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RESPONSE OF ARTIFICIAL POTATO TO PHOSPHOROUS AND POTASSIUM LEVELS ON AVAILABLE OF SOME NUTRIENTS, AMOUNT ABSORBED AND THEIR PRODUCTIVITY

Thamer Hammad Mohammed Al-Dulaimi* and Waqas Al-Joboory

Department of Soil Sciences and Water Resources, College of Agriculture, University of Anbar, Iraq.
*e-mail : tha19g2001@uoanbar.edu.iq

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ABSTRACT : A field experiment was carried out during autumn season of 2020 at one of the fields of the Al-Hamdhiya Research Station, College of Agriculture, Anbar University, to find out response of artificial potato to phosphorous and potassium levels on available of some nutrients, the amount absorbed and their productivity. The experiment was carried out according to randomized complete block design (RCBD) at three replicates. The experiment included seventeen treatments: T1: 200, 0, 0 (control treatment), T2: 200, 0, 100, T3: 200, 0, 200, T4: 200, 0, 300, T5: 200, 144, 0, T6: 200, 192, 0, T7: 200, 240, 0, T8: 200, 144, 100, T9: 200, 192, 100, T10: 200, 240, 100, T11: 200, 144, 200, T12: 200, 192, 200, T13: 200, 240, 200,T14: 200, 144, 300, T15: 200, 192, 300 and T16: 200, 240, 300 Kg NPK.ha^{-1} respectively, as well as T17: application of organic matter at level of 20 ton.ha^{-1}. The results indicated that theT15 treatment(200, 192, 300 Kg NPK.ha^{-1}) was significantly superior and gave the highest tuber weight (70.11 g),plant tubers yield (677.5 g.plant^{-1}), tubers yield (57.59 Meq.ha^{-1}) and the highest available of N and K in the soil (48.03 and 240 mg.Kg^{-1} soil) respectively, whereas the T16 treatment (200, 240, 300 Kg NPK.ha^{-1}) gave the highest available of P in the soil (18.91 mg.Kg^{-1} soil) and the highest plant content of N, P and K (0.66, 0.09 and 0.78Kg.plant^{-1}) respectively with non-significant difference with T15treatment.

Key words : *Solanum tuberosum* L., nutrients, mineral fertilizers, tuber yield.

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INTRODUCTION

Potato (*Solanum tuberosum* L.) is the fourth most important crop in the world after wheat, maize and rice with a production of 314.1 million tons on 18.1 million hectares (Arslanoglu *et al*, 2011). Also, potato is an important food source that contains high levels of carbohydrates, proteins, vitamins and minerals. Nutrients play an important role in plant growth and the quantity and quality of yield, as they participate or help in vital processes and perform many important functions in the plant, and their deficiency leads to physiological imbalance as a result of nutritional imbalance. The main dependence to achieve the required productivity is through the use of manufactured mineral fertilizers, despite the availability of organic agriculture and the possibility of recycling plant and animal residues, but the excessive use of mineral fertilizers, mismanagement and not adding them rationally leads to pollution of the agricultural environment, and continuing to use fertilizers incorrectly leads to an imbalance and new undesirable traits may appear in plants. Nitrogen and phosphorous are among the most essential nutrients related to pollution (White *et al*, 2007). The amount of potassium fertilizer that is required to be added exceeds the required amount of nitrogen and phosphate fertilizers for the potato crop, as this crop has a high need of potassium compared with other elements (Tisdale *et al*, 1997). The potato crop requires high levels of nutrients, as this crop produces more dry matter than grain crops in a short period of time, and this results in the consumption of large amounts of nutrients per unit area per unit time, which most soils cannot replace, thus the adding fertilizers becomes necessary in this case with attention to the optimal nutritional balance of nitrogen, phosphorous and potassium to obtain the highest production (Singh and Trehan, 1998). Different levels of phosphorus and potassium and a constant level of nitrogen were used to find out the effect of the interaction between phosphorus and potassium on the growth and yield characteristics of potatoes, it was found that the interaction of different levels had a significant effect on growth and yield, and the highest tuber yield was at high levels of interaction (Setu, 2012). Setu (2012) found that the levels of phosphorous (46, 92, 138, 184 and 230 Kg P_2O_5.ha^{-1}) and potassium (100, 200, 300 Kg K_2O.ha^{-1}) didn't significantly affect the vegetative growth and plant yield of tubers, but It had a significant effect on the total yield of tubers. Therefore, this research aims to find out the response of artificial potato to phosphorous and potassium levels on available of some nutrients, the amount absorbed and their productivity.

MATERIALS AND METHODS

A field experiment was carried out during autumn season of 2020 at one of the fields of the Al-Hamdhiya research Station, College of Agriculture, Anbar University, to find out response of artificial potato to phosphorous and potassium levels on available of some nutrients, the amount absorbed and their productivity. Soil samples from 0-30 cm depth were taken from different locations of the field, mixed well to homogenize, air dried and smoothed and passed through a sieve with holes 2 mm diameter, and a composite sample was taken from it for the purpose of conducting some physical and chemical analyzes. Drip irrigation was used in the experiment. Soil management operations were carried out, including plowing, smoothing and leveling. The field was divided into 48 experimental units (terraces). The area of each terrace was 2 m^2 (0.5 m x 4 m). The experiment was carried out according to randomized complete block design (RCBD) at three replicates. The experiment included seventeen treatments: T1: 200, 0, 0 (control treatment), T2: 200, 0, 100, T3: 200, 0, 200, T4: 200, 0, 300, T5: 200, 144, 0, T6: 200, 192, 0, T7: 200, 240, 0, T8: 200, 144, 100, T9: 200, 192, 100, T10: 200, 240, 100, T11: 200, 144, 200, T12: 200, 192, 200, T13: 200, 240, 200, T14: 200, 144, 300, T15: 200, 192, 300 and T16: 200, 240, 300 Kg NPK ha^{-1} respectively, as well as T17: application of organic matter at level of 20 ton ha^{-1}. Nitrogen fertilizer was added as a urea (46% N) at rate 200 Kg N.ha^{-1} at three doses, the first after 14 days of emergence, the second after 30 days of the first and the third after 30 days of the second dose, while the phosphate and potassium fertilizers were added according to the treatments. Phosphate fertilizer was added as a triple super phosphate fertilizer (45% P_2O_5) at one dose before planting, whereas the potassium fertilizer was added as a potassium sulfate fertilizer (41% K) at three doses, the first before planting, the second after 14 days of emergence and the third after 30 days of the second dose. Lady Rosetta artificial potato seed was planted on 9 October 2020. Crop management operations were carried out whenever needed. The plants were harvested at the stage of full maturity.

Studied traits

1. Tuber weight (g) was calculated by drying tubers in the oven at 65-70 C until constant weight.

2. Total tubers yield (t ha^{-1}) was calculated by multiplying the marketable tubers of individual plants × planting density.

3. Available amounts of N, P and K in the soil (mg.Kg^{-1} soil): Soil samples were taken from each experimental unit to estimate the available amounts of N, P and K in the soil.

4. Plant content of N, P and K (Kg.plant^{-1}): The plants were dried, ground and 0.2 g were taken from each experimental unit and the samples were digested wet with an acidic mixture (HNO_3 + $HClO_4$) at a 2:1 to determine the percentage of phosphorous in the plant by using a spectrophotometer, while the percentage of nitrogen in the plant was estimated by using the Microkeldal apparatus, whereas the percentage of potassium in the plant was estimated by using a Flame Photometer (Jones and Case, 1990). The absorbed amounts of the NPK were calculated by multiplying the dry weight of the plant x the percentage of each element.

The data were statistically analyzed by using Gnestatprogram and least significant difference (LSD) test at 0.05 probability level was used to compare the treatment means.

Table 1 : Some chemical and physical properties of soil.

Property	Value	Unit	Available nutrients	Value	Unit
ECe	2.42	dS m^{-1}	N	56.5	mg kg^{-1} soil
pH	7.71	—	K	185.0	
O.M	7.20	g kg^{-1} soil	P	14.4	
Particle size analysis (g kg^{-1} soil)			Texture		
Clay	Silt	Sand	Loamy soil		
136	440	424			

RESULTS AND DISCUSSION

Tuber weight (g)

The results in Table 2 reveal that there are significant differences among fertilizer treatments in the tuber weight; the T15 treatment had a highest mean (70.11g) without significant difference with T16 treatment (67.63 g) at an increase of 28.71 and 24.16% respectively compared with the T1 treatment which had a lowest mean (54.47g).

Table 2 : Effect of fertilizer treatment on Plant tubers yield.

Treatment	Tuber weight (g)	Plant tubers yield (g.plant^{-1})	Tuber yield (Meq ha^{-1})	Treatment	Tuber weight (g)	Plant tubers yield (g.plant^{-1})	Tuber yield (Meq ha^{-1})
T1	54.47	467.4	39.73	**T9**	58.67	590.5	50.19
T2	55.26	489.1	41.58	**T10**	60.04	599.4	50.95
T3	55.31	496.8	42.22	**T11**	60.47	606.2	51.53
T4	55.43	544.1	46.25	**T12**	61.11	628.0	53.38
T5	57.23	564.9	48.02	**T13**	62.11	632.7	53.78
T6	60.98	569.6	48.42	**T14**	59.63	634.8	53.96
T7	58.22	574.0	48.79	**T15**	70.11	677.5	57.59
T8	58.44	576.9	49.04	**T16**	67.63	646.2	55.04
LSD 0.05	7.858	26.88	2.285	**LSD 0.05**	7.858	26.88	2.285

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

The results in Table 2 shows that the T15 treatment significantly superior and gave the highest meanofplant tubers yield (677.5g.plant^{-1}) followed by T17, T16, T14, T13 and T12 treatments, which gave 647.6, 646.2, 634.8, 632.7 and 628.0 g.plant^{-1}at an increase of44.95, 38.55, 38.25, 35.82, 35.37 and 34.36% respectively compared with the T1 treatment which gavethe lowest mean (467.4g.plant^{-1}).

Tuber yield (Meq ha^{-1})

The results in Table 2 indicate that the T15 treatment significantly superior and achieved the highest mean of tuber yield (57.59Meq ha^{-1}) followed by T16, T14, T13 and T12 treatments, which achieved 55.04, 53.96, 53.78 and 53.38 Meq ha^{-1} at an increase of44.95, 38.54, 35.82, 35.36 and 34.36% respectively compared with the T1 treatment which achieved the lowest mean (39.73Meq ha^{-1}). The reason of increase the total tuber yield when adding mineral fertilizer may be attributed to the increase in the availability of nutrients in the soil solution and uptake by plants, which increased with the increase of the application level to the soil, which led to an increase the absorbed amounts by the roots and an increase the concentrations of these nutrients in the leaves and increased their efficiency in the photosynthesis process through their role in increasing the absorption and representation of CO_2 and then transferring the products of this process to the tubers which was positively reflected on increasing the tuber yield. These results are in agreement with Bieluga and Witeka (1996).

Available Nitrogen (mg N.Kg^{-1} soil)

The results in Table 3 show that there are significant differences among fertilizer treatments in the available nitrogen in the soil at full maturity stage; the T15 treatment had a highest mean (48.03 mg N.Kg^{-1} soil) followed by T16 and T7 treatments (46.51 and 46.10 mg N.Kg^{-1} soil) at an increase of 64.43, 59.23 and 57.82% respectively compared with the T1 treatment, which had a lowest mean (29.21 mg N.Kg^{-1} soil). It appears from Table 3 that the increase of phosphorous or potassium or both fertilizers increased the available nitrogen in the soil. The reason of increase may be due to potassium replacing the ion installed on the surfaces of the soil colloids and releasing the ion thus increasing the available nitrogen in the soil, or the reason of increase could be due to the effect of phosphoric acid present in triple super phosphate fertilizer (TSP) in increasing the availability of most of the main elements originally present in the soil (Al-Salmani *et al*, 1998).

Available phosphorous (mg P.Kg^{-1} soil)

The results in Table 3 reveal that the T16 treatment significantly superior and gave the highest mean of available phosphorous in the soil at full maturity stage (18.91mg P.Kg^{-1} soil) without significant difference with T15 treatment (18.27 mg P.Kg^{-1} soil) followed by T14, T13, T12, T11, T10, T9 and T8, which gave 17.40, 16.55, 15.95, 14.26, 14.03, 14.02 and 13.69 mg P.Kg^{-1} soil at an increase of 161.55, 152.70, 140.66, 128.91, 120.61, 97.23, 94.05, 93.91 and 89.35% respectivelycompared with the T1 treatment which gavethe lowest mean (7.23 mg P.Kg^{-1} soil). The reason of increase the available phosphorus in the soil could be attributed to the increase the phosphorus added by the phosphate fertilizer treatments, as well as the formation of phosphoric acid resulting from application ofTSP fertilizer which leads to the dissolution of calcium phosphate forms originally present in the soil thus increases the available phosphorus (Tisdale *et al*, 1985).

Available potassium (mg K.Kg^{-1} soil)

The results in Table 3 indicate that the T15 treatment significantly superior and achieved the highest of available potassium in the soil at full maturity stage (240.00 mg K.Kg^{-1} soil) followed by T16 treatment (232.67 mg K.Kg^{-1} soil) at an increase of 39.53 and 35.27% respectively

Table 3 : Effect of fertilizer treatment on available N, P and K (mg kg^{-1} soil).

Treatment	N	P	K	Treatment	N	P	K
T1	29.21	7.23	172.00	**T9**	39.24	14.02	213.33
T2	30.08	7.80	182.33	**T10**	40.46	14.03	214.00
T3	31.09	7.86	186.67	**T11**	41.18	14.26	215.33
T4	32.54	7.88	189.67	**T12**	42.21	15.95	219.33
T5	33.76	11.32	202.00	**T13**	44.02	16.55	226.33
T6	44.85	11.37	203.00	**T14**	45.55	17.40	231.67
T7	46.10	11.77	208.33	**T15**	48.03	18.27	240.00
T8	38.22	13.69	211.00	**T16**	46.51	18.91	232.67
LSD 0.05	0.41	1.48	8.11	**LSD 0.05**	0.41	1.48	8.11

Table 4 : Effect of fertilizer treatment on plant content of N, P and K (mg kg^{-1} plant).

Treatment	N	P	K	Treatment	N	P	K
T1	0.39	0.05	0.46	**T9**	0.48	0.06	0.55
T2	0.45	0.05	0.51	**T10**	0.53	0.07	0.61
T3	0.44	0.05	0.49	**T11**	0.52	0.07	0.61
T4	0.46	0.06	0.53	**T12**	0.60	0.08	0.70
T5	0.47	0.06	0.56	**T13**	0.58	0.07	0.68
T6	0.48	0.06	0.56	**T14**	0.58	0.08	0.67
T7	0.46	0.06	0.53	**T15**	0.65	0.09	0.74
T8	0.50	0.07	0.59	**T16**	0.66	0.09	0.78
LSD 0.05	0.073	0.011	0.097	**LSD 0.05**	0.073	0.011	0.097

compared with the T1 treatment which achieved the lowest mean (172.00 mg K.Kg^{-1} soil). The reason of increase may be attributed to increase in the concentration of available and residual potassium in the soil when the levels of potassium application were increased which resulted in the increase the amount of available potassium. These results are in agreement with Al-Sheikhly (2006).

Plant content of nitrogen (mg N Kg.plant^{-1})

The results in Table 4 show that there are significant differences among fertilizer treatments in the vegetative growth content of nitrogen; the T16 treatment had a highest mean (0.66Kg.plant^{-1}) without significant difference with T15 treatment (0.65 Kg.plant^{-1}) followed by T12 treatment (0.60 Kg.plant^{-1}) at an increase of69.23, 66.67 and 53.85% respectively compared with the T1 treatment, which had a lowest mean (0.39Kg.plant^{-1}).

Plant content of phosphorous (mg P Kg.plant^{-1})

The results in Table 4 reveal that the T16 treatment significantly superior and gave the highest mean of plant content of phosphorous (0.09Kg.plant^{-1})without significant difference with T15 treatment (0.09 Kg.plant^{-1}) followed by T12, T14, T13, T10, T11 and T8 which gave 0.08, 0.08, 0.07, 0.07, 0.07 and 0.07 Kg.plant^{-1} at an increase of 80, 80, 60, 60, 40, 40, 40 and 40% respectively compared with the T1 treatment which gavethe lowest mean (0.05 Kg.plant^{-1}).

Plant content of potassium (mg K Kg.plant^{-1})

The results in Table 4 indicate that the T16 treatment significantly superior and achieved the highest mean of plant content of potassium (0.78Kg.plant^{-1}) without significant difference with T15 treatment (0.74 Kg.plant^{-1}) followed by T12 which achieved 0.70 Kg.plant^{-1} at an increase of 69.57, 60.87 and 52.17% respectively compared with the T1 treatment which gave the lowest mean (0.46 Kg.plant^{-1}). The an increasing the absorbed amount of nutrients may have come as a result the application of mineral fertilizers, which increased the availability of these nutrients in the soil and the continuity of their release during the harvested stage (Table 3), which was positively reflected on increasing the absorbed amount of these elements in the vegetative part of potato. These results are in agreement with Blackshow (2002).

CONCLUSION

We conclude that the adding 200, 192, 300 Kg NPK.ha^{-1} led to an increase in the available of NPK in the soil, plant content of NPK and tubers yield of potato with non-significant difference with the adding 200, 240, 300 Kg NPK.ha^{-1} in the plant content of NPK and the available of phosphorus in the soil, which indicates the possibility of reducing the amount of phosphorus added to the soil.

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