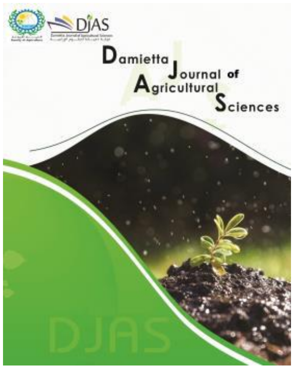
DJAS., Vol. (4) (III) Special Issue: (45-55) (2025) 10.21608/djas.2025.452635

Damietta Journal of Agricultural Sciences
https://djas.journals.ekb.eg
1st Damietta Conference for Horticulture
Sustainable Development for Horticultural crops in Light of Climate Changes
ISSN: 2812-5347(Print)- 2812-5355 (Online)

Sweet potato as a promising strategic crop in Egypt: Effect of different organic fertilizers and boron on sweet potato under decreasing levels of potassium fertilization

Ali F. A. Hamaeil; Mahmoud A.M. Abd El-Hady and Asmaa Ibrahim El-Ghareeb
Horticulture Department, Faculty of Agriculture, Damietta University, Egypt.



ABSTRACT

Sweet potato is a strategic crop in Egypt, with cultivation expanding continuously to face the domestic and export market demands. This expansion needs the development of optimized fertilization programs to maximize its productivity and quality. Therefore, a field trial was implemented during the 2024 growing season to evaluate the effect of different organic fertilizers (control, chicken manure ChM, and compost, each applied at 12.0 tons ha^{-1}) and boron supplementation (applied as boric acid at 80 mg L^{-1} or not applied) on sweet potato (cv. Balady) grown under decreasing levels of mineral potassium fertilization (100, 75, and 50% of recommended potassium dose KRD). Growth criteria such as plant height, fresh and dry weights as well as total chlorophyll content and NPK concentrations were assessed after 100 days from transplanting. Additionally, tuber yield and its components, such as average root weight and length, and total tuber yield as well as quality traits (e.g., carbohydrate, starch content, total sugar, vitamin C), were evaluated after 140 days from transplanting. The compost outperformed the ChM treatment, as both organic fertilizers significantly improved growth performance and yield attributes compared to the control. The obtained results also show that the highest values of growth performance and tuber yield attributes were realized with 100% of KRD, and the values decreased as the KRD decreased. Moreover, plants treated with boron element exhibited superior growth performance and yield attributes compared to those without boron. Notably, plants grown under 75% KRD, in combination with organic fertilizers (either ChM or compost) and boron, demonstrated growth performance and tuber yield better than those cultivated under the 100% KRD without both organic fertilizers and boron application. This suggests that partial substitution of mineral potassium with organic amendments and boron can optimize nutrient efficiency and sustain productivity.

Keywords: *ChM, compost, boron, potassium fertilization*

INTRODUCTION

Sweet potatoes (*Ipomoea batatas* L) are a high-value crop in many countries around the world, including Egypt **(Abdel-Naby *et al*., 2018)**, where they play a pivotal role in food security, nutrition, and export markets. Recently, sweet potatoes have been proposed in Egypt as a partial substitute for wheat in bread making **(Elhassaneen *et al*., 2024)**. Their rich carbohydrate, vitamin, and antioxidant content make them a staple food, and their adaptability to diverse environmental conditions supports their widespread cultivation **(Sharaf-Eldin *et al*., 2019)**.

To maximize their yield and quality, proper nutrient management is essential, with potassium (K) being one of the most important elements for optimal growth and tuber development. Potassium plays a vital role in enhancing photosynthesis, activating enzymes, and regulating water in plants **(Liu *et al*., 2017)**. In root and tuber crops such as sweet potatoes, potassium significantly influences tuber formation, starch accumulation, and overall yield **(Liu *et al*., 2024; Shu *et al*., 2024)**. However, potassium fertilizers are often expensive and unavailable in the Egyptian market, leading to a growing need for alternative sources **(Ciceri & Allanore, 2019)**.

An effective strategy for reducing reliance on mineral potassium fertilizers is to incorporate organic fertilizers, which can improve soil fertility and provide nutrients. Chicken manure (ChM) is a nutrient-rich organic fertilizer that provides essential macronutrients, such as nitrogen, phosphorus, and potassium, making it a suitable alternative to synthetic fertilizers **(Agbede and Oyewumi, 2022)**. The fertilizers enhances soil microbial activity, improves water retention, and increases nutrient efficiency **(Abukari *et al*., 2024)**. The slow-release nature of chicken manure ensures a consistent supply of nutrients, such as potassium, to plants, potentially enhancing root growth and tuber formation in sweet potato crops **(Hadiro and Arifin, 2025)**.

Compost is another valuable organic amendment that improves soil structure, water-holding capacity, and the availability of nutrients, such as nitrogen, phosphorus, and potassium **(Navarro *et al*., 2020)**. It enhances soil organic matter content, supports beneficial microbial communities, and contributes to the gradual release of essential nutrients, including potassium. Compared to chicken manure, organic fertilizer has a more stable and balanced nutritional composition, reducing the risk of nutrient leaching and ensuring long-term soil fertility **Bardisi (2025)**.

Boron (B) is an essential micronutrient for plant growth, particularly for cell wall formation, sugar transport, and root development. In tuber crops, boron plays a crucial role in increasing tuber size, improving carbohydrate translocation, and reducing physiological disorders such as cracking and hollowing **(Sharaf-Eldin *et al*., 2019)**. Boron deficiency can lead to poor tuber quality and reduced market value. Foliar application of boron has been found to be an effective method for ensuring its availability to plants **(Sarkar *et al*., 2024)**.

Given the importance of potassium in sweet potato production and its limited availability in the Egyptian market, this study aims to investigate the potential use of organic fertilizers (chicken manure and compost) as partial alternatives to mineral potassium fertilization. Additionally, the study evaluates the effect of boron supplementation on plant growth, tuber yield, and quality. By exploring these sustainable fertilization strategies, this research seeks to develop an effective nutrient management program that enhances productivity while reducing reliance on expensive mineral fertilizers.

MATERIALS AND METHODS

A field experiment was carried out during the summer growing season of 2024 in kafr Saad District, Damietta governorate, Egypt under a split split-plot experimental design with three replicates to evaluate the effect of different organic fertilizers (control, chicken manure ChM, and compost, each applied at 12.0 tons ha^{-1}) and boron supplementation (applied as boric acid at 80 mg L^{-1} or not applied) on sweet potato (cv. Balady) grown under decreasing levels of mineral potassium fertilization (100, 75, and 50% of recommended potassium dose KRD). The main plots were assigned to organic fertilizer treatments, while the sub-plots were allocated to potassium fertilization levels. The sub-sub plots were designated for boron applications.

Sweet potato transplants were cultivated in the nursery under irrigation circumstances and transplanted to the field on 29th of April. The transplants length were approximately 25 cm, as they were cultivated on ridges measuring 10 m in length and 0.8 m in width, with an effective plot area of 8.0 m². The space between transplants was approximately 25 cm. Organic fertilizers were applied before one month from transplanting. Urea (46%N) and calcium superphosphate (7% P) were added as sources of NP at rates of 40 and 45 kg fed^{-1} for N and P_2O_5, respectively. Potassium sulphate (48% K_2O) was added according to the studied treatments, with 100% KRD corresponding to 60 kg K_2O fed^{-1}, 75% KRD corresponding to 45 kg K_2O fed^{-1}, 50% KRD corresponding to 30 kg K_2O fed^{-1} two times after 30 days of the transplanting and three weeks later. Boron solution was prepared from boric acid and applied according to the studied treatments at 40, 60 and 80 days after transplanting. Other traditional agricultural practices such as hilling weeds, pest and diseases control were done.

Before planting, the physical and chemical properties of the soil sample from the experimental site were analyzed according to **Dewis and Freitas (1970)**, as their properties are shown in Table 1. The banana compost was obtained from commercial Egyptian market, while ChM was obtained from private poultry farm. The chemical composition of both organic fertilizers are shown in Table 2. The harvest occurred on 20th September, 2024. Table 3 illustrates the measurements at two stages using six randomly selected sweet potato plants for each treatment. The obtained findings were statistically analyzed via ANOVA at the least significant difference (LSD) test at a 5% significance level, additionally; Duncan's letters were used **(Gomez and Gomez, 1984)**.

RESULTS AND DISCUSSION

Growth criteria at 100 days after transplanting

Tables 4 and 5 illustrate the effects of organic fertilizers, levels of potassium recommended dose KRD, and boron supplementation on the growth parameters of sweet potato plants after 100 days from transplanting. The findings reveal significant differences among treatments, highlighting the critical role of organic amendments, mineral potassium, and boron in enhancing sweet potato growth. Effect of organic fertilization: Organic fertilization with chicken manure and compost significantly improved all growth criteria compared to the control (Table 4). Compost application resulted in the highest values for plant height (177.38 cm), fresh weight (785.77 g $plant^{-1}$), and dry weight (146.21 g $plant^{-1}$), followed closely by chicken manure.

Table 1. Attributes of the initial soil

Available nitrogen, mg kg^{-1}	Available phosphorus, mg kg^{-1}	Available potassium, mg kg^{-1}	Available boron, mg kg^{-1}	O.M,%	pH	EC, dSm^{-1}
39.8	7.13	300	0.56	1.30	7.9	2.75

Table 2. Traits of organic fertilizers, as analysis was implemented according to **Tandon (2005)**

Characteristics	Values	
	ChM	Compost
K, g kg^{-1}	7.5	16.03
P , mg kg^{-1}	0.78	0.92
Zn , mg kg^{-1}	19.6	21.0
Mn, mg kg^{-1}	21.1	21.9
O.M,%	30.6	35.0
Total N, %	1.56	1.70
EC,dSm^{-1}	4.38	4.10
pH	6.35	6.30

Table 3. Methods, formula and references of measurements

Measurements		Methods and formula	References
After 100 days from transplanting			
Growth traits	1. Plant height 2. plant fresh and dry weights 3. leaf area 4. No. of branches 5. No. of leaves	Visually and manually	----------------
Photosyn-thetic	Chlorophyll (total Chl.)	Using 80% acetone *via* spectro-photometrically	**Ritchie, (2008)**
Digesting the sweet potato leaves	Digesting process was done by mixed of H_2SO_4 & $HClO_4$		**Peterburgski, (1968)**
Leaves chemical constitutes	N P K (%) and B (mg kg^{-1})	☒ Micro-Kjeldahl apparatus (for N) ☒ Spectrophotometric apparatus (Olsen method for P) ☒ Flame photometer apparatus (for K) ☒ Hot water method (for B)	**Tandon, (2005)**
After 140 days from transplanting			
Yield and its components	1. Average root weight 2. Root length 3. Root diameter 4. root shape (length/diameter) 5. Total tuber roots yield	Manually and visually	----------------
Quality parameters	1. Starch 2. Total sugar 3. Vitamin C 4. Beta carotene		**A.O.A.C (2007)**

The same trend was found for No. of branches plant^{-1}, No. of leaves plant^{-1} and leaf area, cm^2 plant^{-1}. This enhancement can be attributed to the rich nutrient content of organic fertilizers, particularly their contribution to soil organic matter, which improves soil structure, water retention, and microbial activity **(Navarro *et al.*, 2020).** Additionally, organic amendments enhance the availability of essential macronutrients, including nitrogen, phosphorus, and potassium, promoting vigorous vegetative growth (**Agbede and Oyewumi, 2022).**

Effect of potassium fertilization: Decreasing potassium levels negatively affected plant growth (Table 4). For example, 100% of KRD treatment produced the highest value of plant height (182.74 cm) and leaf number (167.50 plant^{-1}), while reducing potassium to 50% KRD significantly decreased these values (155.54 cm plant height and 116.11 leaves plant^{-1}). This reduction is expected, as potassium plays a fundamental role in enzyme activation, osmoregulation, and photosynthesis efficiency **(Liu *et al.*, 2017)**. The significant decline in plant dry weight at lower potassium levels suggests a restricted translocation of assimilates to growing tissues, reducing overall biomass accumulation.

Effect of boron supplementation: Foliar application of boron at 80 mg L^{-1} resulted in significant improvements (Table 4) in plant height (173.63 cm), plant fresh weight (761.72 g plant^{-1}), dry weight (142.06 g plant^{-1}), branch number (16.96), leaf number (147.66 plant^{-1}), and leaf area (456.66 cm^2 plant^{-1}) compared to the control (171.23 cm, 754.71 g plant^{-1}, 138.34 g plant^{-1}, 16.07, 140.92, and 447.00 cm^2 plant^{-1}, respectively). Boron is essential for cell wall formation, carbohydrate metabolism, and hormonal balance in plants (**Sarkar *et al.*, 2024**). The increased leaf area in boron-treated plants suggests an improved photosynthetic capacity, which directly contributes to enhanced biomass production.

Interaction effects: The interaction between organic fertilizers, potassium levels, and boron supplementation (Table 5) shows that the best growth parameters were recorded under compost or chicken manure combined with 100% KRD and boron application. The highest plant height (189.91 cm) and leaf area (530.00 cm^2 plant^{-1}) were observed with compost, 100% KRD, and boron supplementation. Notably, plants grown under 75% KRD, in combination with organic fertilizers (either ChM or compost) and boron, demonstrated growth performance better than those cultivated under the 100% KRD without both organic fertilizers and boron application. In other words, this synergistic effect suggests that organic fertilizers enhance potassium use efficiency, reducing dependence on mineral potassium while ensuring optimal plant growth. Furthermore, boron application under reduced potassium levels (75% KRD) mitigated growth declines, indicating its role in improving nutrient uptake and metabolic stability under suboptimal potassium conditions. The obtained results are in harmony with those of (**Sharaf-Eldin *et al.*, 2019; Bardisi, 2025).**

Leaves chemical constituents and photosynthetic pigment at 100 days after transplanting

Table 6 illustrates the individual effects of different organic fertilizers, different levels of mineral potassium fertilization and boron supplementation on leaves chemical constituents and photosynthetic pigments of sweet potato, while Table 7 shows the interaction effect of the same treatments on the same traits.

Effect of organic fertilization: Organic fertilization had a significant influence on leaf nutrient content and total chlorophyll level. Compost application resulted in the highest values of nitrogen (3.22%), phosphorus (0.378%), potassium (2.97%), boron (34.37 mg kg^{-1}), and total chlorophyll (1.320 mg g^{-1}). Chicken manure ranked second, followed by the control treatment, which recorded the lowest values for all measured parameters. These results indicate that compost is the most effective organic amendment for enhancing leaf nutrient status and photosynthetic efficiency in sweet potato.

Effect of mineral potassium fertilization: The level of mineral potassium fertilization significantly influenced leaf nutrient content and total chlorophyll level. The highest values were obtained at 100% of the recommended potassium dose (KRD), where nitrogen, phosphorus, and potassium concentrations reached 3.34%, 0.390%, and 3.14%, respectively. Additionally, boron content (35.29 mg kg^{-1}) and total chlorophyll (1.392 mg g^{-1}) were highest under this treatment. A reduction to 75% of KRD slightly decreased these values, while the 50% KRD treatment resulted in the lowest nutrient concentrations and photosynthetic pigment content. These findings suggest that a higher potassium supply is essential for maintaining optimal leaf nutrient levels and photosynthetic performance in sweet potato.

Effect of boron supplementation: Foliar application of boron at 80 mg L^{-1} significantly improved leaf nutrient composition and chlorophyll content compared to the control (tap water). Boron-treated plants exhibited higher nitrogen (3.16%), phosphorus (0.368%), potassium (2.92%), boron (39.41 mg kg^{-1}), and total chlorophyll (1.265 mg g^{-1}) levels than untreated plants. These results indicate that boron plays a crucial role in enhancing nutrient uptake and photosynthetic efficiency in sweet potato.

Interaction effects: The combined effects of organic fertilization, mineral potassium application, and boron supplementation showed significant interactions for all measured parameters. The highest values for leaf nutrient content and total chlorophyll were observed in compost-treated plants receiving 100% KRD along with boron foliar application, where nitrogen, phosphorus, and potassium concentrations reached 3.51%, 0.413%, and 3.27%, respectively. Boron concentration and total chlorophyll were also maximized under this combination at 40.79 mg kg^{-1} and 1.518 mg g^{-1}, respectively. In contrast, the lowest values were recorded in control plants receiving 50% KRD without boron supplementation.

Notably, plants grown under 75% KRD, in combination with organic fertilizers (either ChM or compost) and boron, demonstrated leaf chemical composition and photosynthetic pigment content in sweet potato better than those cultivated under the 100% KRD without both organic fertilizers and boron application. The obtained results are in accordance with those of **Liu *et al*. (2017); Sharaf-Eldin *et al.* (2019); Liu *et al*. (2024); Shu *et al*. (2024), Hadiro and Arifin (2025).**

Tuber yield and its components at harvest stage (140 days from transplanting)

The tuber yield and its components were significantly affected by different organic fertilizers, varying levels of mineral potassium fertilization, and boron supplementation. The individual effects of these treatments are presented in Table 8, while Table 8 highlights their interaction effects.

Effect of organic fertilization: Organic fertilization played a crucial role in enhancing tuber yield and its components. Compost application resulted in the highest values for root length (20.25 cm), root diameter (5.21 cm), and total tuber yield (12.88 tons fed^{-1}). Chicken manure ranked second, with values slightly lower than compost but significantly higher than the control treatment, which recorded the lowest values in all measured parameters. The increase in tuber yield with compost and chicken manure applications can be attributed to improved soil fertility, enhanced nutrient availability, and better root development.

Effect of mineral potassium fertilization: The level of potassium fertilization significantly affected tuber yield and its components. The highest values were observed at 100% of the recommended potassium dose (KRD), where root length, root diameter, and average root weight reached 21.24 cm, 5.58 cm, and 183.23 g, respectively. This treatment also recorded the highest total tuber yield (13.40 tons fed^{-1}). Reducing the potassium dose to 75% resulted in slightly lower values, while the 50% KRD treatment recorded the lowest values across all measured parameters. These findings indicate that an adequate potassium supply is essential for optimizing tuber yield and quality in sweet potato.

Effect of boron supplementation: Foliar application of boron at 80 mg L^{-1} significantly improved tuber yield and its components compared to the control treatment (tap water). Boron-treated plants exhibited higher root length (19.99 cm), root diameter (5.03 cm), and average root weight (165.65g) than untreated plants. Additionally, boron supplementation increased total tuber yield to 12.35 tons fed^{-1}, compared to 11.99 tons fed^{-1} in the control treatment. These results highlight the vital role of boron in enhancing nutrient uptake, cell division, and root elongation, leading to improved tuber yield.

Interaction effects: The interaction between organic fertilization, mineral potassium application, and boron supplementation significantly influenced tuber yield and its components (Table 9). The highest values were observed in compost-treated plants receiving 100% KRD combined with boron foliar application, where root length, root diameter, and average root weight reached 22.55 cm, 6.20 cm, and 207.63 g, respectively. This combination also resulted in the highest total tuber yield (14.75 tons fed^{-1}). Notably, sweet potato plants grown with 75% KRD, supplemented with organic fertilizers (either ChM or compost) and boron, exhibited higher yield and improved yield components compared to those cultivated with 100% KRD without organic fertilizers and boron application. These findings align with those of **Liu *et al*. (2017); Sharaf-Eldin *et al.* (2019); Liu *et al*. (2024); Shu *et al*. (2024), Hadiro and Arifin (2025).**

Tuber quality at harvest stage (140 days from transplanting)

Table 10 illustrates the individual effects of different organic fertilizers, different levels of mineral potassium fertilization and boron supplementation on tuber quality traits, while Table 11 shows the interaction effect of the same treatments on the same traits.

Effect of organic fertilization: The results indicate that applying organic fertilizers whether chicken manure or compost, significantly improved tuber quality compared to the control treatment. Starch content, total sugar, vitamin C, and beta-carotene levels were all higher in plants treated with organic fertilizers, with the superiority of compost treatment. Organic fertilizers enhance soil fertility by increasing organic matter and microbial activity, leading to better nutrient availability, particularly potassium, which plays a crucial role in starch and sugar accumulation

(Navarro *et al.*, 2020; Agbede and Oyewumi, 2022). Additionally, compost and chicken manure improve soil structure, facilitating root development and nutrient uptake, which translates into higher vitamin and beta-carotene content in the tubers (**Abukari *et al*., 2024; Bardisi, 2025; Hadiro and Arifin, 2025).**

Effect of mineral potassium fertilization: Increasing potassium fertilization to 100% of the recommended dose (KRD) resulted in the highest values for starch, sugars, vitamin C, and beta-carotene, while reducing potassium application to 50% of KRD significantly lowered these parameters. These results may be attributed to the vital role of potassium in higher plants, as it is a key nutrient in carbohydrate synthesis and enzyme activation, essential for photosynthesis and the translocation of sugars into tubers. A potassium deficiency limits the transport of assimilates, reducing starch accumulation and overall tuber quality, which explains the significant drop in quality traits at 50% of KRD **(Liu *et al*., 2017; Liu *et al*., 2024; Shu *et al*., 2024).**

Effect of foliar boron application: Foliar application of boron at 80 mg L^{-1} significantly improved all measured parameters compared to the control (tap water) and this may be attributed to that boron plays a crucial role in cell wall formation and sugar transport, which explains the increase in total sugar content in boron-treated tubers. Additionally, boron enhances calcium uptake and transport, improving vitamin C and beta-carotene synthesis, which contributes to better nutritional quality in sweet potato tubers **(Sharaf-Eldin *et al*., 2019; Sarkar *et al*., 2024).**

Interaction effects: The interaction effects revealed that the best treatment combination for enhancing tuber quality was organic fertilization (chicken manure or compost) + 100% KRD + foliar boron application. This combination led to the highest starch, sugar, vitamin C, and beta-carotene contents.

The synergy between organic and mineral fertilizers ensures an optimal balance of macro- and micronutrients, enhancing nutrient uptake efficiency. Organic matter improves microbial activity, facilitating potassium and boron availability to plants. A full potassium dose (100% KRD) ensures sufficient carbohydrate synthesis and translocation to tubers, leading to better quality attributes. Foliar boron application further enhances metabolic processes, contributing to increased vitamin C and beta-carotene accumulation. Conversely, reducing potassium fertilization to 50% KRD resulted in a significant decline in all quality traits, even when combined with organic fertilizers and foliar boron application. This indicates that potassium plays a fundamental role in improving tuber quality, and reducing its availability directly limits the biochemical processes responsible for starch and sugar accumulation.

On the other hand, it can be noticed that sweet potato plants grown with 75% KRD, supplemented with organic fertilizers (either ChM or compost) and boron, exhibited higher values of quality traits compared to those cultivated with 100% KRD without both organic fertilizers and boron application.

Table 4. Individual effects of different organic fertilizers, different levels of mineral potassium fertilization and boron supplementation on growth criteria of sweet potato

Characters / Treatments	Plant height, cm	Plant fresh weight, g plant^{-1}	Plant dry weight, g plant^{-1}	No. of branches plant^{-1}	No. of leaves plant^{-1}	Leaf area, cm^2 plant^{-1}
A- Organic treatments:						
Control	164.15 b	707.55 b	129.81 b	14.72 b	128.61 b	418.16 b
Chicken manure	175.77 a	781.33 a	144.59 a	17.17 a	150.05 a	465.94 a
Compost	177.38 a	785.77 a	146.21 a	17.67 a	154.22 a	471.38 a
B- Mineral fertilization:						
100 % of KRD	182.74 a	827.26 a	153.49 a	19.06 a	167.50 a	500.61 a
75 % of KRD	179.02 a	811.80 b	145.29 b	17.17 b	149.28 b	472.94 b
50 % of KRD	155.54 b	635.59 c	121.82 c	13.33 c	116.11 c	381.94 c
C- Foliar application treatments:						
Control (Tap water)	171.23 b	754.71 b	138.34 b	16.07 b	140.92 b	447.00 b
Boron (80mg L^{-1})	173.63 a	761.72 a	142.06 a	16.96 a	147.66 a	456.66 a

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

Table 5. Interaction effects of different organic fertilizers, different levels of mineral potassium fertilization and boron supplementation on growth criteria of sweet potato

Organic	Mineral	Foliar	Plant height, cm	Plant fresh weight, g plant^{-1}	Plant dry weight, g plant^{-1}	No. of branches plant^{-1}	No. of leaves plant^{-1}	Leaf area, cm^2 plant^{-1}
Control	100 % of KRD	Control (Tap water)	170.09	754.79	140.35	16.33	142.00	452.66
		Boron (80mg L^{-1})	172.58	758.60	142.97	16.66	147.00	458.33
	75 % of KRD	Control (Tap water)	167.42	741.39	129.65	15.00	128.00	424.00
		Boron (80mg L^{-1})	168.55	747.82	131.70	15.66	133.66	429.66
	50 % of KRD	Control (Tap water)	152.13	618.76	115.84	12.00	109.00	365.33
		Boron (80mg L^{-1})	154.11	623.96	118.35	12.66	112.00	379.00
Chicken manure	100 % of KRD	Control (Tap water)	186.87	857.14	156.08	19.66	171.66	514.00
		Boron (80mg L^{-1})	188.69	863.66	161.44	20.33	180.66	528.00
	75 % of KRD	Control (Tap water)	181.03	839.31	150.59	17.33	153.00	486.66
		Boron (80mg L^{-1})	185.49	847.36	153.17	18.33	160.00	498.00
	50 % of KRD	Control (Tap water)	155.21	638.30	120.73	13.33	114.00	381.33
		Boron (80mg L^{-1})	157.33	642.16	125.50	14.00	121.00	387.66
Compost	100 % of KRD	Control (Tap water)	188.29	861.29	157.38	20.00	177.66	520.66
		Boron (80mg L^{-1})	189.91	868.04	162.73	21.33	186.00	530.00
	75 % of KRD	Control (Tap water)	184.92	839.51	151.45	17.66	156.00	492.00
		Boron (80mg L^{-1})	186.70	855.42	155.20	19.00	165.00	507.33
	50 % of KRD	Control (Tap water)	155.16	641.93	122.99	13.33	117.00	386.33
		Boron (80mg L^{-1})	159.28	648.43	127.50	14.66	123.66	392.00
LSD at 5%			**10.35**	**16.51**	**3.47**	**2.01**	**4.80**	**26.37**

Table 6. Individual effects of different organic fertilizers, different levels of mineral potassium fertilization and boron supplementation on leaves chemical constituents and photosynthetic pigments of sweet potato

Treatments \ Characters	N,%	P,%	K,%	B,mgkg^{-1}	Total chlorophyll, mg g^{-1}
A- Organic treatments:					
Control	2.97 c	.338 c	2.75 c	32.86 b	1.131 c
Chicken manure	3.19 b	.374 b	2.93 b	33.73 a	1.294 b
Compost	3.22 a	.378 a	2.97 a	34.37 a	1.320 a
B- Mineral fertilization:					
100 % of KRD	3.34 a	.390 a	3.14 a	35.29 a	1.392 a
75 % of KRD	3.21 b	.376 b	3.02 b	34.80 b	1.297 b
50 % of KRD	2.83 c	.325 c	2.49 c	30.88 c	1.056 c
C- Foliar application treatments:					
Control (Tap water)	3.10 b	.359 b	2.85 b	27.90 b	1.232 b
Boron (80mg L^{-1})	3.16 a	.368 a	2.92 a	39.41 a	1.265 a

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

Table 7. Interaction effects of different organic fertilizers, different levels of mineral potassium fertilization and boron supplementation on leaves chemical constituents and photosynthetic pigments of sweet potato

Organic	Mineral	Foliar	N,%	P,%	K,%	B,mgkg^{-1}	Total chlorophyll, mg g^{-1}
Control	100 % of KRD	Control (Tap water)	3.10	.354	2.98	28.63	1.207
		Boron (80mg L^{-1})	3.12	.359	3.00	39.96	1.239
	75 % of KRD	Control (Tap water)	3.03	.347	2.84	28.33	1.151
		Boron (80mg L^{-1})	3.06	.350	2.88	39.77	1.178
	50 % of KRD	Control (Tap water)	2.75	.305	2.38	23.06	.998
		Boron (80mg L^{-1})	2.78	.315	2.45	37.44	1.012
Chicken manure	100 % of KRD	Control (Tap water)	3.41	.399	3.17	30.20	1.436
		Boron (80mg L^{-1})	3.48	.409	3.23	40.58	1.490
	75 % of KRD	Control (Tap water)	3.23	.381	3.04	29.99	1.324
		Boron (80mg L^{-1})	3.32	.392	3.11	40.20	1.376
	50 % of KRD	Control (Tap water)	2.80	.322	2.46	23.76	1.046
		Boron (80mg L^{-1})	2.90	.339	2.55	37.65	1.094
Compost	100 % of KRD	Control (Tap water)	3.44	.405	3.22	31.56	1.463
		Boron (80mg L^{-1})	3.51	.413	3.27	40.79	1.518
	75 % of KRD	Control (Tap water)	3.29	.387	3.09	30.11	1.394
		Boron (80mg L^{-1})	3.35	.398	3.14	40.39	1.357
	50 % of KRD	Control (Tap water)	2.85	.328	2.50	25.49	1.068
		Boron (80mg L^{-1})	2.92	.339	2.62	37.89	1.119
LSD at 5%			**0.08**	**0.006**	**0.07**	**0.72**	**0.024**

Table 8. Individual effects of different organic fertilizers, different levels of mineral potassium fertilization and boron supplementation on tuber yield and its components of sweet potato

Treatments / Characters	Root length, cm	Root diameter, cm	Root shape (length/diameter)	Average root weight, g	Total roots yield, ton fed^{-1}
A- Organic treatments:					
Control	18.57 c	4.44 c	4.19 a	147.82 c	11.01 c
Chicken manure	19.97 b	5.09 b	3.96 b	167.80 b	12.62 b
Compost	20.25 a	5.21 a	3.93 b	171.60 a	12.88 a
B- Mineral fertilization:					
100 % of KRD	21.24 a	5.58 a	3.82 c	183.23 a	13.40 a
75 % of KRD	20.25 b	5.17 b	3.92 b	166.73 b	12.53 b
50 % of KRD	17.31 c	3.98 c	4.34 a	137.26 c	10.60 c
C- Foliar application treatments:					
Control (Tap water)	19.21 b	4.79 b	4.04 a	159.16 b	11.99 b
Boron (80mg L^{-1})	19.99 a	5.03 a	4.01 a	165.65 a	12.35 a

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

Table 9. Interaction effects of different organic fertilizers, different levels of mineral potassium fertilization and boron supplementation on tuber yield and its components of sweet potato

Treatments: Organic	Mineral	Foliar	Root length, cm	Root diameter, cm	Root shape (length/diameter)	Average root weight, g	Total tuber roots yield, ton fed^{-1}
Control	100 % of KRD	Control (Tap water)	19.93	4.77	4.18	155.43	11.40
		Boron (80mg L^{-1})	20.13	5.06	3.98	157.10	11.63
	75 % of KRD	Control (Tap water)	19.53	4.64	4.20	154.16	11.11
		Boron (80mg L^{-1})	19.82	4.69	4.22	154.94	11.24
	50 % of KRD	Control (Tap water)	15.45	3.67	4.21	131.31	10.27
		Boron (80mg L^{-1})	16.55	3.81	4.34	134.00	10.46
Chicken manure	100 % of KRD	Control (Tap water)	21.42	5.72	3.74	187.79	13.89
		Boron (80mg L^{-1})	21.96	5.91	3.72	198.40	14.50
	75 % of KRD	Control (Tap water)	20.24	5.25	3.86	165.80	12.75
		Boron (80mg L^{-1})	20.72	5.53	3.74	177.68	13.33
	50 % of KRD	Control (Tap water)	16.98	3.91	4.34	137.35	10.55
		Boron (80mg L^{-1})	18.54	4.20	4.41	139.77	10.75
Compost	100 % of KRD	Control (Tap water)	21.46	5.83	3.68	193.04	14.22
		Boron (80mg L^{-1})	22.55	6.20	3.63	207.63	14.75
	75 % of KRD	Control (Tap water)	20.41	5.34	3.82	168.80	13.08
		Boron (80mg L^{-1})	20.77	5.60	3.71	179.00	13.65
	50 % of KRD	Control (Tap water)	17.44	4.01	4.35	138.79	10.66
		Boron (80mg L^{-1})	18.90	4.29	4.40	142.35	10.90
LSD at 5%			**0.50**	**0.28**	**029**	**3.75**	**0.32**

Table 10. Individual effects of different organic fertilizers, different levels of mineral potassium fertilization and boron supplementation on quality of sweet potato

Treatments / Characters	Starch, %	Total sugar, %	Vitamin C, mg 100g^{-1}	Beta carotene, mg 100g^{-1}
A- Organic treatments:				
Control	18.74 b	9.76 c	19.93 b	7.32 b
Chicken manure	20.11 a	10.75 b	20.99 a	8.01 a
Compost	20.30 a	10.90 a	21.15 a	8.12 a
B- Mineral fertilization:				
100 % of KRD	20.90 a	11.32 a	21.61 a	8.44 a
75 % of KRD	20.32 b	10.80 b	20.92 b	8.08 b
50 % of KRD	17.93 c	9.29 c	19.53 c	6.93 c
C- Foliar application treatments:				
Control (Tap water)	19.55 b	10.33 b	20.53 b	7.72 b
Boron (80mg L^{-1})	19.88 a	10.61 a	20.85 a	7.92 a

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

Table 11. Interaction effects of different organic fertilizers, different levels of mineral potassium fertilization and boron supplementation on tuber quality of sweet potato

Organic	Mineral	Foliar	Starch, %	Total sugar, %	Vitamin C, mg $100g^{-1}$	Beta carotene, mg $100g^{-1}$
Control	100 % of KRD	Control (Tap water)	19.59	10.26	20.29	7.75
		Boron (80mg L^{-1})	19.73	10.43	20.82	7.81
	75 % of KRD	Control (Tap water)	19.14	9.93	19.89	7.49
		Boron (80mg L^{-1})	19.39	10.12	20.09	7.60
	50 % of KRD	Control (Tap water)	17.07	8.85	19.15	6.51
		Boron (80mg L^{-1})	17.53	9.00	19.36	6.78
Chicken manure	100 % of KRD	Control (Tap water)	21.32	11.59	21.93	8.62
		Boron (80mg L^{-1})	21.58	11.89	22.23	8.82
	75 % of KRD	Control (Tap water)	20.59	10.97	21.07	8.19
		Boron (80mg L^{-1})	20.94	11.23	21.52	8.38
	50 % of KRD	Control (Tap water)	17.84	9.19	19.50	6.89
		Boron (80mg L^{-1})	18.40	9.64	19.68	7.20
Compost	100 % of KRD	Control (Tap water)	21.45	11.79	21.94	8.78
		Boron (80mg L^{-1})	21.72	11.96	22.48	8.86
	75 % of KRD	Control (Tap water)	20.74	11.07	21.34	8.24
		Boron (80mg L^{-1})	21.12	11.48	21.63	8.61
	50 % of KRD	Control (Tap water)	18.24	9.36	19.66	6.98
		Boron (80mg L^{-1})	18.53	9.73	19.84	7.23
LSD at 5%			**0.48**	**0.20**	**0.43**	**0.36**

CONCLUSION

The findings of this study highlight the significant role of organic fertilizers and boron supplementation in enhancing the growth performance and tuber yield of sweet potato, particularly under reduced potassium fertilization levels. While the highest productivity was observed with 100% of the recommended potassium dose (KRD), the combination of 75% KRD with organic fertilizers (compost or chicken manure) and boron resulted in comparable or even superior growth and yield attributes. This suggests that partial substitution of mineral potassium with organic amendments and boron can optimize nutrient efficiency and sustain productivity. Therefore, it is recommended to integrate organic fertilizers and boron application into fertilization programs to improve sweet potato yield and quality while reducing reliance on high mineral potassium inputs, promoting sustainable agricultural practices.

FUNDING:

This research did not receive any external funding

CONFLICTS OF INTEREST:

The authors declare no conflict of interest.

AUTHORS CONTRIBUTIONS:

Supervision, conceptualization, methodology and review: Ali F. A. Hamaeil; Mahmoud A.M. Abd El-Hady. Validation and revision: Ali F. A. Hamaeil; Mahmoud A.M. Abd El-Hady. Writing—original draft preparation and editing: Asmaa El-Ghareeb

REFERENCES

A.O.A.C. (2007). ″Official Methods of Analysis. 18th Ed. Association of Official Analytical Chemists″, Inc., Gaithersburg, MD, Method 04.

Abdel-Naby, H. M. E., Fathy, E. L. E., Doklega, S., & Wafa, N. M. (2018). Response of sweet potato plants to mineral and bio-fertilization. Journal of Plant Production, 9(12), 969-974.

Abukari, I. A., Yahaya, I., Carey, E. E., Abidin, P. E., Acheremu, K., Adjebeng-Danquah, J., & Seidu, A. (2024). Effect of chicken manure, compost and cow dung on the growth and yield of sweet potato [*Ipomoea batatas* (L.) Lam.] under Guinea Savannah Agroecological Zone of Ghana. Agricultural Sciences, 15(11), 1271-1289.

Agbede, T. M., & Oyewumi, A. (2022). Benefits of biochar, poultry manure and biochar–poultry manure for improvement of soil properties and sweet potato productivity in degraded tropical agricultural soils. Resources, Environment and Sustainability, 7, 100051.

Bardisi, E. (2025). Productivity and quality of sweet potato roots affected by organic fertilization and some environmentally friendly nutrients. Scientific Journal of Agricultural Sciences, 7(1), 21-39.

Ciceri, D., & Allanore, A. (2019). Local fertilizers to achieve food self-sufficiency in Africa. Science of the total environment, 648, 669-680.

Dewis, J., & Freitas, F. (1970). Physical and chemical methods of soil and water analysis. FAO soils Bulletin, (10).

Elhassaneen, Y. A., Gharib, M. A., & Omara, A. Z. (2024). Enrichment of Egyptian balady bread with nutrients and bioactive compounds through mixing it with sweet potato and cauliflower leaves powder. American Journal of Food Science and Technology, 12(6), 192-206.

Gomez; K. A., & Gomez, A.A (1984). "Statistical Procedures for Agricultural Research". John Wiley and Sons, Inc., New York.pp:680.

Hadiro, W., & Arifin, N. (2025). Growth and yield of sweet potato (*Ipomoea batatas* L.) clone ARF-03 due to application of chicken manure in peat soil. Brazilian Journal of Development, 11(3), e78417-e78417.

Liu, B. K., Xv, B. J., Si, C. C., Shi, W. Q., Ding, G. Z., Tang, L. X., & Liu, H. J. (2024). Effect of potassium fertilization on storage root number, yield, and appearance quality of sweet potato (*Ipomoea batatas* L.). Frontiers in Plant Science, 14, 1298739.

Liu, M., Zhang, A., Chen, X., Jin, R., Li, H., & Tang, Z. (2017). The effect of potassium deficiency on growth and physiology in sweet potato [*Ipomoea batatas* (L.) Lam.] during early growth. Hort Science, 52(7), 1020-1028.

Navarro, J., Salazar, J., Kang, J. J., Parsons, J., Cheng, C. L., Castillo, A., & Pujol Pereira, E. I. (2020). Compost and biochar to promote soil biological activities under sweet potatoes cultivation in a subtropical semiarid region. Applied and Environmental Soil Science, 2020(1), 7230595.

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

Ritchie, R. J. (2008). Universal chlorophyll equations for estimating chlorophylls a, b, c, and d and total chlorophylls in natural assemblages of photosynthetic organisms using acetone, methanol, or ethanol solvents. Photosynthetica, 46, 115-126.

Sarkar, S., Dey, S., Dhar, A., & Banerjee, H. (2024). Boron nutrition in tuber crops: an inclusive insight. International Journal of Vegetable Science, 30(4), 470-496.

Sharaf-Eldin, M. A., AbdAlla, M. A., Mostafa, S. A., & Montaser, W. E. (2019). Boron foliar application in relation to sweet potato productivity. Journal of Plant Production, 10(3), 327-333.

Shu, X., Jin, M., Wang, S., Xu, X., Deng, L., Zhang, Z., & Lv, Z. (2024). The effect of nitrogen and potassium interaction on the leaf physiological characteristics, yield, and quality of sweet potato. Agronomy, 14(10), 2319.

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

الملخص العربي

البطاطا كمحصول استراتيجي واعد في مصر: تأثير الأسمدة العضوية المختلفه والبورون علي البطاطا تحت مستويات متناقصة من التسميد البوتاسي

علي فتحي علي حمايل،محمود احمد محمد عبد الهادي، أسماء ابراهيم الغريب
قسم البساتين-كلية الزراعة – جامعة دمياط -مصر.

تُعد البطاطا من المحاصيل الاستراتيجية في مصر، حيث يتزايد نطاق زراعتها بشكل مستمر لتلبية احتياجات السوقين المحلي والدولي. ويتطلب هذا التوسع تطوير برامج تسميد محسّنة لتحقيق أعلى إنتاجية وجودة. لذلك، تم تنفيذ تجربة حقلية خلال موسم النمو لعام 2024 لدراسة تأثير أنواع مختلفة من الأسمدة العضوية (الكنترول ، سماد زرق الدواجن ، والكمبوست، بمعدل 12.0 طن للهكتار لكل منها) وإضافة البورون رشا (مطُبَّقًا على هيئة حمض البوريك بتركيز 80 ملجم لكل لتر أو غير مطُبَّق) على محصول البطاطا صنف "بلدي" النامي تحت مستويات متناقصة من التسميد البوتاسي المعدني)100، 75، 50% من الجرعة الموصى بها من التسميد البوتاسيي المعدني KRD). تم تقييم معايير النمو، مثل ارتفاع النبات، والأوزان الطازجة والجافة، بالإضافة إلى محتوى الكلوروفيل الكلي وتركيزات العناصر الغذائية الأساسية (NPK) ، بعد 100 يوم من نقل العقل. كما تم قياس إنتاجية الدرنات ومكوناتها، من خلال بعض المدلولات ومنها متوسط وزن الجزور المتدرنة، وطول الجزور المتدرنة ، والإنتاج الكلي للدرنات، إلى جانب الخصائص النوعية، والتي شملت محتوى الكربوهيدرات والنشا، والسكر الكلي، وفيتامين C ، وذلك بعد 140 يومًا من نقل العقل. تفوق الكمبوست على سماد زرق الدواجن، كما تفوقت الأسمدة العضوية بشكل عام على المعاملة الكنترول. أظهرت النتائج أيضا أن أعلى معدلات النمو وإنتاجية للجزور المتدرنة تحققت عند استخدام 100% من KRD، بينما انخفضت القيم مع تقليل مستويات التسميد البوتاسي. علاوة على ذلك، أظهرت النباتات المعاملة بالبورون أداءً نمويًا وإنتاجيًا متفوقًا مقارنة بالنباتات التي لم تتلقَّ معاملة البورون. ومن الجدير بالذكر أن النباتات النامية تحت مستوى 75% من KRD، عند دمجها مع الأسمدة العضوية (سواء الكمبوست أو سماد زرق الدواجن) ومعاملة البورون، أظهرت أداءً نمويًا وإنتاجيًا أفضل من تلك المزروعة تحت مستوى 100% من KRD بدون إضافة الأسمدة العضوية أو البورون. ويشير هذا إلى أنّ الاستبدال الجزئي للبوتاسيوم المعدني بالمُضافات العضوية والبورون يُمكن أن يُحسّن كفاءة العناصر الغذائية ويحافظ على الإنتاجية.