Journal of Plant Production

Journal homepage & Available online at: www.jpp.journals.ekb.eg

Optimizing Potato Yield and Quality *Via* Organic and Mineral Potassium Sources

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ABSTRACT

It is known that potassium plays a pivotal role as a sizing agent for potato tubers. So, this research was conducted to evaluate the impact of different treatments on potato, aiming for improved potassium fertilization practices and higher returns. The study focused on the evaluation of the application of banana residues compost to soil as the main factor (applied or not), potassium humate *via* fertigation as the sub-main factor (applied or not), and the foliar application of mineral potassium sources as the sub-sub-main factor (including potassium nitrate, potassium citrate, potassium silicate, and a control group) on the growth performance and yield quality of potato plants during the successive seasons (2021/22 and 2022/23). The potato plants cultivated in soil treated with banana residues compost demonstrated enhanced growth performance, including higher fresh and dry weights, as well as superior quantitative and qualitative yield compared to plants grown on untreated soil. Moreover, the application of potassium humate further optimized the yield and quality of potato compared to plants grown without potassium humate. Regarding the foliar application of diverse potassium sources, the most effective treatment was found to be potassium nitrate, followed by potassium citrate then potassium silicate, with the control group showing the least favorable results. Overall, the combination of applying banana residues compost along with potassium humate treatment and the subsequent spraying of potassium nitrate proved to be the most successful intervention, significantly improving the growth performance and both quantitative and qualitative yield of potato plants compared to other interventions.

Keywords: Potassium nitrate, potassium citrate, potassium silicate

INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most crucial staple crops globally, playing a vital role in ensuring food security and addressing nutritional demands for a significant portion of the world's population (Abd-Elgawad, 2020; Koch *et al.*, 2020). Potato, a highly valuable commercial and nutritional crop, boasts a well-balanced nutritional profile with approximately 16.0% carbohydrates, 2.5% fibers, 2.0% protein, and 0.10% fats, alongside essential minerals like nitrogen, phosphorus, potassium, calcium, and magnesium (Abd El-Hady *et al.*, 2021). Its nutritional richness makes it an essential component of the human diet. In Egypt, the importance of potato cultivation cannot be overstated, as it ranks among the primary crops contributing to the nation's food supply and economic stability. The adaptability of potatoes to various agro-climatic conditions and their relatively short growth cycle make them a favorable choice for cultivation in Egypt (Hamaiel *et al.*, 2021).The government is taking proactive measures to promote the expansion of potato cultivation areas due to its immense significance as both a staple crop and a potential source of export revenue. Recognizing the vital role of potatoes in addressing food security and supporting economic growth, the focus on enhancing potato production has become a key priority for sustainable agricultural development in the country (Abd El-Nabi *et al.*, 2022). As the demand for high-quality potatoes increases, there is a growing need to explore innovative agricultural practices that can optimize potato yield and enhance overall crop quality. Traditional methods of fertilization have been widely employed, but recent research indicates that combining organic and bio-based substances with conventional fertilization techniques could unlock new opportunities for boosting potato productivity (Soliman *et al.*, 2022).

Banana residues, which include peels, stems, and leaves, are abundant agricultural by-products often overlooked for their potential benefits (Ghinea *et al.*, 2019). These residues are rich in essential nutrients, including potassium, an essential macronutrient vital for various physiological processes in plants. Proper utilization of these organic waste materials, such as through composting, presents an environmentally friendly approach to enhance soil fertility and nutrient availability for potato cultivation (Chen *et al.*, 2021). El-Afifi *et al.* (2016) mentioned that banana residues compost can be used as a partial substitute for potassium mineral forms. Besides Soliman (2023) reported the positive response of potato plant to banana residues compost.

Potassium humate, a humic acid derived from organic sources, has also garnered attention for its beneficial effects on plant growth and nutrient uptake (Idrees *et al.*, 2020). When applied through fertigation (the integration of irrigation and fertilization), potassium humate can improve soil structure and increase nutrient absorption by the plants (Moustafa, 2020). Additionally, the applying potassium

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DOI: 10.21608/jpp.2023.226106.1258

humate has been demonstrated as an effective means of supplying essential nutrients directly to the leaves (Mahdi *et al.*, 2021), thereby enhancing photosynthetic efficiency and overall crop performance (Mohammed *et al.*, 2021).

Potassium (K) plays a crucial role in the development of sugars and starches within potato tubers, as it enhances the process of photosynthesis and its subsequent transfer to the tubers (El-Hadidi *et al.*, 2017). Additionally, K contributes to the conversion of these sugars into essential components such as starch, proteins, and vitamins. Consequently, potatoes demand substantial quantities of potassium for their optimal growth and productivity (Ewais *et al.*, 2020). Various potassium sources, including potassium nitrate, potassium citrate, potassium silicate, potassium acetate, and others, exhibit different levels of effectiveness and absorption within the plant. These sources stimulate and activate vital physiological processes, ultimately leading to an increase in the solid content of tuber crops and promoting better sizing when applied through spraying techniques (Mikkelsen and Roberts, 2020). Moreover, according to Torabian *et al.* (2021), potassium also plays a crucial role in regulating water balance within plant tissues, thereby contributing to proper water management and enhancing overall plant health.

Finally, achieving a profitable potato yield and ensuring high-quality crops heavily rely on effective potassium management. Consequently, the main goal of this study is to assess the combined impact of banana residues compost as a soil amendment, potassium humate through fertigation, and the foliar application of diverse potassium sources on the performance and yield quality of potato plants. By identifying the most effective combined treatment for optimizing the productivity of potatoes, a strategically important crop in Egypt.

MATERIALS AND METHODS

A field trials were performed during two successive seasons of 2021/22 and 2022/23 at a private farm located in Met-Antar village, Talkha district, Dakahlia governorate, Egypt (31°4'54"N 31°24'4"E) under split split plot design with three replicates to evaluate the application of banana residues compost to soil as the main factor (applied at rate of 10 ton ha^{-1} or not), potassium humate *via* fertigation as the sub-main factor (applied at rate of 6.0 kg ha^{-1} or not), and the foliar application of diverse potassium sources as the sub-sub-main factor (including potassium nitrate, potassium citrate and potassium silicate at rate of 2.0 g K L^{-1} for each form, in addition to a control group) on the growth performance and yield quality of potato plants during the successive seasons (2021/22 and 2022/23).

Soil Sampling and Studied substances

Initial soil analysis

Initial soil samples were analyzed according to Jones (2018), where their characteristics are shown in Table1.

Banana residues compost

The residues of banana trees, including peels, stems, and leaves, were collected from a private farm near the experimental site. Subsequently, a composting process, following the method outlined by El-Hammady *et al.* (2003), was carried out for a duration of six months. Banana peels, stems, and leaves were gathered and subsequently chopped into smaller pieces. The compost pile was consistently watered during its construction to ensure the proper moisture level. Additionally, every one to two weeks, the compost pile was turned using a pitchfork or shovel, facilitating aeration and accelerating the decomposition process. Table 2 displays the properties of the compost derived from these tree residues.

Table 1.Characteristics of the initial soil (samples taken at depth of 0-30 cm)

Characteristics		Values	
		Season of 2021/22	Season of 2022/23
Available nutrients	Nitrogen, $mgKg^{-1}$	51.5	55.5
	Phosphorus, $mgKg^{-1}$	8.50	8.90
	Potassium, $mgKg^{-1}$	215.3	224.9
Hydro physical measurements	Field capacity,%	35.0	35.0
	Saturation,%	70.0	70.0
Chemical properties	$CaCO_3$, %	2.3	2.3
	Organic matter, %		
	EC dSm^{-1} (suspension 1: 5)	2.88	3.01
	pH (suspension 1:2.5)	8.12	8.11
Particle size distribution	Clay,%	48.3	48.6
	Sand,%	15.6	15.7
	Silt,%	36.1	35.7
Textural class		Clayey texture	Clayey texture

Table 2. Properties of the tree residues compost

Characteristics	Values
K, g kg^{-1}	15.05
C:N ratio	11.8
EC,dSm^{-1}	4.00
pH	6.25
O.M,%	34.5
Total C, %	20.0
Total N, %	1.70
P , mg kg^{-1}	0.82
Zn , mg kg^{-1}	20.0
Mn, mg kg^{-1}	22.0

Potassium sources

The different mineral sources of potassium were acquired, including potassium nitrate (KNO_3, 38.7 % K), potassium citrate ($K_3C_6H_5O_7$, 45.0 % K_2O) and potassium silicate (K_2SiO_3, 60.0 % K) from Green Gold Company, Egypt. Additionally, potassium humate (containing 10.0% K_2O) was obtained from the Misr Biotechnology Company, Egypt. Table 3 displays the specifications of potassium humate, and the analyses were conducted following the methods outlined by Tandon (2005) and Javanshah and Saidi (2016).

Table 3. Some characteristic of potassium humate

HA	FA	Solubility	Moisture	pH	Total macro element			Total	
					N	P_2O_5	K_2O	Carboxylic groups	Phenolic groups
	%					%		mmol/100g HS	
610.	.340	100	6.0	8.30	0.50	1.0	10	520	400

Experimental Setup

Potato tubers (Cv Spunta) were acquired from the Ministry of Agricultural and Soil Reclamation (MASR). These tubers were divided into pieces, each weighing approximately 40.0 g. The experimental area measured 120.0 m^2 (20.0 m × 6.0 m). Prior to planting, half plots only were treated with banana residues compost at a rate of 10 ton ha^{-1} (according to the studied treatments), along with calcium superphosphate (15% P_2O_5) at a rate of 100 kg P_2O_5 fed^{-1} during field preparation for all plots. Planting occurred on the 24th of December in both study seasons, using tuber pieces in moist soil. The irrigation network was installed one week after planting. For nitrogen fertilization, urea (46.5% N) was used through a fertigation system at a rate of 150 kg N fed^{-1}. Traditional potassium fertilization was carried out by adding potassium sulfate (48% K_2O) *via* the fertigation system at a rate of 50.0 kg fed^{-1}. It is also worth noting that potassium humate was added at rate of 6.0 kg ha^{-1} *via* the fertigation system in one dose after 45 days after planting. Additionally, the first foliar application of mineral potassium sources was performed 45 days after planting and repeated three times with 15-day intervals. Also, it should be noted that all recommended agricultural practices were followed as per MASR guidelines. Tubers were harvested 110 days after planting.

Measurements

After 80 days from planting

In this stage (after the second third of the plant life cycle), a random selection of five plants from each replicate was sampled for various measurements. These included plant height (cm), fresh and dry weights (g $plant^{-1}$), and photosynthetic pigments, specifically chlorophyll content (SPAD value). For the analysis of chemical composition in potato foliage during the same period, the oven-dried potato leaves were ground and then digested using a mixture of perchloric and sulfuric acids in a 1:1 ratio, following the method described by Peterburgski (1968). The determination of total N, P, and K (%) in potato foliage was carried out using the Kjeldahl method, spectrophotometry, and a flame photometer, respectively, based on the procedure outlined by Kalra (1997).

After 110 days from planting

In this stage (harvest stage), a random samples of five plants from each replicate were taken for determination some yield and quality traits *i.e.,* average weight of one tuber (g), No. of tuber $plant^{-1}$ and total tuber yield (Mg ha^{-1}), total carbohydrates (%), total sugars (%), dry matter (%),vitamin C (mg $100g^{-1}$), specific gravity (%) total dissolved solids (TDS) (%) and protein (%). All quality parameters were determined according to AOAC (2000).

Statistical analysis

The recorded data underwent statistical analysis using Analysis of Variance (ANOVA), and the least significance differences (LSD) method, as described by Duncan, (1955), were applied to separate means at a 0.05 level of probability. This approach was in accordance with the methodology outlined by Gomez and Gomez, (1984).

RESULTS AND DISCUSSION

Growth performance, photosynthetic pigments and leaves chemical constituents

The data presented in Tables 4 and 5 demonstrate the impact of applying banana residues compost to the soil and using potassium humate *via* fertigation, along with the foliar application of diverse potassium sources, on the performance of potato plants. The assessment was conducted at the 80-days from planting and includes measurements such as plant height (cm), fresh and dry weights (g $plant^{-1}$), and chlorophyll content (SPAD value) during the successive seasons of 2021/22 and 2022/23. Furthermore,

Table 4. Impact of applying banana residues compost to the soil and using potassium humate *via* fertigation, along with the foliar application of diverse potassium sources on growth parameters and photosynthetic pigment of potato plants at period of 80 days from planting during season of 2021/22

Treatments			Plant height, cm	Fresh weight, g $plant^{-1}$	Dry weight, g $plant^{-1}$	Chlorophyll, SPAD
Main factor: Banana Residues Compost (BRC) treatments						
Control (Without BRC)			57.52b	233.45b	52.56b	40.84b
With BRC			62.30a	268.70a	57.41a	42.52a
LSD at 5%			0.04	1.13	0.14	0.45
Sub main factor: Potassium Humate (KH) treatments						
Control (Without KH)			58.68b	242.42b	53.66b	41.20b
With KH			61.15a	259.73a	56.30a	42.17a
LSD at 5%			0.02	0.61	0.05	0.47
Sub sub main factor: Potassium Mineral Sources (PMS)						
K_1: Potassium nitrate			60.95a	257.90a	55.72a	42.07a
K_2: Potassium citrate			60.24b	253.26b	55.32b	41.89ab
K_3:Potassium silicate			59.59c	249.06c	54.68c	41.50bc
K_4: Control (Without PMS)			58.87d	244.09d	54.22d	41.27c
LSD at 5%			0.21	0.89	0.21	0.43
Interaction						
Without BRC	Without KH	K_1	57.18j	232.02m	51.97i	40.85hij
		K_2	56.72k	226.32n	51.48j	40.79hij
		K_3	56.04l	223.58o	50.30k	40.19ij
		K_4	54.81m	220.44p	50.08k	40.05j
	With KH	K_1	59.92g	248.08i	54.72g	41.37fgh
		K_2	58.95h	244.30j	54.66g	41.34fgh
		K_3	58.76h	238.21k	53.81h	41.12gh
		K_4	57.79i	234.64l	53.47h	40.99ghi
With BRC	Without KH	K_1	62.25d	265.25e	56.96d	42.30cde
		K_2	61.39e	263.28f	56.71de	42.06c-f
		K_3	60.50f	257.29g	56.39e	41.83d-g
		K_4	60.53f	251.19h	55.42f	41.48e-h
	With KH	K_1	64.46a	286.25a	59.25a	43.77a
		K_2	63.91b	279.12b	58.41b	43.36ab
		K_3	63.05c	277.14c	58.22bc	42.85bc
		K_4	62.35d	270.10d	57.90c	42.54bcd
LSD at 5%			0.42	1.78	0.42	0.87

Means within a row followed by a different letter (s) are statistically different at a 0.05 level

Table 5. Impact of applying banana residues compost to the soil and using potassium humate *via* fertigation, along with the foliar application of diverse potassium sources on growth parameters and photosynthetic pigment of potato plants at period of 80 days from planting during season of 2022/23

Treatments			Plant height, cm	Fresh weight, g plant^{-1}	Dry weight, g plant^{-1}	Chlorophyll, SPAD
Main factor: Banana Residues Compost (BRC) treatments						
Control (Without BRC)			58.44b	237.18b	53.56b	41.47b
With BRC			63.15a	272.46a	58.49a	43.13a
LSD at 5%			1.38	11.12	1.35	1.09
Sub main factor: Potassium Humate (KH) treatments						
Control (Without KH)			59.53b	245.97b	54.77b	41.84b
With KH			62.06a	263.66a	57.29a	42.75a
LSD at 5%			0.75	1.54	0.68	0.24
Sub sub main factor: Potassium Mineral Sources (PMS)						
K_1: Potassium nitrate			61.89a	261.89a	56.55a	42.68a
K_2: Potassium citrate			61.16ab	257.22b	56.42a	42.51ab
K_3: Potassium silicate			60.38ab	252.37c	55.87ab	42.11bc
K_4: Control (Without PMS)			59.75b	247.79d	55.27b	41.90c
LSD at 5%			1.59	2.15	0.82	0.53
Interaction						
Without BRC	Without KH	K_1	58.10f-i	235.49i	53.12gh	41.50ghi
		K_2	57.61ghi	229.91j	52.33hi	41.44ghi
		K_3	56.79hi	227.24jk	51.31i	40.93hi
		K_4	55.75i	223.84k	51.09i	40.91i
	With KH	K_1	61.04b-f	252.73fg	55.57ef	41.88e-i
		K_2	60.07c-g	249.68g	55.69ef	41.89e-i
		K_3	59.57d-h	240.94h	54.87f	41.64f-i
		K_4	58.58e-i	237.57hi	54.50fg	41.54ghi
With BRC	Without KH	K_1	63.12abc	269.45d	58.12a-d	42.90cde
		K_2	62.19a-d	266.21d	57.91bcd	42.68c-f
		K_3	61.30b-e	260.53e	57.72cd	42.41d-g
		K_4	61.41b-e	255.11f	56.52de	41.98e-h
	With KH	K_1	65.31a	289.88a	59.39ab	44.42a
		K_2	64.77a	283.08b	59.73a	44.02ab
		K_3	63.86ab	280.76b	59.57a	43.48abc
		K_4	63.28ab	274.64c	58.97abc	43.15bcd
LSD at 5%			3.18	4.30	1.63	1.06

Means within a row followed by a different letter (s) are statistically different at a 0.05 level

Tables 6 and 7 provide information on the chemical composition of the foliage, specifically the percentages of nitrogen (N), phosphorus (P), and potassium (K) at the same period during both seasons. The collected data offers valuable insights into the effects of the studied treatments on potato growth and chemical composition at this specific period of growth.

Table 6. Impact of applying banana residues compost to the soil and using potassium humate *via* fertigation, along with the foliar application of diverse potassium sources on chemical constituents in leaves of potato plants at period of 80 days from planting during season of 2021/22

Treatments			Nitrogen, %	phosphorus,%	Potassium, %
Main factor: Banana Residues Compost (BRC) treatments					
Control (Without BRC)			3.13b	0.352b	3.15b
With BRC			3.62a	0.411a	3.52a
LSD at 5%			0.07	0.007	0.03
Sub main factor: Potassium Humate (KH) treatments					
Control (Without KH)			3.25b	0.366b	3.25b
With KH			3.50a	0.397a	3.42a
LSD at 5%			0.04	0.008	0.02
Sub sub main factor: Potassium Mineral Sources (PMS)					
K_1: Potassium nitrate			3.49a	0.391a	3.40a
K_2: Potassium citrate			3.41b	0.385b	3.37a
K_3: Potassium silicate			3.33c	0.380b	3.33b
K_4: Control (Without PMS)			3.27d	0.371c	3.26c
LSD at 5%			0.04	0.005	0.04
Interaction					
Without BRC	Without KH	K_1	3.08fg	0.346ef	3.11fg
		K_2	3.05g	0.340fg	3.08fgh
		K_3	2.96h	0.333gh	3.04gh
		K_4	2.90h	0.330h	3.01h
	With KH	K_1	3.41d	0.374d	3.34d
		K_2	3.28e	0.372d	3.30d
		K_3	3.23e	0.368d	3.20e
		K_4	3.13f	0.352e	3.15ef
With BRC	Without KH	K_1	3.59c	0.408b	3.50c
		K_2	3.49cd	0.396c	3.48c
		K_3	3.47cd	0.392c	3.47c
		K_4	3.44a	0.387c	3.34d
	With KH	K_1	3.88a	0.435a	3.64a
		K_2	3.82b	0.431a	3.63a
		K_3	3.66b	0.428a	3.60ab
		K_4	3.62b	0.414b	3.53bc
LSD at 5%			0.07	0.010	0.08

Means within a row followed by a different letter (s) are statistically different at a 0.05 level

Table 7. Impact of applying banana residues compost to the soil and using potassium humate *via* fertigation, along with the foliar application of diverse potassium sources on chemical constituents in leaves of potato plants at period of 80 days from planting during season of 2022/23

Treatments			Nitrogen, %	phosphorus,%	Potassium, %
Main factor: Banana Residues Compost (BRC) treatments					
Control (Without BRC)			3.16b	0.358b	3.19b
With BRC			3.71a	0.420a	3.57a
LSD at 5%			0.18	0.010	0.05
Sub main factor: Potassium Humate (KH) treatments					
Control (Without KH)			3.32b	0.374b	3.29b
With KH			3.54a	0.404a	3.47a
LSD at 5%			0.12	0.005	0.03
Sub sub main factor: Potassium Mineral Sources (PMS)					
K_1: Potassium nitrate			3.49a	0.398a	3.44a
K_2: Potassium citrate			3.49a	0.391b	3.41a
K_3:Potassium silicate			3.41ab	0.387c	3.37b
K_4: Control (Without PMS)			3.35b	0.378d	3.30c
LSD at 5%			0.13	0.004	0.04
Interaction					
Without BRC	Without KH	K_1	3.15fg	0.354fg	3.14fg
		K_2	3.11fg	0.346gh	3.11gh
		K_3	3.03g	0.339hi	3.08gh
		K_4	2.96g	0.337i	3.06h
	With KH	K_1	3.15fg	0.382d	3.38d
		K_2	3.35def	0.376de	3.34d
		K_3	3.32ef	0.372e	3.24e
		K_4	3.21fg	0.359f	3.19ef
With BRC	Without KH	K_1	3.69bc	0.416b	3.54c
		K_2	3.58cd	0.404c	3.53c
		K_3	3.54cde	0.401c	3.51c
		K_4	3.53cde	0.396c	3.38d
	With KH	K_1	3.97a	0.442a	3.69a
		K_2	3.90ab	0.440a	3.68a
		K_3	3.74abc	0.438a	3.64av
		K_4	3.70bc	0.422b	3.57bc
LSD at 5%			0.25	0.008	0.07

Means within a row followed by a different letter (s) are statistically different at a 0.05 level

Individual effect of compost treatments:

The obtained results show that the potato plants cultivated in soil treated with banana residues compost possessed the maximum values of plant height (cm), fresh and dry weights (g plant^{-1}), chlorophyll content (SPAD value), nitrogen (%), phosphorus (%) and potassium (%) compared to the corresponding plants which were grown on untreated soil (without banana residues compost). This trend was consistently observed during both studied seasons. The superiority of banana residues compost may be attributed to its content of organic matter and essential nutrients like nitrogen, phosphorus, and potassium. When applied to the soil, the compost gradually releases these nutrients, providing a continuous and balanced supply to the potato plants. This improved nutrient availability contributes to better plant growth and enhanced nutrient content in the potatoes. Banana residues compost improves soil structure, leading to better aeration and water retention capacity. This creates a favorable environment for root development and nutrient uptake, promoting overall plant growth and vitality. Chlorophyll is responsible for photosynthesis, the process through which plants produce their food. The higher chlorophyll content (SPAD value) in potato plants grown with banana residues compost suggests improved photosynthetic activity, leading to increased plant growth and biomass accumulation. The nitrogen, phosphorus, and potassium present in banana residues compost contribute to the enrichment of these essential nutrients in the plant tissues. Nitrogen is vital for vegetative growth, phosphorus plays a key role in root development and energy transfer, and potassium is crucial for overall plant health and crop yield. The improved soil structure resulting from the application of banana residues compost promotes robust root development. This, in turn, facilitates greater nutrient and water uptake by the plants, supporting their overall growth and development. Organic compost materials release nutrients gradually over time, ensuring a steady supply throughout the growth period. This sustained nutrient release supports consistent plant growth and helps maintain nutrient balance in the soil. Banana residues compost fosters a diverse and active microbial community in the soil. These microorganisms aid in nutrient cycling and mineralization, making nutrients more available to the plants and contributing to their improved growth and nutrient content. Overall, the positive impact of using banana residues compost on potato growth and nutrient content is rooted in its ability to enrich the soil with essential nutrients, improve soil structure, and stimulate beneficial microbial activity. This leads to optimized nutrient availability, enhanced photosynthetic activity, and better plant development, resulting in higher values for plant height, fresh and dry weights, chlorophyll content, nitrogen content, phosphorus content, and potassium content in potato plants grown with this organic amendment. The findings are in harmony with those of El-Afifi *et al.* (2016).

Individual effect of potassium humate treatments:

It was found that the applying potassium humate *via* fertigation led to obtain the maximum values of plant height (cm), fresh and dry weights (g plant^{-1}), chlorophyll content (SPAD value), nitrogen (%), phosphorus (%) and potassium (%) compared to the control treatment (without potassium humate). The same trend was found during both studied seasons. The positive effect of potassium humate may be due to its ability in enhancing the availability and uptake of essential nutrients by potato plants. It acts as a chelating agent, forming complexes with nutrients, making them more accessible to the roots. This enhanced nutrient uptake contributes to improved plant growth and development. Increased chlorophyll content (SPAD value) in potato leaves treated with potassium humate suggests improved photosynthetic efficiency. Enhanced photosynthesis leads to greater energy production and carbon assimilation, resulting in higher biomass accumulation and better plant growth. Moreover, Potassium humate has been reported to improve the stress tolerance of plants (Ali *et al.,* 2021). It helps in mitigating the negative effects of abiotic stresses like drought, heat, and salinity, which may be present in the growing environment. As a result, the treated plants exhibit better growth and higher nutrient content. The application of potassium humate *via* fertigation promoted root growth and development. Healthier and more extensive root systems increase the plant's ability to take up water and nutrients from the soil, leading to improved overall growth and nutrient absorption. Potassium humate could activate soil microorganisms, increasing their activity and efficiency in nutrient mobilization. These microorganisms help break down organic matter in the soil, releasing essential nutrients for plant uptake, and thus positively impacting the plant's nutrient content. Potassium humate could increase the CEC of the soil, allowing it to hold and exchange more nutrients. This improved nutrient-holding capacity further supports the enhanced nutrient uptake by the plant. Overall, the positive effects of applying potassium humate via fertigation on potato growth and nutrient content can be attributed to improved nutrient uptake, enhanced photosynthesis, stress tolerance, root development, and increased nutrient mobilization. The same trend observed across both seasons indicates the reliability and consistency of these results, making potassium humate a valuable option for enhancing potato crop performance and nutrient status. The obtained results are in agreement with those of Idrees *et al.* (2020); Moustafa (2020).

Individual effect of mineral potassium sources:

The results of the study revealed that potato plants treated with potassium nitrate exhibited the highest values for various parameters, including plant height (cm), fresh and dry weights (g plant^{-1}), chlorophyll content (SPAD value), nitrogen (%), phosphorus (%), and potassium (%). Following potassium nitrate, potassium citrate then potassium silicate treatments showed relatively favorable outcomes, while the control group demonstrated the least favorable results. Remarkably, this trend remained consistent across both studied seasons, indicating that the effect of the different potassium treatments on potato performance was stable and reproducible over time. The superior performance of potassium nitrate, followed by potassium citrate and potassium silicate, emphasizes their potential as effective potassium sources for enhancing potato growth and nutrient content. Overall, the results highlight the importance of potassium in promoting potato growth and nutrient content. Potassium plays a crucial role in nutrient uptake and translocation within plants. It enhances the uptake of other essential nutrients like phosphorus, calcium, and magnesium. Therefore, higher potassium availability may have indirectly contributed to improved nitrogen and phosphorus uptake, leading to higher nitrogen (%) and phosphorus (%) content in the potato plants treated with potassium nitrate and other potassium sources. The superiority of potassium nitrate treatment can be attributed to its dual contribution of potassium and nitrogen, essential for various physiological processes and crop development. Nitrogen is a key component of proteins, enzymes, and chlorophyll, essential for plant growth and photosynthesis. The availability of both potassium and nitrogen from potassium nitrate contributes to enhanced plant growth and biomass accumulation, resulting in higher plant height, fresh and dry weights, and chlorophyll content. The relatively favorable outcomes of potassium citrate and potassium silicate treatments suggest their potential as alternative potassium sources, while the control group underscores the necessity of proper potassium fertilization to optimize potato crop performance. Potassium citrate is a highly soluble form of potassium, while potassium silicate provides both potassium and silicon to the plants. Silicon is known to enhance plant strength and resistance to biotic and abiotic stresses. The presence of these different forms of potassium in the treatments may have contributed to the favorable outcomes in plant growth and nutrient content, albeit to a lesser extent compared to potassium nitrate. Similar results were found by EL-Sherpiny *et al.* (2022).

Interaction effect:

The combination of applying banana residues compost along with potassium humate treatment and the subsequent spraying of potassium nitrate led to the highest values of plant height (cm), fresh and dry weights (g plant^{-1}), chlorophyll content (SPAD value), nitrogen (%), phosphorus (%), and potassium (%) compared to other interventions. Consistency in the observed trend was evident across both studied seasons. The results consistently showed similar effects of the treatments on potato growth and chemical composition during both the 2021/22 and 2022/23 seasons. This finding adds to the reliability and validity of the data, reinforcing the significance of the identified patterns and outcomes. The stability of the observed trend across multiple seasons suggests that the evaluated treatments have a reliable and predictable impact on potato performance, making them promising options for enhancing potato cultivation in the future. The combination of applying banana residues compost and potassium humate treatment likely created a synergistic effect that enhanced the overall nutrient availability and uptake in the potato plants. The organic matter and nutrients present in banana residues compost, along with the chelating properties of potassium humate, facilitated the absorption and utilization of essential nutrients like nitrogen, phosphorus, and potassium by the plants. This synergy may have led to increased plant height, fresh and dry weights, and higher chlorophyll content. The subsequent spraying of potassium nitrate further boosted the potassium content in the potato plants, complementing the potassium supply from potassium humate and banana residues compost. As previously discussed, potassium is essential for various plant processes, including tuber formation, nutrient uptake, and photosynthesis. The additional potassium supply from potassium nitrate likely contributed to the higher nitrogen and phosphorus uptake, leading to increased nitrogen (%) and phosphorus (%) content in the potato plants.

Quantitative and qualitative yield

The data presented in Tables 8, 9,10 and 11 provide insights into the influence of the studied treatments on tuber quantitative and qualitative yield at the harvest stage, which occurred at 110 days from planting..

Table 8. Impact of applying banana residues compost to the soil and using potassium humate *via* fertigation, along with the foliar application of diverse potassium sources on tubers yield of potato plants at harvest stage during season of 2021/22

Treatments			Average tuber weight, g	No. of tuber plant^{-1}	Yield, Mg ha^{-1}
Main factor: Banana Residues Compost (BRC) treatments					
Control (Without BRC)			150.16b	5.14b	39.10b
With BRC			157.41a	5.76a	45.89a
LSD at 5%			0.78	0.03	0.05
Sub main factor: Potassium Humate (KH) treatments					
Control (Without KH)			152.16b	5.24b	40.40b
With KH			155.41a	5.66a	44.59c
LSD at 5%			0.36	0.02	0.02
Sub sub main factor: Potassium Mineral Sources (PMS)					
K_1: Potassium nitrate			154.75a	5.54a	43.44a
K_2: Potassium citrate			154.08b	5.48b	42.80b
K_3:Potassium silicate			153.47c	5.42c	42.16c
K_4: Control (Without PMS)			152.84d	5.37d	41.58d
LSD at 5%			0.56	0.03	0.15
Interaction					
Without BRC	Without KH	K_1	149.11i	5.01k	37.80m
		K_2	148.74i	4.92l	37.06n
		K_3	148.47i	4.85m	36.42o
		K_4	148.38i	4.74n	35.61p
	With KH	K_1	152.74f	5.47gh	42.26i
		K_2	152.20fg	5.42hi	41.73j
		K_3	151.34gh	5.39ij	41.24k
		K_4	150.30h	5.35j	40.69l
With BRC	Without KH	K_1	156.82c	5.69d	45.18e
		K_2	156.04cd	5.64e	44.52f
		K_3	155.31de	5.54f	43.55h
		K_4	154.43e	5.51fg	43.08g
	With KH	K_1	160.32a	5.98a	48.53h
		K_2	159.34ab	5.94ab	47.91a
		K_3	158.74b	5.90bc	47.43b
		K_4	158.27b	5.86c	46.92c
LSD at 5%			1.12	0.05	0.30

Means within a row followed by a different letter (s) are statistically different at a 0.05 level

Table 9. Impact of applying banana residues compost to the soil and using potassium humate *via* fertigation, along with the foliar application of diverse potassium sources on tubers yield of potato plants at harvest stage during season of 2022/23

Treatments			Average tuber weight, g	No. of tuber plant^{-1}	Yield, Mg ha^{-1}
Main factor: Banana Residues Compost (BRC) treatments					
Control (Without BRC)			152.10b	5.14b	39.61b
With BRC			159.67a	5.75a	46.47a
LSD at 5%			0.77	0.03	0.46
Sub main factor: Potassium Humate (KH) treatments					
Control (Without KH)			154.39b	5.23b	40.90b
With KH			157.37a	5.67a	45.18a
LSD at 5%			0.36	0.02	022
Sub sub main factor: Potassium Mineral Sources (PMS)					
K_1: Potassium nitrate			156.75a	5.54a	44.00a
K_2: Potassium citrate			156.35a	5.47ab	43.38b
K_3:Potassium silicate			155.59b	5.41bc	42.70c
K_4: Control (Without PMS)			154.83c	5.36c	42.08d
LSD at 5%			0.56	0.07	0.50
Interaction					
Without BRC	Without KH	K_1	151.50hi	4.98g	38.20i
		K_2	150.97ij	4.91g	37.48ij
		K_3	149.96j	4.87gh	36.96jk
		K_4	149.86j	4.76h	36.12k
	With KH	K_1	154.73f	5.47ef	42.83fg
		K_2	154.34f	5.41ef	42.24g
		K_3	153.16g	5.40ef	41.83gh
		K_4	152.25gh	5.34f	41.17h
With BRC	Without KH	K_1	158.69d	5.68c	45.64d
		K_2	158.54d	5.64cd	45.21d
		K_3	158.42d	5.49de	44.03e
		K_4	157.21e	5.47ef	43.52ef
	With KH	K_1	162.08a	6.01a	49.31a
		K_2	161.57ab	5.94ab	48.60ab
		K_3	160.84bc	5.90ab	47.99bc
		K_4	160.01c	5.87b	47.50c
LSD at 5%			1.13	0.14	1.01

Means within a row followed by a different letter (s) are statistically different at a 0.05 level

Table 10. Impact of applying banana residues compost to the soil and using potassium humate *via* fertigation, along with the foliar application of diverse potassium sources on tubers quality of potato plants at harvest stage during season of 2021/22

Treatments			**T. Carbohydra-tes %**	**T. Sugars, %**	**Dry matter, %**	**Vitamin C, mg.100g**	**Specific gravity, %**	**TDS, %**	**Protein, %**
Main factor: Banana Residues Compost (BRC) treatments									
Control (Without BRC)			26.14b	5.11b	19.68b	21.02b	1.037b	6.3b	12.69b
With BRC			28.48a	5.59a	21.70c	22.91a	1.062a	7.42a	14.89a
LSD at 5%			0.41	0.23	0.16	0.05	0.002	0.07	0.05
Sub main factor: Potassium Humate (KH) treatments									
Control (Without KH)			26.82b	5.22b	20.21b	21.47b	1.044b	6.67b	13.44b
With KH			27.80a	5.48c	21.17a	22.46a	1.055a	7.11a	14.15a
LSD at 5%			0.21	0.03	0.11	0.04	0.003	0.05	0.05
Sub sub main factor: Potassium Mineral Sources (PMS)									
K_1: Potassium nitrate			27.76a	5.44a	21.06a	22.27a	1.054a	7.04a	14.17a
K_2: Potassium citrate			27.45ab	5.38b	20.83b	22.10b	1.051b	6.96b	13.86b
K_3:Potassium silicate			27.16bc	5.33c	20.58c	21.94c	1.048c	6.84c	13.64c
K_4: Control (Without PMS)			26.89c	5.26d	20.29d	21.54d	1.045d	6.72d	13.51d
LSD at 5%			0.35	0.05	0.13	0.08	0.002	0.04	0.05
Interaction									
Without BRC	Without KH	K_1	26.10hij	5.05h	19.49ij	20.84k	1.034ij	6.24jk	12.54kl
		K_2	25.84ijk	5.01hi	19.28jk	20.69kl	1.033ij	6.20k	12.47lm
		K_3	25.54jk	4.95ij	19.10k	20.55l	1.032ij	6.17kl	12.43m
		K_4	25.15k	4.87j	19.01k	20.30m	1.030j	6.09l	12.29n
	With KH	K_1	27.06fg	5.35fg	20.43g	21.72gh	1.048g	6.77g	13.37h
		K_2	26.70gh	5.31g	20.40g	21.59h	1.043h	6.66h	13.06i
		K_3	26.46ghi	5.26g	20.00h	21.38i	1.040h	6.39i	12.76j
		K_4	26.28hi	5.10h	19.71i	21.09j	1.036i	6.33ij	12.62k
With BRC	Without KH	K_1	28.51bcd	5.56cd	21.62d	22.65e	1.060cd	7.37c	15.21cd
		K_2	28.04cde	5.48de	21.27e	22.49f	1.056de	7.23d	14.48e
		K_3	27.93de	5.43ef	21.17e	22.40f	1.053ef	7.06e	14.12f
		K_4	27.47ef	5.41ef	20.77f	21.87g	1.051fg	6.95f	13.97g
	With KH	K_1	29.35a	5.79a	22.68a	23.88a	1.074a	7.78a	15.56a
		K_2	29.21ab	5.73ab	22.38b	23.64b	1.070ab	7.74a	15.41b
		K_3	28.69abc	5.69b	22.04c	23.43c	1.067b	7.71a	15.25c
		K_4	28.64bcd	5.64bc	21.67d	22.91d	1.062c	7.50b	15.15d
LSD at 5%			0.71	0.09	0.27	0.16	0.004	0.09	0.10

Means within a row followed by a different letter (s) are statistically different at a 0.05 level

Table 11. Impact of applying banana residues compost to the soil and using potassium humate *via* fertigation, along with the foliar application of diverse potassium sources on tubers quality of potato plants at harvest stage during season of 2022/23

Treatments			**T. Carbohydra-tes %**	**T. Sugars, %**	**Dry matter, %**	**Vitamin C, mg.100g**	**Specific gravity, %**	**TDS, %**	**Protein , %**
Main factor: Banana Residues Compost (BRC) treatments									
Control (Without BRC)			26.64b	5.27b	19.99b	21.66b	1.040b	6.49b	12.84b
With BRC			29.10a	5.77a	22.01a	23.67a	1.064a	7.56a	15.08a
LSD at 5%			0.54	0.09	0.47	0.35	0.001	0.15	0.35
Sub main factor: Potassium Humate (KH) treatments									
Control (Without KH)			27.37b	5.39b	20.53b	22.14b	1.045b	6.80b	13.60b
With KH			28.36a	5.65a	21.47a	23.19a	1.059a	7.25a	14.33a
LSD at 5%			0.36	0.08	0.26	0.23	0.001	0.09	0.09
Sub sub main factor: Potassium Mineral Sources (PMS)									
K_1: Potassium nitrate			28.32a	5.61a	21.39a	22.94a	1.057a	7.18a	14.34a
K_2: Potassium citrate			28.05a	5.55ab	21.16a	22.81ab	1.054ab	7.11ab	14.04b
K_3:Potassium silicate			27.70b	5.50b	20.88ab	22.67b	1.051b	6.97bc	13.80c
K_4: Control (Without PMS)			27.39b	5.41c	20.58b	22.24c	1.046c	6.85c	13.67c
LSD at 5%			0.32	0.06	0.55	0.24	0.004	0.18	0.18
Interaction									
Without BRC	Without KH	K_1	26.55ijk	5.22i	19.84fg	21.45fg	1.038ij	6.36i	12.68gh
		K_2	26.36jk	5.16ij	19.65fg	21.32fgh	1.035jk	6.32i	12.61gh
		K_3	26.07kl	5.10jk	19.49g	21.17gh	1.034jk	6.30i	12.57gh
		K_4	25.54l	5.02k	19.26g	20.91h	1.029k	6.22i	12.47h
	With KH	K_1	27.53fg	5.51fgh	20.74def	22.31d	1.050efg	6.92fgh	13.51e
		K_2	27.24gh	5.46gh	20.69def	22.21de	1.047fgh	6.82gh	13.22ef
		K_3	27.02ghi	5.41h	20.28efg	22.09de	1.044ghi	6.56hi	12.92fg
		K_4	26.80hij	5.24i	19.97efg	21.80ef	1.040hij	6.44i	12.76gh
With BRC	Without KH	K_1	29.20c	5.72cd	21.97abc	23.32bc	1.061cd	7.52bcd	15.38b
		K_2	28.77cd	5.66de	21.59bcd	23.23c	1.057cde	7.40cde	14.70c
		K_3	28.46de	5.63def	21.41bcd	23.16c	1.054def	7.21def	14.26d
		K_4	28.02ef	5.58efg	21.06cde	22.54d	1.051efg	7.08efg	14.12d
	With KH	K_1	30.00a	5.98a	23.00a	24.66a	1.079a	7.93a	15.80a
		K_2	29.85ab	5.92ab	22.71a	24.49a	1.075a	7.89a	15.64ab
		K_3	29.26bc	5.88ab	22.35ab	24.26a	1.072ab	7.82ab	15.44b
		K_4	29.21c	5.81bc	22.02abc	23.72b	1.064bc	7.64abc	15.31b
LSD at 5%			0.63	0.12	1.09	0.49	0.008	0.36	0.35

Means within a row followed by a different letter (s) are statistically different at a 0.05 level

The parameters assessed include the average weight of one tuber (g), No. of tuber plant^{-1} and total tuber yield (Mg ha^{-1})**,** total carbohydrates (%), total sugars (%), dry matter (%),vitamin C (mg 100g^{-1}), specific gravity (%) total dissolved solids (%) and protein (%). These traits are considered essential factors that significantly impact potato plant performance, production, and tuber quality. The information provided in these tables sheds light on how the studied treatments influenced the final tuber yield, the size of individual tubers, and the nutritional quality of the harvested potatoes. These traits are crucial indicators of the overall success of potato cultivation and its potential impact on both agricultural productivity and human nutrition. Understanding the effects of the studied interventions on these factors is fundamental for optimizing potato crop management strategies and achieving desirable yields and tuber quality in sustainable agriculture practices

Individual effect of compost treatments:

The obtained results show that the potato plants cultivated in soil treated with banana residues compost possessed the maximum values of the average weight of one tuber (g), No. of tuber plant^{-1} and total tuber yield (Mg ha^{-1}), total carbohydrates (%), total sugars (%), dry matter (%),vitamin C (mg 100g^{-1}), specific gravity (%) total dissolved solids (%) and protein (%). compared to the corresponding plants which were grown on untreated soil (without banana residues compost). The results indicate that potato plants cultivated in soil treated with banana residues compost exhibited superior performance across multiple parameters. This enhancement in tuber yield can be attributed to several scientific reasons. Firstly, the organic matter and nutrients present in banana residues compost enrich the soil, promoting better root development and nutrient uptake by the plants. This leads to increased tuber formation and size. Secondly, the improved soil structure resulting from compost application enhances water and nutrient retention, creating an optimal environment for tuber growth. Additionally, the higher total carbohydrates, sugars, and dry matter content observed in the compost-treated potatoes suggest enhanced photosynthesis and increased carbohydrate allocation to tuber storage, contributing to overall tuber yield. Moreover, the higher levels of vitamin C, specific gravity, total dissolved solids, and protein in the compost-treated potatoes reflect improved nutritional quality, making them more desirable for human consumption. This consistent trend across both studied seasons confirms the reliability and effectiveness of using banana residues compost for maximizing potato yield and nutritional value. The obtained results are in harmony with those of El-Nour *et al. (*2015); Soliman (2023).

Individual effect of potassium humate treatments:

It was found that the applying potassium humate *via* fertigation led to obtain the maximum values of the average weight of one tuber (g), No. of tuber plant^{-1} and total tuber yield (Mg ha^{-1})**,** total carbohydrates (%), total sugars (%), dry matter (%),vitamin C (mg 100g^{-1}), specific gravity(%) total dissolved solids (%) and protein (%). compared to the control treatment (without potassium humate). The same trend was found during both studied seasons. The results of the study demonstrate that applying potassium humate *via* fertigation resulted in optimizing potato tuber yield and quality. The observed improvement in tuber yield and size can be attributed to scientific reasons such as enhanced nutrient uptake and improved photosynthetic activity. Potassium humate acts as a chelating agent, making essential nutrients more readily available to the plants. This improved nutrient availability contributes to better tuber formation and size. Additionally, the enhanced photosynthetic activity resulting from potassium humate application may have led to increased carbohydrate allocation to tuber storage, reflected in higher total carbohydrates, sugars, and dry matter content in the treated potatoes. Moreover, the higher levels of vitamin C, specific gravity, total dissolved solids, and protein in the potassium humate-treated potatoes indicate improved nutritional quality and overall desirability. These findings highlight the significant role of potassium humate in optimizing potato tuber yield and nutritional attributes, making it a valuable addition to enhance potato cultivation practices. Similar results were reported by Mahdi *et al.* (2021); Mohammed *et al.* (2021).

Individual effect of mineral potassium sources:

The findings indicate that potato plants sprayed with potassium nitrate had the highest values of the average weight of one tuber (g), No. of tuber plant^{-1} and total tuber yield (Mg ha^{-1})**,** total carbohydrates (%), total sugars (%), dry matter (%),vitamin C (mg 100g^{-1}), specific gravity(%) total dissolved solids (%) and protein (%).followed by potassium citrate then potassium silicate and lately the control group which had the lowest values. The same trend was found during both studied seasons. The observed results highlight that potato plants sprayed with potassium nitrate demonstrated the most favorable outcomes in various crucial parameters related to tuber yield and quality. This can be attributed to the scientific reasons related to potassium's essential role in promoting tuber growth and development, as discussed earlier. Potassium is vital for tuber formation, carbohydrate allocation, and nutrient uptake, leading to increased tuber yield and size. Additionally, the higher levels of total carbohydrates, sugars, dry matter, vitamin C, specific gravity, total dissolved solids, and protein in the potassium nitrate-treated potatoes indicate improved nutritional quality and overall desirability for consumption. Following potassium nitrate, the potassium citrate and potassium silicate treatments showed relatively favorable results, suggesting their potential as effective alternative potassium sources. However, the control group, without any potassium application, exhibited the least favorable results, emphasizing the crucial role of potassium fertilization in optimizing potato tuber yield and quality. These findings underscore the significance of potassium, particularly from potassium nitrate, in enhancing potato crop performance and nutritional attributes, making it a key consideration for potato cultivation practices. EL-Sherpiny *et al.* (2022) also reported similar findings.

Interaction effect:

Regarding interaction effect, the combination of the best treatments specific to each studied factor (banana residues compost x potassium humate x potassium nitrate) recorded the highest values of the average weight of one tuber (g), No. of tuber plant^{-1} and total tuber yield (Mg ha^{-1})**,** total carbohydrates (%), total sugars (%), dry matter

(%),vitamin C (mg $100g^{-1}$), specific gravity(%) total dissolved solids (%) and protein (%). of potato plants during both studied seasons. Whilst, the combination of the fewer treatments specific to each studied factor (control) realized the lowest values of all aforementioned traits. The same trend was found during both studied seasons.

CONCLUSION

In conclusion, this research reaffirms the crucial role of potassium as a sizing agent for potato tubers and highlights the importance of effective fertilization practices to achieve optimal yields. The obtained results clearly demonstrated that soil treated with banana residues compost significantly enhanced the growth performance of potato plants, leading to improve quantitative and qualitative yields. Additionally, the application of potassium humate *via* fertigation further optimized potato yield and quality. Among the diverse potassium sources, potassium nitrate emerged as the most effective foliar application treatment. Overall, the most successful intervention involved the combination of applying banana residues compost with potassium humate treatment and subsequent spraying of potassium nitrate. This combined approach resulted in substantial improvements in the growth performance and both quantitative and qualitative yield of potato plants compared to other interventions.

Recommendations:

Based on the findings of this study, the following recommendations are proposed:

1. Farmers and agricultural practitioners should consider incorporating banana residues compost into the soil as an effective means of enhancing potato crop growth and productivity. The compost's organic matter and nutrient content can significantly contribute to soil fertility and nutrient availability.
2. The use of potassium humate *via* fertigation should be adopted as a valuable practice to further optimize potato yield and quality. Fertigation allows for efficient nutrient delivery to the plants, ensuring better nutrient uptake and utilization.
3. When selecting potassium sources for foliar application, potassium nitrate is recommended due to its superior performance in promoting potato growth and yield. However, additional research may be beneficial to explore specific dosages and application timings for different stages of potato growth.
4. Continual research and field trials are encouraged to explore other organic and bio-based additives that could complement potassium fertilization and enhance potato crop performance even further.
5. It is essential for farmers and researchers to collaborate in monitoring and evaluating the long-term effects of these practices on soil health, plant performance, and overall agricultural sustainability.

By implementing these recommendations, farmers can optimize their potato cultivation practices, achieve higher yields, and contribute to the overall food security and economic stability of the region. Moreover, such sustainable agricultural practices will pave the way for a more resilient and prosperous potato production sector in the future.

REFERENCES

Abd El-Hady, M. A. M., Doklega, S. M. A., & El-Ezz, S. A. (2021). Influence of organic and potassium fertilization on potato yield and quality. Plant Archives, 21(Supplement 1): 560-568.

Abd El-Nabi, H., El-Shal, Z. S. A., Doklega, S., & Abdel Razek, M. E. A. (2022). Effect of water deficit, organic fertilization and some soil additions on potato productivity. J. of Plant Production, 13(8): 611-619.

Abd-Elgawad, M. M. (2020). Biological control agents in the integrated nematode management of potato in Egypt. Egyptian J. of Biological Pest Control, 30(1): 1-13.

Ali, M. M., Petropoulos, S. A., Selim, D. A. F. H., Elbagory, M., Othman, M. M., Omara, A. E. D., & Mohamed, M. H. (2021). Plant growth, yield and quality of potato crop in relation to potassium fertilization. Agronomy, 11(4), 675.

AOAC, (2000).˝ Official Methods of Analysis‶. 18th Ed. Association of Official Analytical Chemists, Inc., Gaithersburg, MD, Method 04.

Chen, Y., Wang, W., Zhou, D., Cai, B., Zhang, M., Qi, D., ... & Xie, J. (2021). Acetobacter orientalis XJC-C with a high lignocellulosic biomass-degrading ability improves significantly composting efficiency of banana residues by increasing metabolic activity and functional diversity of bacterial community . Bioresource Technology, 324, 124661.

Duncan, D.B. (1955). Multiple rang and multiple F test. Biometrics, 11: 1-42.

El-Afifi, S. T., Zaghloul, M. M., Saif Eldeen, U. M., & Mosaad, F. S. (2016). Effect of some natural potassium fertilizer sources on growth, productivity and quality of sweet potato (*Ipomoea batatas* L.). J. of Plant Production, 7(8): 869-875.

El-Hadidi, E., Ewais, M., & Shehata, A. (2017). Fertilization effects on potato yield and quality. J. of Soil Sciences and Agricultural Engineering, 8(12): 769-778.

El-Hammady, A. M., Abo–Hadid, A. F., Selim, S. M., El–Kassas, H. I., & Negm, R. (2003). Production of compost from rice straw using different accelerating amendments. J. of Environment and Science. Ain Shams University, 6(3): 112-116.

El-Nour, M. E., Elfadil, A. G., Manal, F. A., & Saeed, B. A. (2015). Effects of banana compost on growth, development and productivity of sorghum bicolor cultivar (Tabat). Adv. Biol, 8(2).

EL-Sherpiny, M. A., Kany, M. A., & Ibrahim, N. R. (2022). Improvement of performance and yield quality of potato plant via foliar application of different boron rates and different potassium sources. Asian J. of Plant and Soil Sciences: 294-304.

Ewais, M. A., Abd El-Rahman, L. A., & Sayed, D. A. (2020). Effect of foliar application of boron and potassium sources on yield and quality of potato (*Solanum tuberosum* L.). Middle East J. of Applied Sciences, 10(1): 120-137.

Ghinea, C., Apostol, L. C., Prisacaru, A. E., & Leahu, A. (2019). Development of a model for food waste composting. Environmental Science and Pollution Research, 26: 4056-4069.

Gomez, K. A. and Gomez, A. A. (1984). "Statistical procedures for agricultural research". John Wiley and Sons, Inc., New York.pp:680.

Hamaiel, A. F., Abd El-Hady, M. A. M., & Othman, A. A. (2021). Influence of tuber soaking times with some nutrients on potato growth and productivity. Plant Archives, 21(Supplement 1): 2513-2518.

Idrees, M. U. H. A. M. M. A. D., Anjum, M. A., Mirza, J. I., Ahmad, I., & Munir, T. M. (2020). Potassium humate amendment regulates soil NPK supply and growth parameters of potato (*Solanum tuberosum* L.) in a calcareous soil. *Pak. J. Bot.*, *52*(5): 1647-1653.

Javanshah, A., & Saidi, A. (2016). Determination of humic acid by spectrophotometric analysis in the soils. *Int. J. Adv. Biotechnol. Res.*, *7*: 19-23.

Jones, J. (2018). Soil analysis handbook of reference methods. CRC press.

Kalra, Y. (Ed.). (1997). Handbook of reference methods for plant analysis. CRC press.

Koch, M., Naumann, M., Pawelzik, E., Gransee, A., & Thiel, H. (2020). The importance of nutrient management for potato production Part I: Plant nutrition and yield. Potato research, 63(1): 97-119.

Mahdi, A. H., Badawy, S. A., Abdel Latef, A. A. H., El Hosary, A. A., Abd El Razek, U. A., & Taha, R. S. (2021). Integrated effects of potassium humate and planting density on growth, physiological traits and yield of *Vicia faba* L. grown in newly reclaimed soil. Agronomy, 11(3), 461.

Mikkelsen, R. L., & Roberts, T. L. (2021). Inputs: potassium sources for agricultural systems. Improving potassium recommendations for agricultural crops, 47-74.

Mohammed, M. H., Abd-Alrahman, H. A., Abdel-Kader, H. H., & Aboud, F. S. (2021). Effect of potassium humate and levels of potassium fertilization on growth, yield and nutritional status of tomato plants. J. Hort. Sci. & Ornam. Plants, 13(2): 124-133.

Moustafa, M. S. (2020). Effect of irrigation intervals and potassium humate on sugar beet productivity. J. of Plant Production, *11*(12): 1239-1243.

Peterburgski, A. V. (1968). "Hand Book of Agronomic Chemistry". Kolas Publishing House Moscow, (in Russian).

Soliman, M. A. (2023). Response of potato plant grown on sandy soil to banana residues and rice straw composts with external application of boron and molybdenum. Asian J. of Plant and Soil Sciences, 9-20.

Soliman, M. A., El-Sherpiny, M. A., & Khadra, A. B. (2022). Improvement of performance and productivity of potato plants via addition of different organic manures and inorganic potassium sources. Asian J. of Plant and Soil Sciences, 331-341.

Tandon, H. L. S. (2005). Methods of analysis of soils, plants, waters, fertilizers & organic manures. Fertilizer Development and Consultation Organization.

Torabian, S., Farhangi-Abriz, S., Qin, R., Noulas, C., Sathuvalli, V., Charlton, B., & Loka, D. A. (2021). Potassium: A vital macronutrient in potato production—A review. Agronomy, 11(3), 543.

تحسين إنتاجية وجودة البطاطس بواسطة مصادر البوتاسيوم العضوية والمعدنية

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الملخص

من المعروف أن البوتاسيوم يلعب دورًا حيويًا كعامل تحجيم لدرنات البطاطس. لذلك، تم إجراء هذا البحث لتقييم تأثير معاملات مختلفة على البطاطس، بهدف تحسين ممارسات التسميد البوتاسي وزيادة المحصول. ركزت الدراسة على تقييم إضافة سماد مكمورة بقايا الموز الي التربة كعامل رئيسي (تم إضافته أو لم يتم)، واضافة هيومات البوتاسيوم عبر الري بالتنقيط كعامل منشق (تم إضافته أو لم يتم)، والرش الورقي لمصادر بوتاسيوم معدنية كعامل منشق ثاني (نترات البوتاسيوم، سترات البوتاسيوم، سيليكات البوتاسيوم، ومجموعة الكنترول) على أداء نمو البطاطس وجودة المحصول خلال موسمين متعاقبين (22/2021و23/2022). أظهرت نباتات البطاطس التي تم زراعتها في التربة المعاملة بسماد مكمورة بقايا الموز أداء نمو متطوراً، معبرا عنه بزيادة الأوزان الطازجة والجافة، بالإضافة إلى تحسن المحصول الكمي والنوعي لها بالمقارنة مع النباتات التي تم زراعتها في التربة الغير معاملة (بدون تسميد عضوي). علاوة على ذلك، أدى تطبيق هيومات البوتاسيوم عبر الري بالتنقيط إلى زيادة المحصول وجودة البطاطس مقارنة بالنباتات التي تم زراعتها بدون هيومات البوتاسيوم. فيما يتعلق بالرش الورقي لمصادر البوتاسيوم المعدنية، فوجد أن صورة نترات البوتاسيوم كانت الأكثر فاعلية، تليها سترات البوتاسيوم ثم سيليكات البوتاسيوم، بينما كانت مجموعة الكنترول الأقل تأثيراً. بشكل عام، أثبت التفاعل بين مكمورة بقايا الموز بالإضافة إلى هيومات البوتاسيوم وبعد ذلك رش نترات البوتاسيوم أنه التداخل الأكثر نجاحًا، مما أدى إلى تحسن كبير في أداء النمو والمحصول الكمي والنوعي لنباتات البطاطس مقارنة بالتداخلات الأخرى.