Middle East Journal of Agriculture Research
Volume: 14 | Issue: 03| July – Sept.| 2025

EISSN: 2706-7955 ISSN: 2077-4605
DOI: 10.36632/mejar/2025.14.3.26
Journal homepage: www.curresweb.com
Pages: 413-420

Effect of Mineral and Organic Fertilization on the Production of some Medicinal Active Compounds Extracted from Dahlia Plants

Marwa Othman, Abdelaziz M. Hosni, Laila M. Helmy and Ahmed N. Abdelhamid

Horticulture Dept., Agric. Fac., Ain Shams Univ., Cairo, Egypt

Received: 25 May 2025 **Accepted:** 01 July 2025 **Published:** 20 August 2025

ABSTRACT

This research study was carried out in the Research farm of the Horticulture Department, Faculty of Agriculture, Ain Shams University, Egypt. Open-field pot experiments were executed for the duration of the two consecutive winter seasons of 2020/2021 and 2021/2022 on dahlia plant. Combinations of chemical and organic fertilizers were applied to improve quality of dahlia tuberous roots. Total phenolic, total flavonoid and total sugar contents in dahlia tuberous roots were increased significantly with the triple combination treatment from 2% compost tea, 2% vinasse and 5 ppm boron foliar spray under Kristalon fertilizer at rate 100% from the recommended dose and gave the highest values (62.51, 4.84 and 35.39 mg/g) especially in season 2021 and comparative results in season 2022. Compost tea as an individual fertilizer treatment without mixing led to the highest values of total phenolic and total flavonoid content (40.25 mg/g and 2.83 mg/g) under 100% level of Kristalon fertilizer, while vinasse as an individual fertilizer treatment led to the highest amount of total sugar content with 35.18 mg/g under 100% level of Kristalon fertilizer, in both years 2021 and 2022, in respect order.

Keywords: *Dahlia variabilis*, *Asteraceae,* Vinasse, Phenolic compounds, Flavonoids, Tuberous roots, Compost tea

1. Introduction

Most plant species in the plant kingdom particularly higher plants can produce bioactive compounds, which can play a serious role in human health. Medicinal plants are one of the main best sources of industrial and bioactive medicinal materials referred to sometimes as plant secondary metabolites that can be used in food, pharmaceutical, and cosmetic industries. Plant secondary metabolites can be used without harm as food additives (flavors, fragrances, sweeteners, colorants and food preservatives), in addition to nutraceuticals, and pharmaceuticals (Othman *et al.,* 2019).

Dahlia, (*dahlia spp.*) is a plant member of the Aster family (*Asteraceae*) that also involves Dandelion, Cornflower and Artichoke. Dahlia is a herbaceous perennial plant with fleshy edible tuberous roots (Mariña 2015). Dahlia is indigenous to Mexico where it officially declared in 1963 as the National Flower of Mexico, and was established as "National Dahlia Day". Dahlia is a well-known plant since ancient times as an ornamental plant used in landscape design, as potted plant to beautify and decorate houses, in garland, flower bunches, and as cut flowers. However, the importance of the dahlia plant is not limited to being an ornamental plant only, but rather it has many medical, food and industrial uses that are not new in the world (Mejía-Muñoz *et al.,* 2020).

Medical importance of the dahlia plant is attributed to its containment of many important metabolites such as flavonoids, phenolic compounds, proteins, carbohydrate, fructose, starch, inulin, polysaccharides, minerals and vitamins (Bernal *et al.,* 2005). Knowingly, tubers of dahlia plant were usually used from ancient times until now to treat different symptoms and ailments like liver disorders, kidney, digestive, urinary disorders, gallstones, cholesterol, diabetes, wound healing and chronic intestinal disorders (Moldovan *et al.,* 2017).

Chemical fertilizers are considered a major source of plant nutrients, but excessive use of fertilizers represents the major cost in plant production and creates environmental pollution of agro ecosystem, as

Corresponding Author: Marwa Othman, Horticulture Dept., Agric. Fac., Ain Shams Univ., Cairo, Egypt.
E-mail: - marwaplant@agr.asu.edu.eg

well as deterioration of soil, and public health risk. So the use of plant organic fertilizers (an alternative to chemical fertilizer) such as sugarcane vinasse and compost can increase secondary metabolites, vital components and phytohormones production inside medicinal plants. Moreover, some of them are recognized as a low cost and most of them are eco-friendly to the environment. Also, the use of organic amendments may improve soil quality in terms of the structure, porosity, water holding capacity, nutrient content and organic matter content of the soil all of these improve plant growth and crop quality (Sabah and Salwa 2005).

Boron is one of the essential micro-nutrient which is required in the cell walls formation, cell prolongation, enzyme induction, sugars transportation and carbohydrate metabolism. Boron foliar applications lead to increase the vegetative growth, phytochemical constituents and yield productivity of many different plants (Salim *et al.,* 2024).

Accordingly, the objective of this research study was to apply treatments targeted to increase some secondary metabolites from dahlia plant (*dahlia variabilis* L.) through organic fertilizers and boron foliar applications like compost and vinasse.

2. Materials and Methods

2.1 Location and Duration

This research study was carried out in the Horticulture Department Research Farm, Faculty of Agriculture, Ain Shams University, Cairo, Egypt. Open-field pot experiments were executed for the duration of the two consecutive winter seasons of 2020/2021 and 2021/2022.

2.2 Plant Materials

Healthy and symmetrical Dahlia seedlings (*Dahlia variabilis* L.) were purchased at the age of two months from a trusted, approved commercial nursery (Safwat Habib) situated at Mansourih, El-Giza Governorate, Egypt. Dahlia seedlings were planted on December individually in plastic pots 40 cm in diameter (one plant per pot) filled beforehand with cocopeat and sand (3:1 by volume).

2.3 Fertigation and foliar treatments

2.3.1 Treatments added in the Fertigation system

Dahlia seedlings were fertigated every 10 days over the course of three months with three substances individually or in combination:

- Kristalon (19:19:19) as a source of N, P and K nutrients in three levels (100%, 75% and 50%) from the recommendation dose according to the Egyptian Ministry of Agriculture and its chemical analysis was showed: nitrogen 19%, P_2O_5 19%, K_2O 19%, chelated sulfur 2%, chelated magnesium 0.9% and boron 0.025% with EC = 1 mS/cm (1g/l).
- Plant compost tea prepared by blending 250 g of raw compost in 1000 ml of water in dilution ratio 1: 4 then the mixture was turned daily using a fish tank bubbling pump to maintain oxygen saturation in the suspension at room temperature for three days. Finally, the combination was filtered and collected to use as a soil drench application in concentrations (0 and 2 %) every 10 days over the course of three months. The used compost was obtained from an accredited government organization known as Egyptian Company for Solid Waste Recycling. Some chemical characteristics of the compost are shown in Table (1).

Table 1. Some chemical properties of compost used in this study.

Properties	Density	pH	EC (1:10)	Organic matter	Moisture	Ash	Organic carbon
Value	715 kg/m^3	7.93	5.53 dS/m	28.51 %	31.8 %	60.33 %	16.58 %
Properties	**N**	**P**	**K**	**Fe**	**Mn**	**Zn**	**C/N ratio**
Value	1.10 %	0.20 %	1.72 %	0.285 %	0.039 %	0.0025 %	15.07

*Analysis was provided by the Central Lab. Faculty of Agriculture, Ain Shams University.

- Sugarcane vinasse was used as a soil drench application in concentrations (0 and 2 %) obtained from the Egyptian Sugar and Integrated Industries Company located at Giza, Egypt. Some chemical properties of raw vinasse are presented in Table (2).

Table 2. Some chemical properties of raw vinasse used in this study.

Characteristics	Density	pH	EC	Reducing sugars	Organic matter	
Value	1.06 g/cm^3	3.89	11.95 dS/m	4.11 %	50.60 %	

Characteristics	Total phosphorus	Total Potassium	Total calcium	Total magnesium	Total nitrogen	The percentage of carbon / nitrogen (C/N ratio)	Organic carbon
Value	0.38 %	5.8 %	1.2 %	0.21 %	2.43 %	1:12	29.24 %

*Analysis was provided by the Egyptian Sugar and Integrated Industries Company.

2.3.2. Treatments added as foliar spray

Boron solution used in this study was prepared from Boric acid. Concentrations of B (0 and 5 ppm) were prepared by dissolving required quantity of boric acid in distilled water. Foliar application by boron solution was applied every ten days over the course of three months.

2.4 Data collected

From fresh samples of three months dahlia tubers (Fig 1.), internal chemical components were determined for the following:

-Total soluble phenolics as illustrated by Singleton and Rossi (1965).
-Total flavonoids according to the method described by Nagy and Grancai (1996).
-Total soluble sugars assay as articulated by Dubois *et al.* (1956)

All chemical analyses were done colorimetrically inside the laboratories of the Faculty of Agriculture, Ain Shams University using two spectrophotometer devices (UV-VIS, LabTech, Germany) and (Single Beam UV-VIS, Chrom Tech, USA) at different wavelengths.

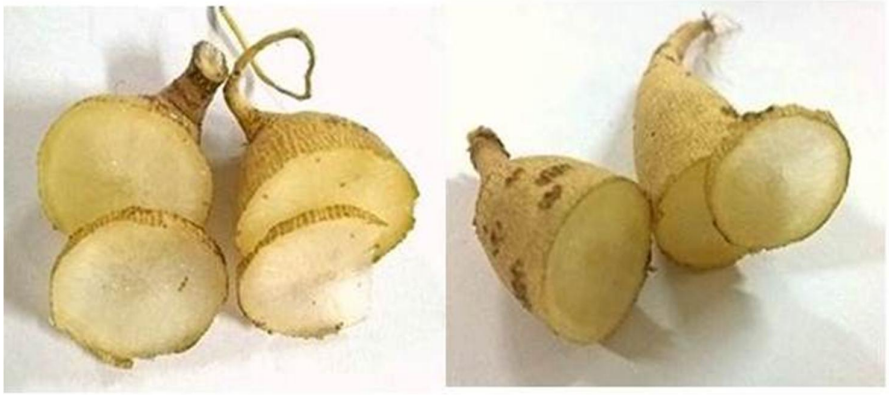

Fig. 1: Fresh samples of three months dahlia tubers.

2.5 Experimental Design and Statistical Analysis

The field pot experiments were carried out in a randomized complete blocks design (RCBD) using with four replications per treatment in both growing seasons. Each replicate contained one pot and each pot contained one Dahlia seedlings. Experiments included two factors: first factor was Kristalon levels and, second factor was organic fertilizers and boron foliar applications as growth stimulators. Results statistically analyzed using CoStat software by one- way analysis of variance and the mean values were compared using LSD test at $P < 5\%$ according to Gomez and Gomez (1984).

3. Results and Discussion

Dahlia tuberous roots were collected after three months from planting in pots and extracted to determine phenolic compounds, flavonoids and total soluble sugars.

3.1 Effects on total phenolic compounds content

Results in Table (3) revealed that the effect of Kristalon fertilization treatments under three levels (100%, 75% and 50%) was not significant, except with Kristalon fertilization treatment in level 50% which gave a lower value of total phenolic compounds content (19.81 and 18.70 mg/g) in dahlia tuberous roots when compared to Kristalon fertilization treatments in levels 100% and 75% that gave the highest values (39.95, 38.84, 38.52 and 37.41 mg/g) for both without any significance between level 100% and level 75% ,and that was in both seasons 2021 and 2022, respectively. Chemical fertilization indicates the important role of nitrogen, phosphorus, and potassium in plants, particularly their role in various important physiological processes within the plant. Nitrogen is essential for the formation of amino and nucleic acids, and thus the formation of important plant enzymes. Phosphorus is important for influencing many processes within the plant, such as cell division and growth, energy transfer (ATP and ADP) and photosynthesis. Potassium is essential for the formation and transport of sugars and starch, and aids in the absorption and transport of other nutrients within the plant. From the above, the importance of chemical fertilization is clear which is reflected in increased vegetative growth and accumulation of secondary metabolites (phenolic, flavonoids compounds and sugars) of plants, thus increasing plant quality and productivity (Taiz *et al.,* 2015). These results are in the same trend with which obtained by Amarowicz *et al.* (2020) on *Helianthus tuberosus* plant. Nitrogen (N) and potassium (K) fertilization significantly influence the levels of polyphenolic compounds and antioxidant capacity in coloured potatoes (Michalska *et al.,* 2016).

Table 3: Effect of some organic fertilizers and boron foliar spray on total phenolic compounds content (mg/g) of dahlia tubers grown under three rates of Kristalon (K) in two seasons (2021 and 2022).

Treatment (T)	Season 2020/2021			
	K50%	**K75%**	**K100%**	**Mean**
Control	13.12 j	30.39 f-h	24.75 h	**22.75 E**
Boron (B)	14.52 j	31.72 e-g	31.88 e-g	**26.04 DE**
Compost tea (CT)	24.28 hi	38.30 de	40.25 cd	**34.28 C**
CT+B	24.39 hi	37.25 d-f	40.29 cd	**33.98 C**
Vinasse (V)	15.85 j	33.55 d-f	35.55 d-f	**28.31 D**
V+B	17.58 ij	34.21 d-f	36.72 d-f	**29.50 D**
CT+V	23.72 hi	45.97 bc	47.64 b	**39.11 B**
CT+V+B	25.05 gh	56.78 a	62.51 a	**48.11 A**
Mean	**19.81 B**	**38.52 A**	**39.95 A**	
$LSD_{0.05}$	K	T	T x K	
	2.42	3.96	6.86	
Treatment (T)	**Season 2021/2022**			
Control	12.01 j	29.28 f-h	23.64 h	**21.64 E**
Boron (B)	13.41 j	30.61 e-g	30.77 e-g	**24.93 DE**
Compost tea (CT)	23.17 hi	37.19 de	39.14 cd	**33.17 C**
CT+B	23.28 hi	36.14 d-f	39.18 cd	**32.87 C**
Vinasse (V)	14.74 j	32.44 d-f	34.44 d-f	**27.20 D**
V+B	16.47 ij	33.10 d-f	35.61 d-f	**28.39 D**
CT+V	22.61 hi	44.86 bc	46.53 b	**38.00 B**
CT+V+B	23.94 gh	55.67 a	61.40 a	**47.00 A**
Mean	**18.70 B**	**37.41 A**	**38.84 A**	
$LSD_{0.05}$	K	T	T x K	
	2.43	3.97	6.87	

As for the effect of organic fertilizers and boron foliar spray treatments, the differences were significant among most treatments, and the fertilization with triple mixture treatment (CT+V+B) gave the highest value (48.11 and 47 mg/g) in both seasons 2021 and 2022, in respect order when compared with all the remaining treatments. Whereas when organic fertilizers and boron foliar applications are compared individually without mixing, it will become clear that the fertilization with compost tea (CT) treatment led to the highest value of total phenolic compounds content (34.28 and 33.17 mg/g) when compared to both vinasse (V) treatment and boron (B) treatment, and that was in both seasons 2021 and 2022, respectively. Pilla *et al.* (2023) mentioned that compost tea can increase the production and

accumulation of phenolic compounds in plants because it contains chelated micronutrients that act as cofactors for enzymes involved in the biosynthesis of phenolic compounds.

Regarding the effect of the interaction between Kristalon fertilization treatments and organic fertilizers or boron foliar spray treatments, results revealed significant differences among most treatments, the highest values (62.51, 56.78, 61.40 and 55.67 mg/g) were being with triple mixture treatment (CT+V+B) under both 100% and 75% levels of Kristalon fertilization treatments when compared to all the remaining treatments in both seasons 2021 and 2022, respectively. While the lowest values (13.12, 14.52, 12.01 and 13.41 mg/g) of total phenolic compounds content in dahlia tuberous roots were showed with the control treatment and boron foliar spray treatment under 50% of Kristalon fertilization, in both years 2021 and 2022, in respect order.

Moreover the effect of interaction among the three treatments of the two organic fertilizers and boron foliar spray individually without mixture between them showed that the fertilization with compost tea (CT) individually under 100% level of Kristalon fertilization gave the highest values (40.25 and 39.14 mg/g) of total phenolic compounds content when compared to both vinasse (V) and boron (B) treatments under the three levels of Kristalon fertilization, in both years 2021 and 2022, in respect order.

3.2 Effects on total flavonoids content

Result data presented in Table (4) show that the effect of Kristalon fertilization treatments under three levels (100%, 75% and 50%) on total flavonoids content in dahlia tuberous roots, the differences between the three levels were significant, and the highest values (2.68 and 2.55 mg/g) of total flavonoids content in dahlia tuberous roots were recorded with 100% level of Kristalon fertilization while compared to all the remaining treatments, in both years 2021 and 2022, in respect order.

Table 4: Effect of some organic fertilizers and boron foliar spray on total flavonoids content (mg/g) of dahlia tubers grown under three rates of Kristalon (K) in two seasons (2021 and 2022).

Treatment (T)	Season 2020/2021			
	K50 %	**K75 %**	**K100 %**	**Mean**
Control	0.41 j	1.63 fg	1.25 h	**1.10 G**
Boron (B)	0.43 j	1.68 fg	1.72 fg	**1.28 F**
Compost tea (CT)	0.94 i	2.73 d	2.83 d	**2.17 BC**
CT+B	1.24 h	2.30 e	2.82 d	**2.12 C**
Vinasse (V)	0.52 j	1.79 f	2.30 e	**1.54 E**
V+B	0.54 j	2.27 e	2.35 e	**1.72 D**
CT+V	0.58 j	2.87 d	3.35 c	**2.27 B**
CT+V+B	1.57 g	4.35 b	4.84 a	**3.58 A**
Mean	**0.78 C**	**2.45 B**	**2.68 A**	
$LSD_{0.05}$	K	T	T x K	
	0.07	0.13	0.22	
Treatment (T)	**Season 2021/2022**			
Control	0.29 h	1.13 f	1.51 e	**0.98 F**
Boron (B)	0.31 h	1.56 e	1.60 e	**1.16 E**
Compost tea (CT)	0.82 g	2.61 c	2.71 c	**2.05 B**
CT+B	1.12 f	2.18 d	2.70 c	**2.00 B**
Vinasse (V)	0.40 h	1.67 e	2.18 d	**1.42 D**
V+B	0.42 h	2.15 d	2.23 d	**1.60 C**
CT+V	0.46 h	2.75 c	3.23 b	**2.15 B**
CT+V+B	1.45 e	4.23 a	4.25 a	**3.31 A**
Mean	**0.66 C**	**2.28 B**	**2.55 A**	
$LSD_{0.05}$	K	T	T x K	
	0.09	0.14	0.25	

As for the effect of organic fertilizers and boron foliar spray treatments, the differences were significant among most treatments, and the fertilization with triple mixture treatment (CT+V+B) gave the highest value (3.58 and 3.31 mg/g) in both seasons 2021 and 2022, in respect order when compared with all the remaining treatments. Whereas when organic fertilizers and boron foliar application treatments are compared individually without mixing, it will become clear that the fertilization with

compost tea (CT) treatment led to the highest value of total flavonoids content (2.17 and 2.05 mg/g) when compared to both vinasse (V) treatment and boron (B) treatment, and that was in both seasons 2021 and 2022, respectively.

Regarding the effect of the interaction between Kristalon fertilization treatments and organic fertilizers or boron foliar spray treatments, results revealed significant differences among most treatments, the highest values of total flavonoids content in dahlia tuberous roots (4.84 and 4.25 mg/g) were being with triple mixture treatment (CT+V+B) under 100% level of Kristalon fertilization treatment when compared to all the remaining treatments in both seasons 2021 and 2022, respectively. While the lowest values (0.41, 0.43, 0.29 and 0.31 mg/g) of total flavonoids content in dahlia tuberous roots were showed with the control treatment and boron foliar spray treatment under 50% of Kristalon fertilization, in both years 2021 and 2022, in respect order. Raza *et al.* (2024) recorded that the combination of between organic and mineral fertilizers improves flavonoids biosynthesis. Results are in the same trend with which observed by Omar *et al.* (2012) on Cassava tubers by using organic and mineral fertilizers.

Moreover the effect of interaction among the three treatments of the two organic fertilizers and boron foliar spray individually without mixture between them showed that the fertilization with compost tea (CT) individually under both 100% and 75% levels of Kristalon fertilization treatments gave the highest values (2.83, 2.73, 2.71 and 2.61 mg/g) of total flavonoids content in dahlia tuberous roots when compared to both vinasse (V) and boron (B) treatments under the three levels of Kristalon fertilization treatments, in both years 2021 and 2022, in respect order.

3.3 Effects on total sugar content

Results in Table (5) revealed that the effect of Kristalon fertilization treatments under three levels (100%, 75% and 50%) was significant, Kristalon fertilization treatment in level 100% gave the highest values of total sugar content in dahlia tuberous roots (31.25 and 30.02 mg/g) in both seasons 2021 and 2022, respectively.

As for the effect of organic fertilizers and boron foliar spray treatments, the differences were significant among most treatments, and the fertilization with triple mixture treatment (CT+V+B) and binary mixture treatment of (CT+V) fertilization gave the highest values (31.48, 30.59, 30.25 and 29.36 mg/g) in both seasons 2021 and 2022, in respect order when compared with all the remaining treatments. Whereas when organic fertilizers and boron foliar applications are compared alone without mixing, it will become clear that the fertilization with vinasse (V) treatment led to the highest value of total sugar content in dahlia tuberous roots (29.97 and 28.74 mg/g) when compared to both compost tea (CT) treatment and boron (B) treatment, and that was in both seasons 2021 and 2022, respectively.

Regarding the effect of the interaction between Kristalon fertilization treatments and organic fertilizers or boron foliar spray treatments, results revealed significant differences among most treatments, the highest values of total sugar content in dahlia tuberous roots (35.39, 35.67, 35.18, 34.68, 34.16, 34.44, 33.95 and 33.45 mg/g) were being with four treatments without any significance among them; triple mixture treatment (CT+V+B), binary mixture treatment of (V+B), individual fertilization treatment with vinasse (V) and binary mixture treatment of (CT+V) under 100% level of Kristalon fertilization treatment when compared to all the remaining treatments in both seasons 2021 and 2022, respectively. Khalil *et al.* (2020) recorded that vinasse as an organic fertilizer led to significant increase in sugar accumulation in *Beta vulgaris* plant.

While the lowest values (18.15, 18.02, 16.92 and 16.79 mg/g) of total sugar content in dahlia tuberous roots were showed with the control treatment and boron foliar spray treatment under 50% of Kristalon fertilization, in both years 2021 and 2022, in respect order.

Moreover the effect of interaction among the three treatments of the two organic fertilizers and boron foliar spray individually without mixture between them showed that the individual fertilization treatment with vinasse (V) under 100% level of Kristalon fertilization gave the highest values (35.18and 33.95 mg/g) of total sugar content in dahlia tuberous roots when compared to both compost tea (CT) treatment and boron (B) treatments under the three levels of Kristalon fertilization, in both years 2021 and 2022, in respect order. España-Gamboa *et al.* (2011) noticed that vinasse increase sugar content in tuber plants, as it is a rich source of various macro and micro nutrients essential for plant growth and metabolism especially potassium. Potassium is a main factor for sugar translocation, as it plays a vital

role in enzyme activation, stomatal regulation (influencing photosynthesis), and the loading of sugars into the phloem for transport to storage organs.

Table 5: Effect of some organic fertilizers and boron foliar spray on total sugar content (mg/g) of dahlia tubers grown under three rates of Kristalon (K) in two seasons (2021 and 2022).

Treatment (T)	Season 2020/2021			
	K50%	**K75%**	**K100%**	**Mean**
Control	18.15 k	23.35 ij	25.09 f-h	**22.20 D**
Boron (B)	18.02 k	23.44 h-j	25.15 fg	**22.20 D**
Compost tea (CT)	22.60 j	23.70 g-j	29.19 e	**25.16 C**
CT+B	23.01 j	22.61 j	29.62 e	**25.08 C**
Vinasse (V)	24.80 f-i	29.94 e	35.18 a	**29.97 B**
V+B	24.75 f-i	30.58 de	35.67 a	**30.34 B**
CT+V	25.09 f-h	31.99 cd	34.68 ab	**30.59 AB**
CT+V+B	25.73 f	33.33 bc	35.39 a	**31.48 A**
Mean	**22.77 C**	**27.37 B**	**31.25 A**	
$LSD_{0.05}$	K	T	T x K	
	0.59	0.96	1.67	
Treatment (T)	**Season 2021/2022**			
Control	16.92 k	22.12 ij	23.86 f-h	**20.97 D**
Boron (B)	16.79 k	22.21 h-j	23.92 fg	**20.97 D**
Compost tea (CT)	21.37 j	22.47 g-j	27.96 e	**23.93 C**
CT+B	21.78 j	21.38 j	28.39 e	**23.85 C**
Vinasse (V)	23.57 f-i	28.71 e	33.95 a	**28.74 B**
V+B	23.52 f-i	29.35 de	34.44 a	**29.11 B**
CT+V	23.86 f-h	30.76 cd	33.45 ab	**29.36 AB**
CT+V+B	24.50 f	32.10 bc	34.16 a	**30.25 A**
Mean	**21.54 C**	**26.14 B**	**30.02 A**	
$LSD_{0.05}$	K	T	T x K	
	0.59	0.96	1.67	

4. Conclusion

Organic fertilizers in current study represented by compost tea and vinasse can enhance the quality of dahlia tuberous roots, in terms of the amount of useful secondary metabolites. This is side by side with the recommended dose of mineral fertilizers to obtain the maximum value. So fertigated dahlia plants with compost tea 2%, vinasse 2% and 100% of the recommended dose from Kristalon in addition to 5 ppm boron as foliar application gave the best results.

Acknowledgment

The authors would like to thank Faculty of Agriculture, Ain Shams University for providing the facilities to carry out the research work. I would like to express my sincere appreciation to Dr. Karam Hafez Abd El-latef Aisa, lecturer of Agronomy at fac. of agriculture, Ain Shams Univ. for providing me with the necessary support to complete the statistical analyses.

References

Amarowicz, R., B. Cwalina-Ambroziak, M.A. Janiak, and B. Bogucka, 2020. Effect of N fertilization on the content of phenolic compounds in Jerusalem artichoke (*Helianthus tuberosus* L.) tubers and their antioxidant capacity. Agronomy, 10(8): 1215. https://doi.org/10.3390/agronomy10081215

Bernal, B.H., J. Calle, E.Q. Duarte, R. Pinzón, and M. Velásquez, 2005. Inulin from tubers of Dahlia imperialis Roetz. Revista Colombiana de Ciencias. Químico Farmacéuticas, 122-125. https://revistas.unal.edu.co/index.php/rccquifa/article/view/9184

Dubois, M., K.A. Gilles, J.K. Hamilton, P.A. Rebers, and F. Smith, 1956. Colorimetric method for determination of sugars and related substances. Analytical Chemistry, 28(3): 350-356. https://doi.org/10.1021/ac60111a017

España-Gamboa, E., J. Mijangos-Cortes, L. Barahona-Perez, J. Dominguez-Maldonado, G. Hernández-Zarate, and L. Alzate-Gaviria, 2011. Vinasses: characterization and treatments. Waste Management and Research, 29(12): 1235-1250. https://doi.org/10.1177/0734242X10387313

Gomez, K.A., and A.A. Gomez, 1984. Statistical Procedures for Agricultural Research, 2nd Edition. John Wiley and Sons, New York, USA, 690. https://scholar.google.com/scholar_lookup?title=Statistical%20procedures%20for%20agricultural%20research&author=Gomez&publication_year=1984

Khalil, S., B. Makhlouf, and K. El-Gabry, 2020. Using vinasse as a source of potassium fertilization for sugar beet and a sandy soil amendment. Egyptian Journal of Agronomy, 42(3): 235-248. https://doi.org/10.21608/agro.2020.37407.1222

Mariña, L.J., 2015. Cultivation of the Dahlia. Cultivos Tropicales, 36(1): 103-110. https://www.cabidigitallibrary.org/doi/full/10.5555/20153178953

Mejía-Muñoz, J.M., I. De Luna-García, E.F. Jiménez-Ruiz, E. Sosa-Montes, C. Flores-Espinosa, G. Treviño-De Castro, and J. Reyes-Santiago, 2020. Research on dahlia, the national flower of Mexico. Acta Horticulturae, 1288: 103-108. https://doi.org/10.17660/ActaHortic.2020.1288.15

Michalska, A., A. Wojdyło, and B. Bogucka, 2016. The influence of nitrogen and potassium fertilisation on the content of polyphenolic compounds and antioxidant capacity of coloured potato. Journal of Food Composition and Analysis, 47: 69-75. https://doi.org/10.1016/j.jfca.2016.01.004

Moldovan, I., Z. Szekely-Varga, and M. Cantor, 2017. Dahlia an unforgettable flower-a new perspective for therapeutic medicine. Hop and Medicinal Plants, 25(1-2): 56-68. https://doi.org/10.15835/hpm.v25i1-2.12879

Nagy, M., and D. Grančai, 1996. Colorimetric determination of flavanones in propolis. Pharmazie, 51: 100-101. https://www.cabidigitallibrary.org/doi/full/10.5555/19980200088

Omar, N.F., S.A. Hassan, U.K. Yusoff, N.A.P. Abdullah, P.E.M. Wahab, and U.R. Sinniah, 2012. Phenolics, flavonoids, antioxidant activity and cyanogenic glycosides of organic and mineral-base fertilized cassava tubers. Molecules, 17(3): 2378-2387. https://doi.org/10.3390/molecules17032378

Othman, M., L.M. Helmi, and A.M. Hosni, 2019. Effect of growth regulator NAA and IBA applications on total phenolic and flavonoid compounds extracted from in vitro produced callus of chicory plant (*Cichorium intybus* L.). Arab Universities Journal of Agricultural Sciences, 27(3): 1929-1936. https://doi.org/10.21608/ajs.2019.15333.1067

Pilla, N., V. Tranchida-Lombardo, P. Gabrielli, A. Aguzzi, M. Caputo, M. Lucarini, and M. Zaccardelli, 2023. Effect of compost tea in horticulture. Horticulturae, 9(9): 984. https://doi.org/10.3390/horticulturae9090984

Raza, A., C. Chaoqun, L. Luo, M.A. Asghar, L. Li, N. Shoaib, and C. Yin, 2024. Combined application of organic and chemical fertilizers improved the catechins and flavonoids biosynthesis involved in tea quality. Scientia Horticulturae, 337, 113518. https://doi.org/10.1016/j.scienta.2024.113518

Sabah, M.A., and A. Salwa, 2005. Response of *Helianthus tuberosus* L. to organic and bio-organic fertilizers. Arab Universities Journal of Agricultural Sciences, 13(3): 609-623. https://doi.org/10.21608/ajs.2005.15262

Salim, E., E. Abdelbaky, and A. El Moghazy, 2024. Impact of zeolite and boron on yield and quality of Sugar Beet in Borg El-Arab region. Menoufia Journal of Plant Production, 9(12): 417-428. https://dx.doi.org/10.21608/mjppf.2025.345513.1062

Singleton, V.L., and J.A. Rossi, 1965. Colorimetry of total phenolics with phosphomolybdic-phosphotungstic acid reagents. American Journal of Enology and Viticulture, 16(3): 144-158. https://doi.org/10.5344/ajev.1965.16.3.144

Taiz, L., E. Zeiger, I.M. Møller, and A. Murphy, 2015. Plant Physiology and Development, 6th edition. Sinauer Associates, Sunderland, 761 . https://www.cabidigitallibrary.org/doi/full/10.5555/20173165866