46 d	64.52 d	66.17 d	77.78 c	متوسط تأثير التسميد الحيوي	
	Universa	83.95 bc	87.07 ab	91.43 a	86.31 ab		
bio-fertilizer X potassium	without addition	74.70 b	76.94 ab	78.34 ab	83.41 a	78.35 a	
	Addition 5 g. m ²	74.71 b	74.65 b	79.26 ab	80.68 ab	77.32 a	
Average effect of potassium		74.70 b	75.80 b	78.80 ab	82.04 a		

* The averages that share the same alphabetic letter for each factor and each interference do



not differ significantly among themselves according to Duncan's polynomial test at the probability level ($P \leq 0.05$).

The results of Table (4) indicate that the Universa cultivar was significantly superior to the Taurus cultivar with a value of (965.08 g.plant⁻¹) While the two treatments of potassium fertilization (200 and 300 kg.ha⁻¹) were significantly superior to the two treatments without addition and the level (100 kg.ha⁻¹) in this trait. In the bilateral interaction between the cultivars and the levels of bio-fertilization, the cultivar Universa and the biofertilizer were given (5 gm.m²). The highest yield of one plant was significantly superior to

the rest of the treatments, with a value of (1017.12 g.plant⁻¹) significantly over all treatments of this interaction, the cultivar Taurus gave the lowest yield of the plant at the level of fertilization (100 kg.ha⁻¹), which amounted to (730.13 g.plant⁻¹) Potassium (300 kg.ha⁻¹) was significantly superior to some treatments, with a value of (948.64 g.plant⁻¹). The highest yield of one plant in the triple interaction was significantly distinguished for the cultivar Universa and the bio-fertilizer at the level of potassium fertilization (200 kg. ha⁻¹) on all treatments of this interaction with a value of (1096.21 g.plant⁻¹)

Table (4) Effect of cultivar, bio-fertilizer and potassium and the interference between them on plant yield (g. plant⁻¹)

Cultivar	Bio-fertilizer levels g. m ²	Potassium levels kg. ha ⁻¹				cultivarX Bio-fertilizer	Average effect of cultivar
		without addition	100	200	300		
Taurus	without addition	748.90 fg	702.21 g	827.09 ef	921.99 cd	800.05 c	792.39 b
	Addition 5 g. m ²	777.21 e-g	758.04 e-g	780.52 e-g	823.14 ef	784.73 c	
Universa	without addition	848.49 de	853.35 de	974.99 bc	975.28 bc	913.03 b	965.08 a
	Addition 5 g. m ²	1064.21 ab	977.85 bc	1096.21 a	930.21 cd	1017.12 a	
cultivar X potassium	Taurus	763.05 de	730.13 e	803.81 d	872.57 c	متوسط التسميد الحيوي تأثير	
	Universa	956.35 b	915.60 bc	1035.60 a	952.75 b		
bio-fertilizer X potassium	without addition	798.70 d	777.78 d	901.04 a-c	948.64 a	856.54 b	
	Addition 5 g. m ²	920.71 a-c	867.95 c	938.37 ab	876.68 bc	900.92 a	
Average effect of potassium		859.70 b	822.86 b	919.70 a	912.66 a		

* The averages that share the same alphabetic letter for each factor and each interference do not differ significantly among themselves according to Duncan's polynomial test at the probability level ($P \leq 0.05$).

Table (5) indicates that the cultivar Universa gave the total yield of tubers significantly superior to the cultivar Taurus (43.972 ton.ha⁻¹). And for the average effect of the biofertilizer,

the biologically fertilized plants showed a significant superiority over the non-fertilized plants (40.819 ton. ha⁻¹), and the potassium fertilization treatment at the level (200 and 300



kg. ha⁻¹) gave a significant superiority over the control and potassium fertilization treatments at the level (100 kg.ha⁻¹). The interaction between the cultivars and the biological fertilization showed that the highest total yield of tubers appeared in the cultivar Universa, which was significantly superior to all treatments of this interaction (46.341 ton.ha⁻¹). As for the interaction between the cultivars and the potash fertilization, it gave the cultivar Universa and Potassium at levels (200 and 300 kg.ha⁻¹) significant superiority and gave the highest total yield on all treatments of this interaction (46.801 ton.ha⁻¹) and (45.434 ton.ha⁻¹), and in the bilateral interaction between biological and potassium fertilization, the highest total yield of tubers appeared in the

biologically fertilized plants at the level (5 g.m²) and at the level (200 kg.ha⁻¹) potassium (42.549 ton.ha⁻¹) and the differences did not reach the significant level with the rest of the treatments except for the two biological fertilization without addition and the two levels of potassium fertilization for the plants comparison and level (100 kg.ha⁻¹). The highest total yield of tubers in the triple interaction between the three study factors appeared in the cultivar Universa, with bio-fertilized (5 g.m²) and at the level of potassium fertilization (200 kg.ha⁻¹) (48.720 ton.ha⁻¹), which was significantly superior to the treatments of the cultivar Taurus fertilized and non-biologically fertilized and for different levels of potassium fertilization.

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Table (5) Effect of cultivar, bio-fertilizer and potassium and the interference between them on total yield (ton. ha⁻¹)

Cultivar	Bio-fertilizer levels g. m ²	Potassium levels kg. ha ⁻¹				cultivarX Bio-fertilizer	Average effect of cultivar
		without addition	100	200	300		
Taurus	without addition	32.805 cd	31.209 d	36.759 cd	38.310 bc	34.771 c	35.034 b
	Addition 5 g. m ²	34.542 cd	33.691 cd	36.377 cd	36.583 cd	35.298 c	
Universa	without addition	37.650 c	37.926 c	44.881 a	45.961 a	41.605 b	43.972 a
	Addition 5 g. m ²	48.277 a	43.460 ab	48.720 a	44.907 a	46.341 a	
cultivar X potassium	Taurus	33.674 de	32.450 e	36.568 d	37.447 cd	متوسط تأثير التسميد الحيوي	
	Universa	42.964 ab	40.693 bc	46.801 a	45.434 a		
bio-fertilizer X potassium	without addition	35.228 bc	34.568 c	40.820 a	42.136 a	38.187 b	
	Addition 5 g. m ²	41.410 a	38.575 ab	42.549 a	40.745 a	40.819 a	
Average effect of potassium		38.319 b	36.571 b	41.684 a	41.440 a		

* The averages that share the same alphabetic letter for each factor and each interference do not differ significantly among themselves according to Duncan's polynomial test at the probability level (P< 0.05).

Conclusions

We conclude from the study that the Universa cultivar was significantly superior in the number of total tubers, average market weight of the tubers, yield of plant and the total yield of tubers, and that the use of bio-fertilization cause a significant increase in the average weight of the tuber , average weight of the marketing tuber and total yield. Potassium fertilizer at 300 kg.ha⁻¹ cause a significant increase in the average weight of the tuber , average weight of the marketing tuber.

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