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ROLE OF BIO- AND NANOFERTILIZERS IN MANAGING BIOCHEMICAL COMPOSITION OF POTATO (*SOLANUM TUBEROSUM* L.)

O.H. MAHMOOD*, J.J.J. ALNUAIMI, and A.H. AL-ZUBAIDI

Al-Musayyib Technical College, Al-Furat Al-Awsat Technical University, Babylon, Iraq
*Corresponding author's email: sabraoassociateeditors@gmail.com, ola.h@uokerbala.edu.iq
Email addresses of co-authors: alnuaimid92@atu.edu.iq, alihussan75@yahoo.com

SUMMARY

The field potato (*Solanum tuberosum* L.) experiment, carried out at the Musayyib project area, Babil Governorate, Iraq, followed a randomized complete block design with factorial arrangement and three replications. The presented study sought to determine the effects of four biofertilization levels (without adding + full recommended fertilizer, addition of 10 g mixture of four types of bacterial fertilizer + half of the recommended fertilizer, addition of 10 g of fungal biofertilizer (mycorrhiza) + half of the recommended fertilizer, and addition of 10 g mixture of bacterial and fungal biofertilizers + half of the recommended fertilizer) symbolized as B0, B1, B2, and B3, respectively. Meanwhile, the study determined nanofertilizer two levels' effect (0 + full recommended fertilizer and 2 g L^{-1} + half of the recommended fertilizer) denoted by symbols N0 and N1, respectively, on the growth and tuber yield of three potato cultivars (Rashida, Sifra, and Arizona), carried out in the growing season of 2022–2023. The results revealed the cultivar Arizona was superior over the rest of the cultivars in the tuber's percentage of nitrogen, phosphorus, potassium, protein, and starch. Treatment B3 of biofertilization and nanofertilizer (N1) also showed considerable superiority in the tuber's percentage of nitrogen, phosphorus, potassium, protein, and starch. Moreover, the triple interaction between the study factors had a positive effect on most of the studied traits.

Keywords: Potato (*S. tuberosum* L.), cultivars, bacterial biofertilization, nanofertilization, macro elements

Key findings: Potato (*S. tuberosum* L.) cultivar Arizona performed better and gave the highest tuber's percentage of nitrogen, phosphorus, potassium, protein, and starch. Biofertilization (bacterial and fungal fertilizers) and nanofertilizers (2 g L^{-1}) also revealed the noticeable advantage for biochemical traits in potato tubers.

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INTRODUCTION

Potato (*Solanum tuberosum* L.) belongs to the family Solanaceae, which includes 90 genera and about 200 species (Hassan, 2003). It has become one of the most important strategic vegetable crops in various countries, ranking fourth worldwide for production and economic importance after wheat, corn, and rice. In tuber crops, potato is also a leading vegetable crop (Hassan, 1999). The area cultivated with potatoes in Iraq amounted to 12,645 ha^{-1}, with a productivity of 270,591 tons and a tuber yield of 1,337.45 kg ha^{-1} (CSO, 2022).

The use of biofertilizers (microorganisms) is currently one of the vital technologies introduced in the agricultural field to increase production and improve quality. Beneficial microorganisms found in biofertilizers maintain the ecosystem, enrich soil properties and plant growth, and enhance crop productivity (Sahoo *et al.,* 2014). Biofertilization also contributes to soil properties' amendment, lowers the pH, and by secreting organic acids dissolves the elements and increases the readiness of available elements for absorption by crop plants (Youssef, 2011).

With population increase, climate change, and depletion of natural resources, traditional agriculture is almost unable to fulfill the people's need for food. Therefore, it is necessary to resort to agriculture technology. Nanoscience occupies the crucial position because it has many applications in the field of agriculture at the stages of production, processing, storage, and packaging to transportation of agricultural products (Ali *et al.,* 2014).

Given the importance of the potato crop globally and its low productivity and population increase in Iraq, it is necessary to use the best means and techniques to raise production and improve its quality. Among these means, the nanofertilizers are a complement to traditional fertilizer to accelerate and facilitate the process of entering nutrients into the plants, and then, stimulate plant growth and improve quantitative production. One should also note here the current agricultural system as characterized by low productivity over time in many countries. Therefore, the recommendation to use modern methods with chemical fertilizers is valid for the purpose of increasing yields and improving their quality. The presented study aimed to investigate the effects of biofertilizers (bacterial and fungal) and nanofertilizers on tuber's biochemical traits of three potato cultivars.

MATERIALS AND METHODS

The field experiment commenced during the growing season of 2022–2023 at the Musayyib project area, Babil Governorate, Iraq. The study investigated the role of bio- and nano-fertilizers on the biochemical traits of three potato cultivars. The experiment followed a randomized complete block design (RCBD) in a factorial arrangement with three replications, with the treatments randomly distributed within each replication. The first factor was biofertilization with four levels (without addition + full fertilizer recommendation, addition of 10 g mixture of four types of bacterial fertilizer + half of the recommended fertilizer, addition of 10 g of fungal biofertilizer (mycorrhiza) + half of the recommended fertilizers, and addition of 10 g mixture of bacterial and fungal biofertilizers + half of the recommended fertilizer) symbolized as B0, B1, B2, and B3, respectively. The second factor was nanofertilizer with two concentrations (0 + full recommended dose of fertilizer and 2 g L^{-1} + half of the recommended fertilizer), symbolized as N0 and N1, respectively. The third factor was three potato cultivars (Rashida, Sifra, and Arizona) symbolized as V1, V2, and V3, respectively.

The well-prepared land for cultivation sustained division into three sectors, and the cultivation made on furrows with a length of two meters and a width of one meter. Three furrows for each experimental unit had an area of 6 m^2 (2 m^2 × 3 m^2). Eight tubers, planted on one side of the furrow, had a distance of 25 cm between the two tubers. The number of tubers per experimental unit reached 24, with 72 experimental units as per three replications. Adding bacterial and fungal biofertilizer (a mixture of bacteria *Azotobacter chroococcum, Bacillus mucilaginosus,* and *Pseudomonas fluorescens,* and the mycorrhizal fungi), loaded on peat moss, bore by the tubers in the soil when planting. The NPK fertilizer recommendation added to the potato plant had a rate of 300 kg ha^{-1} (0:20:20) and 300 kg ha^{-1} urea N46%, with the first fertilizer added before planting after preparing the soil. Applying the urea fertilizer was in two batches, the first after emergence and the second after one month of the first batch (Hassan, 2016). The planting took place in the fall (November 9, 2022), and the foliar spraying with nanofertilizer occurring twice—the first when the leaves appeared completely (45 days after planting) and the second 14 days after the first spraying before flowering.

Data recorded

The nitrogen percentage estimated in tubers followed the method described by Jackson (1958) using a Microkaldal device. The phosphorus percentage estimation of tubers used a spectrophotometer according to the procedure described by Olsen and Sommers (1982). The potassium percentage estimate of the tubers employed a flame photometer (Haynes, 1980). The protein (%) calculation in tubers was according to the percentage of total nitrogen (Cresser and Parsons, 1979), as follows:

Protein percentage in tubers = percentage of nitrogen × 6.25

The percentage of starch in tubers (%) followed the estimation according to AOAC (1970), based on the following equation:

Percentage of starch = 17.55 + 0.89 × (percentage of dry matter in tubers - 24.18)

Statistical analysis

All the recorded data for various biochemical traits underwent the analysis of variance, as per the RCBD design (Al-Mohammadi and Al-Mohammadi, 2012). Using the least significant difference ($LSD_{0.05}$) test helped compare and separate the means. Processing all the analyses utilized the statistics software GenStat12.

RESULTS

Nitrogen (%)

For nitrogen percentage in tubers, the potato cultivars revealed significant differences (Table 1). Cultivar Arizona appeared with the highest percentage (1.936%), followed by the other cultivar Sifra (V2). Meanwhile, the cultivar Rashida provided the lowest nitrogen percentage in tubers (1.714%). Biofertilization also had a positive effect, and the treatment B3 (bacterial and fungal biofertilizer) was notable with the uppermost nitrogen percentage (1.936%), which nonsignificantly differed from treatment B1 (bacterial biofertilizer), while the control treatment (B0) recorded with the lowest percentage (1.733%). Furthermore, substantial differences existed between the nanofertilization treatments. Treatment N1 recorded with the utmost percentage (1.872%), while the control treatment (N0) resulted with the lowest nitrogen percentage (1.794%).

As for the interaction between the cultivars and biofertilization, noteworthy variations between the treatments occurred (Table 1). The treatment B3V3 recorded with the highest nitrogen percentage (2.125%), while the control treatment B0V1 gave the lowest percentage (1.569%). The results of the same table also showed significant differences in the interaction between the cultivars and nanofertilization treatments. Treatment N1V3 recorded with the maximum nitrogen percentage (2.030%), while the lowest percentage (1.686%) resulted in the control treatment N0V1. Likewise, the interaction between the biofertilization and nanofertilization treatments significantly differed, with the treatment N1B3 recorded with the ultimate percentage (1.955%), and the treatment B0N0 recorded with the lowest percentage (1.626%). As for the interaction treatments between the cultivars, biofertilization, and nanofertilization,

Table 1. Effect of the nanofertilization and biofertilization and cultivars and their interaction on the nitrogen percentage in potato tubers.

Treatments		Potato cultivars			Means (%)	
Nanofertilization	Biofertilization	Rashida (V1)	Sifra (V2)	Arizona (V3)	B × N	Means N (%)
N_0 (0 g L^{-1})	B_0	1.460	1.804	1.615	1.626	1.794
	B_1	1.912	1.855	1.907	1.891	
	B_2	1.648	1.863	1.713	1.741	
	B_3	1.723	1.905	2.124	1.917	
N_1 (2 g L^{-1})	B_0	1.678	1.797	2.045	1.840	1.872
	B_1	1.678	1.978	1.929	1.862	
	B_2	1.678	1.797	2.019	1.831	
	B_3	1.938	1.800	2.127	1.955	
$LSD_{0.05}$	0.145				0.0.83	0.042
N × V		N_0	N_1		Cultivars means (%)	
	V_1	1.686	1.743		1.714	
	V_2	1.857	1.843		1.850	
	V_3	1.840	2.030		1.935	
$LSD_{0.05}$	0.072				0.051	
B × V		V_1	V_2	V_3	Biofertilization means (%)	
	B_0	1.569	1.801	1.830	1.733	
	B_1	1.795	1.916	1.918	1.877	
	B_2	1.663	1.830	1.866	1.786	
	B_3	1.831	1.852	2.125	1.935	
$LSD_{0.05}$	0.102				0.059	

remarkable differences appeared in the percentage of nitrogen in the tubers. The triple interaction N1B3V3 displayed with the highest nitrogen percentage (2.127%), while the treatment N0B0V1 recorded with the lowest percentage (1.460%).

Phosphorus (%)

The results revealed significant differences among the potato cultivars for the phosphorus percentage in tubers (Table 2). Cultivar Arizona recorded with the highest percentage of phosphorus (0.431%), followed by the cultivar Sifra, while the cultivar Rashida exhibited the lowest percentage (0.378%). As for the biofertilization treatments, significant differences also emerged among the treatments for phosphorus percentage. The treatment B3 (bacterial and fungal biofertilizer) provided the maximum percentage of phosphorus (0.432%), which did not differ significantly from treatment B1 (bacterial biofertilizer). Meanwhile, the treatment B0 demonstrated the lowest phosphorus percentage in tubers (0.380%). The nanofertilization treatments also had a considerable effect, and the treatment N1 recorded with the supreme percentage (0.517%), while the control treatment (N0) giving the lowest percentage (0.397%).

As for the interaction between cultivars and biofertilization, remarkable differences between the treatments arose for the phosphorus percentage of tubers (Table 2). The treatment B3V3 recorded with the highest percentage (0.474%), while the treatment V1B0 displaying the lowest phosphorus percentage (0.330%). The interaction between cultivars and nanofertilization also showed superiority. Treatment N1V3 appeared with the topmost percentage (0.453%), while treatment N0V1 recorded with the lowest tuber's phosphorus percentage (0.367%). Likewise, the interaction treatments between biofertilization and nanofertilization had a positive effect, and the treatment N1B3 recorded with the highest percentage (0.436%), while treatment N0B0 provided the lowest phosphorus percentage (0.349%). As for the interaction between cultivars, biofertilization, and nanofertilization, substantial disparities for the phosphorus percentage in potato tubers occurred. The triple interaction N1B3V3 recorded with the highest percentage (0.475%), while the lowest phosphorus percentage was evident in the interaction N0B0V1 (0.286%).

Table 2. Effect of the nanofertilization and biofertilization and cultivars and their interaction on the phosphorus percentage in potato tubers.

Treatments		Potato cultivars			Means (%)	
Nanofertilization	Biofertilization	Rashida (V1)	Sifra (V2)	Arizona (V3)	B × N	Means N (%)
N_0 (0 g L^{-1})	B_0	0.286	0.402	0.360	0.349	0.397
	B_1	0.426	0.414	0.425	0.422	
	B_2	0.369	0.415	0.382	0.389	
	B_3	0.384	0.425	0.474	0.427	
N_1 (2 g L^{-1})	B_0	0.374	0.401	0.456	0.410	0.517
	B_1	0.374	0.441	0.430	0.415	
	B_2	0.375	0.401	0.450	0.408	
	B_3	0.432	0.402	0.475	0.436	
$LSD_{0.05}$	0.035				0.020	0.010
N × V		N_0	N_1		Cultivars means (%)	
	V_1	0.367	0.389		0.378	
	V_2	0.414	0.411		0.412	
	V_3	0.410	0.453		0.431	
$LSD_{0.05}$	0.017				0.012	
B × V		V_1	V_2	V_3	Biofertilization means (%)	
	B_0	0.330	0.401	0.408	0.380	
	B_1	0.400	0.427	0.428	0.418	
	B_2	0.372	0.408	0.416	0.399	
	B_3	0.408	0.413	0.474	0.432	
$LSD_{0.05}$	0.025				0.014	

Table 3. Effect of the nanofertilization and biofertilization and cultivars and their interaction on the potassium percentage in potato tubers.

Treatments		Potato cultivars			Means (%)	
Nanofertilization	Biofertilization	Rashida (V1)	Sifra (V2)	Arizona (V3)	B × N	Means N (%)
N_0 (0 g L^{-1})	B_0	1.064	1.583	1.530	1.392	1.501
	B_1	1.557	1.168	1.551	1.425	
	B_2	1.687	1.403	1.429	1.506	
	B_3	1.667	1.704	1.670	1.680	
N_1 (2 g L^{-1})	B_0	1.117	1.855	1.852	1.608	1.809
	B_1	1.797	1.774	1.823	1.798	
	B_2	1.780	1.852	1.899	1.843	
	B_3	1.661	2.072	2.223	1.985	
$LSD_{0.05}$	N.S				N.S	0.117
N ×V		N_0	N_1		Cultivars means (%)	
	V_1	1.494	1.589		1.541	
	V_2	1.464	1.888		1.676	
	V_3	1.545	1.949		1.747	
$LSD_{0.05}$	0.204				0.144	
B × V		V_1	V_2	V_3	Biofertilization means (%)	
	B_0	1.090	1.719	1.691	1.500	
	B_1	1.677	1.471	1.687	1.612	
	B_2	1.733	1.628	1.664	1.675	
	B_3	1.664	1.888	1.946	1.833	
$LSD_{0.05}$	0.288				0.166	

Potassium (%)

For potato tuber's potassium percentage, cultivars revealed significant differences (Table 3). Cultivar Arizona recorded with the highest percentage of 1.747%. However, it did not differ significantly from the cultivar Sifra (V2), while the cultivar Rashida recorded with the lowest potassium percentage (1.541%). On biofertilization treatments, they had a positive effect on the percentage of potassium in the potato tubers. The treatment B3 (bacterial and fungal biofertilizer) exhibited the utmost percentage (1.833%), which did not differ significantly with treatment B2 (fungal biofertilizer), while the lowest percentage of potassium resulted in B0 (1.500%). The nanofertilization treatments also significantly affected the tubers, with the N1 treatment recording the highest percentage (1.809%). The lowest potassium percentage appeared in the control treatment N0 (1.501%).

On the interaction treatments between cultivars and biofertilization, a sizable effect showed on the potassium percentage of tubers (Table 3). The treatment B3V3 recorded with the highest percentage (1.946%), while the lowest potassium percentage resulted in treatment B0V1 (1.090%). The interaction between cultivars and nanofertilization treatments also had a positive influence. The treatment N1V3 recorded with the maximum percentage (1.949%), while the lowest potassium percentage emerged in treatment N0V2 (1.464%). The interaction between the biofertilization and nanofertilization treatments and interaction among three studied factors also revealed nonsignificant differences in the percentage of potassium in potato tubers.

Protein (%)

For protein percentage in tubers, the potato cultivars significantly differed (Table 4). The cultivar Arizona recorded with the highest percentage (12.09%), followed by the cultivar Sifra. However, the cultivar Rashida recorded with the lowest protein percentage (10.71%). As for the biofertilization treatments, considerable differences existed among the treatments. The treatment B3 (bacterial and fungal biofertilizer) recorded with the highest percentage (12.10%), which did not differ significantly with treatment B1 (bacterial biofertilizer), while the control treatment B0 recorded with the lowest tuber's protein percentage (10.83%). The nanofertilization treatments also positively affected the percentage of protein in the potato tubers. The N1 treatment provided the highest percentage (11.70%), while the control treatment N0 recorded with the lowest percentage (11.21%).

Regarding the interaction coefficients between the cultivars and biofertilization levels, noteworthy distinctions occurred for protein percentage in potato tubers (Table 4). The treatment B3V3 recorded with the highest percentage (13.28%), while the treatment B0V1 recorded with the lowest percentage (9.80%). The interaction coefficients between cultivars and nanofertilization also positively influenced the tuber's protein percentage, and the treatment N1V3 recorded with the optimum percentage (12.68%), while the lowest rate of protein (10.53%) appeared in treatment N0V1. Likewise, significant differences resulted in the interaction treatments of biofertilization and nanofertilization. The treatment N1B3 recorded with the uppermost percentage (12.21%), while the lowermost protein percentage manifested in treatment N0B0 (10.16%). As for the interaction between cultivars, biofertilization, and nanofertilization, substantial variances surfaced for the tuber's protein percentage. The triple interaction N1B3V3 recorded with the premier percentage (13.29%), while the lowest percentage came from the cultivar Rashida with both control treatments N0B0V1 (9.12%).

Starch (%)

Significant differences emerged among the potato cultivars in the tuber's starch percentage (Table 5). Cultivar Arizona recorded with the maximum percentage (9.694%), followed by the cultivar Sifra. Meanwhile, the lowest starch percentage was evident in the cultivar Rashida (8.042%). Biofertilization treatments also had a positive impact on potato tuber's starch. The highest percentage (9.630%) resulted in treatment B3 (bacterial and fungal biofertilizer), which did not differ significantly from the treatment B1 (bacterial biofertilizer), while the control treatment B0 gave the lowest percentage (8.042%). Likewise, significant differences existed between the nanofertilization treatments. The N1 treatment provided the highest percentage (9.224%), while the lowest tuber's starch percentage arising in the control treatment N0 (8.557%).

As for the interaction coefficients between the cultivars and biofertilization, there were notable divergences (Table 5). The

Table 4. Effect of the nanofertilization and biofertilization and cultivars and their interaction on the protein percentage in potato tubers.

Treatments		Potato cultivars			Means (%)	
Nanofertilization	Biofertilization	Rashida (V1)	Sifra (V2)	Arizona (V3)	B × N	Means N (%)
N_0 (0 g L^{-1})	B_0	9.12	11.27	10.09	10.16	
	B_1	11.95	11.59	11.91	11.82	11.21
	B_2	10.30	11.64	10.70	10.88	
	B_3	10.77	11.90	13.27	11.98	
N_1 (2 g L^{-1})	B_0	10.48	11.23	12.78	11.50	
	B_1	10.49	12.36	12.05	11.63	11.70
	B_2	10.48	11.23	12.62	11.44	
	B_3	12.11	11.25	13.29	12.21	
$LSD_{0.05}$	0.90				0.52	0.26
N × V		N_0	N_1		Cultivars means (%)	
	V_1	10.53	10.89		10.71	
	V_2	11.60	11.51		11.56	
	V_3	11.49	12.68		12.09	
$LSD_{0.05}$	0.45				0.32	
B × V		V_1	V_2	V_3	Biofertilization means (%)	
	B_0	9.80	11.25	11.44	10.83	
	B_1	11.21	11.97	11.98	11.72	
	B_2	10.39	11.43	11.66	11.16	
	B_3	11.44	11.57	13.28	12.10	
$LSD_{0.05}$	0.64				0.37	

Table 5. Effect of the nanofertilization and biofertilization and cultivars and their interaction on the starch percentage in potato tubers.

Treatments		Potato cultivars			Means (%)	
Nanofertilization	Biofertilization	Rashida (V1)	Sifra (V2)	Arizona (V3)	B × N	Means N (%)
N_0 (0 g L^{-1})	B_0	5.710	8.730	7.027	7.156	8.557
	B_1	9.580	9.060	9.400	9.347	
	B_2	8.493	8.757	7.850	8.367	
	B_3	7.890	8.957	11.147	9.361	
N_1 (2 g L^{-1})	B_0	7.557	8.567	10.660	8.928	9.224
	B_1	7.557	9.560	9.677	8.931	
	B_2	7.558	9.413	10.440	9.137	
	B_3	9.753	8.590	11.353	9.899	
$LSD_{0.05}$	1.385				0.800	0.400
N × V		N_0	N_1		Cultivars means (%)	
	V_1	7.941	8.106		8.042	
	V_2	8.876	9.032		8.954	
	V_3	8.856	10.532		9.694	
$LSD_{0.05}$	0.692				0.489	
B × V		V_1	V_2	V_3	Biofertilization means (%)	
	B_0	6.633	8.648	8.843	8.042	
	B_1	8.568	9.310	9.538	9.139	
	B_2	8.025	9.085	9.145	8.752	
	B_3	8.867	8.773	11.250	9.630	
$LSD_{0.05}$	0.979				0.565	

interaction B3V3 recorded with the highest percentage (11.250%), while treatment B0V1 recorded with the lowest starch percentage (6.633%). The interactions between cultivars and nanofertilization also positively affected the tubers, and the treatment N1V3 recorded the topmost percentage (10.532%), while the lowest starch percentage resulted in treatment N0V1 (7.941%). As for the interaction between biofertilization and nanofertilization treatments, significant differences occurred between the treatments, as treatment N1B3 providing the uppermost percentage (9.899%), with the lowest percentage recorded in treatment N0B0

(7.156%). Concerning the interaction between cultivars, biofertilization, and nanofertilization, prominent differences were also evident. The triple interaction N1B3V3 recorded with the highest starch percentage (11.353%), while treatment N0B0V1 displayed the lowest percentage (5.710%).

DISCUSSION

The results showed a significant superiority of the cultivar Arizona over the other potato cultivars in specific biochemical characteristics represented in the tubers' percentage of nitrogen, phosphorus, potassium, protein, and starch. The reason for the enhancement may be due to the nature of the genetic make-up of these cultivars. The differences among the potato cultivars in qualitative traits can also refer to genetic characteristics and their extent of the plant's adaptation to the prevailing environmental conditions for plants' growth and development, and carrying out the metabolic processes (Bashi, 2018; Haq *et al*., 2021).

On the biofertilization treatments, a substantial increase resulted in the quality characteristics of the potato cultivar tubers. This could also be due to the continuous preparation of nutrients in the roots area, in addition to the growth-stimulating substances resulting from the vital activities of microorganisms. In addition to the decomposition of organic matter, such as auxins, gibberellins, cytokinins, and chelating compounds, it works to prepare micronutrients. All these vital processes increase nutrient contents, such as, nitrogen, phosphorus, and potassium in leaves and tubers, the efficiency of the photosynthesis process, and tissues building compounds (Yang *et al.,* 2009).

Biofertilizers have a positive role in providing nutrients, easily absorbed by crop plants, in addition to their secretion of growth stimulants, sugars, and vitamins. These are considerable sources of energy and carbon. These biological products also positively influence the root system and increase its surface area, boosting absorption of nutrients and their transfer to the leaves, becoming a source of plant food for carbohydrate production (Jnawali *et al.,* 2015; Prasad *et al.,* 2017).

Nanofertilizer treatments also showed a significant increase in the qualitative traits of the different cultivars' potato tubers. The reason for the greater enhancement may refer to the boost in the rate of the photosynthesis process and in the production of carbohydrates and dry matter (Qureshi *et al.,* 2018). An explanation could be due to the increased absorption of nutrients, which in turn, worked to enhance the efficiency of the photosynthesis process in the leaves as a result of their expansion, and thus, raising the manufactured carbohydrates. The surplus of these organic compounds gets transferred to the tubers and stored in the form of starch (Agrawal and Rathore, 2014; Polivanova *et al*., 2024).

The nanofertilization treatments also revealed significant superiority in the biochemical traits of the potato cultivar tubers. The reason could be attributable to the positive role of the nitrogen element contained in the nanofertilizer in increasing vegetative growth. This leads to a speedy process of photosynthesis and, then, an increase in manufactured sugars. Thus, eventually increasing the percentage of total solid soluble substances in the tubers. The potassium element stimulates the materials resulting from the photosynthesis process and, then, transfers them to the tubers (Al-Sultan *et al.,* 2023; Pourahmadi *et al.,* 2023).

CONCLUSIONS

Through this study, we conclude using three potato (*Solanum tuberosum* L.) cultivars, the cultivar Arizona emerged leading for tuber's biochemical characteristics over the other cultivars. Likewise, the use of bacterial and fungal biofertilizer and nanofertilizer (2 g L^{-1}) led to a significant increase in the specific quality indicators of the potato tubers.

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