



The Effect of Foliar Spraying with The Nano Fertilizer Optimus-Plus on The Growth and Yield of Four Varieties Of Kohlrabi

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Abstract. The field experiment was carried out in the fall season of the 2019 agricultural season in the fields of the Department of Horticulture and Landscape Engineering, College of Agriculture, University of Diyala, to study the effect of foliar spraying with the Nano fertilizer Optimus-plus at three levels (0, 1.0, 2.0 ml L⁻¹) on the characteristics of vegetative growth and yield of four varieties of Kohlrabi are (local variety, White Vienna, Purple delicacy, Green delicacy) according to the split-plot system, with a completely random block design with three replicates. The results showed that the characteristics of plant height, leaf length, chlorophyll content in the leaves, and the length and weight of the enlarged stem distinguished the Purple Delicacy variety. At the same time, the local variety gave the largest number of leaves, the largest leaf width, the highest length and diameter of the root, and the largest fresh weight of the plant. The White Vienna variety is distinguished by the largest leaf area of the plant, the best diameter, size and weight of the enlarged stem, and the highest total yield. The two foliar spray treatments of 1.0 and 2.0 ml L⁻¹ of the Optimus-plus Nano preparation excelled without significant differences between them in all vegetative growth and yield characteristics compared to the comparison treatment.

Keywords: Kohlrabi; foliar spraying; vegetative growth; yield.

INTRODUCTION

Kohlrabi (*Brassica oleracea* var. *gongylodes*) is a crop of the Cruciferae family. Genetically, it is very close to the rest of the plants of this family. Only one genetic mutation distinguishes it from it in a gene responsible for huge mutations in this plant that gave it its well-known phenotypic appearance [4]. The Central European region is believed to be its original homeland, and from there, its cultivation spread to other regions in Asia and Western Europe. The stalk has good nutritional value, as every 100 grams of swollen stalk contains 90 grams of water and 6.2 grams of carbohydrates (including 2.6 sugars, 3.6 fibers, and 1.7 g proteins and 0.1 g fats. It contains good proportions of vitamin A, B vitamins, vitamin C, and mineral elements, including phosphorus 46 mg, iron 0.4 mg, sodium 20 mg, potassium 350 mg, magnesium 19 mg, and calcium 24 mg [19].

Plant yield is affected by several genetic and environmental factors that control the productivity of the crop. Therefore, choosing the appropriate genetic makeup is the basis

for the success of the agricultural process, especially the presence of dozens of varieties of each crop from which the appropriate ones can be chosen according to the geographical region. Therefore, importing and introducing new varieties is one of the cheapest and fastest plant breeding methods. In developing countries [4]. Previous research on Kohlrabi crop showed that there is a clear difference between the varieties in terms of vegetative growth and yield. A study by [18] at the University of Dhaka in Bangladesh evaluated the performance of five Kohlrabi varieties (Quick Star, UFO, White Vienna, Sufala-14, and Early 0058). Under different types of organic fertilizer, they found that the Quick Star variety was significantly superior in plant height, length and width of leaves, weight and diameter of the enlarged stem, and the total score over the rest of the varieties. In a study conducted [6] to determine the effect of foliar feeding with Young green solution on two varieties of local kale and White Venna, they found that the local variety was superior in the number of leaves, their width, the weight of the enlarged stem, its diameter, and the total yield compared to the White Vienna variety.

In an experiment conducted by [9] to compare the two varieties of Kohlrabi, Delikates Weisser and Purple Vienna, they found that the first variety was superior in terms of plant height, fresh and dry weight of leaves, and weight of the enlarged stem, while the second variety was superior in the number of leaves, diameter, length, and weight of the enlarged stem, and the total yield. In an experiment conducted by [20] to test the performance of three varieties of Kohlrabi under the influence of different types of soil covers, it was found that the variety Timpano was distinguished by the best diameter, the highest weight of the enlarged stem, and the highest total yield compared to the two varieties Olivia and Opimes. [11] studied the effect of cultivar and planting date on Kohlrabi varieties. They found that the Neckar variety gave the lowest number of leaves but was distinguished by the highest weight of fresh leaves and enlarged stems compared to other varieties. In an experiment conducted by [8] to test the performance of a group of Kohlrabi varieties (Purple Vienna, Early White Vienna, Tender Knob Palam, and White Vienna), they found that the first variety was superior in terms of height and spread of leaves and leaf area. [10] tested the performance of two varieties of Kohlrabi in India, Pusa Virat and Vennia White, under the influence of different levels of nitrogen and phosphate fertilizers and found that the first variety was superior in plant length, number of leaves, wet and dry weight of leaves, leaf area, and weight of the enlarged stem compared to the second variety. The study showed that there were significant differences between the Green Delicacy and Purple Delicacy varieties, as the Purple Delicacy variety was superior in most vegetative traits [7].

The application of Nano fertilizer technologies in the field of agriculture is considered the most important application of modern agriculture, which is characterized by the low economic cost resulting from increasing the efficiency of manufactured fertilizers and the resistance of the agricultural product to various environmental conditions [12]. In a study conducted by [5] to determine the effect of urea fertilizer levels (0, 20, and 30 kg dunum⁻¹) on growth and stem yield, they found that the last level was superior to the plant's leaf

area, fresh and dry weight, enlarged stem weight, and total yield. In Egypt [14] found that fertilizing the Grand Duke kale crop with ammonium nitrate at a concentration of 33.5% at a level of 100 kg per acre (4200 m²) achieved a significant increase in the number of leaves and the weight of the enlarged stem compared to the levels of 50 and 75 kg. In a study conducted by [3] in Baghdad to determine the appropriate level of nitrogen fertilizer needed by the kale crop, he found that plants fertilized with the level of 180 kg ha⁻¹ nitrogen in the number of leaves and the weight of the enlarged stem superior compared to non-fertilized plants.

Due to the lack of widespread cultivation of this crop in Iraq in general and the absence of other varieties except the local variety, as well as the limited use of Nano fertilizers in fertilizing this crop, this study was conducted.

METHODS

The field experiment was conducted at the research station of the Department of Horticulture and Landscape Engineering, College of Agriculture, University of Diyala, during the fall agricultural season of 2019 to study the effect of foliar spraying with the Optimus-plus Nano fertilizer on the growth and yield of four types of Kohlrabi.

A. The study included two factors:

First: Classifications. Four classes were used in the study:

1. Green delicacy (V1) is an imported variety produced by Nutsn Cones in the United Kingdom. The color of the leaves is light green, the color of the enlarged stem on the outside is green, and the pulp inside is white.
2. The local (V2) is sourced from a farmer in Karbala Governorate, known for growing this variety for 20 years. Its leaves are light green, the color of the enlarged stem on the outside is green, and the pulp on the inside is white.
3. Purple delicacy (V3) is an imported variety from NutsnCones Seed Company. It is distinguished by the purple color of the leaf petioles and the enlarged stem, while the color of the pulp is white.
4. (V4) White Vienna is an imported variety produced by Just Seed Company. The color of the plant's leaves is dark green, the color of the enlarged stem on the outside is green, and the pulp on the inside is white.

Second: Foliar spraying with a nano-nitrogen preparation (Optimus-plus) produced by the Turkish company Agri Sciences. It is an agricultural fertilizer manufactured according to nanotechnology. It contains 30% amino acids, 5% nitrogen, and 3% organic nitrogen, according to what the producing company stated, and it includes the use of two concentrations in addition to Comparison treatment of my agencies:

- 1- Comparison treatment (F1), spraying with distilled water only.
- 2- The concentration is 1.0 ml L⁻¹ (F2), the company's recommendation for winter vegetable crops.
- 3- Concentration: 2.0 ml L⁻¹ (F3).

Table 1. Some physical and chemical characteristics of field soil

Soil characteristics		Units	value
pH		-	6.74
Ec(1:1)		Ds m ⁻¹	6.95
Ready Elements	N		59.32
	P	mg kg ⁻¹	7.942
	K		84.769
Organic matter			8.373
Separated of soil	Sand		296.2
	Silt	g kg ⁻¹	585.7
	Clay		118.1
Texture		silty loam	Silty loam
Bulk density		g cm ³	1.35

The field experiment used a split-plot system within a randomized complete block design (RCBD), where the varieties occupied the main plots. At the same time, the levels of foliar spraying with the Optimus-plus Nano fertilizer were placed in the secondary plots. The field was prepared for cultivation in terms of ploughing, smoothing, leveling, and animal fertilization with poultry waste and compound fertilizer, according to the recommendations of the cruciferous family before planting. Table 1 shows some of the physical and chemical characteristics of the field soil. The drip irrigation network was extended and installed in the field, and the distance between one pipe and another was 0.75 m. The seeds of the mentioned varieties were planted on August 15, 2018, in one of the specialized nurseries, and five weeks later, they were transferred to the permanent field and planted with dimensions of 0.25 m between one plant and another next to the irrigation pipes. The area reached The experimental unit was 2.25 m² (with dimensions of 3 x 0.75 m), each of which included 12 plants. The foliar spraying process was carried out in the morning three times, the first ten days after planting, followed by the second and third spraying, with a ten-day difference between one spraying and the next. The crop service operations were also applied according to what is recommended for the family's crops. Crusader and whenever necessary. The characteristics of vegetative and root growth were studied, which are plant length, number of leaves, total leaf area, leaf length and width, total chlorophyll content in the leaves, percentage of dry matter in the leaves, length and diameter of the root, characteristics of the yield and its components, which are the weight of the total plant, and

characteristics of the enlarged stem, represented by the weight of the stem, total yield, size, length and diameter of the stem and the proportion of Dissolved solids and specific gravity. Statistical analysis of the studied traits was conducted according to the design above using the program (SAS version 9.1). The arithmetic means were compared according to the Tukey test at the 0.05 level [16].

RESULTS

A. First: Characteristics of vegetative and root growth:

The effect of the type:

The data in Table 2 show a significant effect of the variety on all the studied traits except for the root length trait.

Table 2. Effect of cultivar on vegetative growth characteristics of Kohlrabi crop*

Varieties	Plant length (cm)	leaves number (leaf plant ⁻¹)	Leaf area (dm ²)	Leaf length (cm)	Leaf width (cm)	Chlorophyll content ml/g	dry matter % percentage of leaves	Root length (cm)	Root diameter (cm)
Green delicacy V₁	54.70 bc	16.48 b	156.84 c	47.16 b	21.17 c	2.717 c	18.34 a	9.734 A	1.783 b
local V₂	60.68 ab	19.85 a	182.54 b	56.73 a	27.27 a	2.684 c	16.87 b	10.544 A	2.569 a
Purple delicacy V₃	63.91 A	16.04 b	173.39 bc	57.35 a	25.55 b	2.863 a	16.42 b	9.842 A	1.927 b
White Vienna V₄	51.18 C	19.40 a	213.28 a	43.48 c	22.60 c	2.797 b	17.79 a	9.024 A	2.088 b

*Means that share the same letters are not significantly different from each other according to Tukey's multinomial test at the probability level of 0.05.

The V₃ variety had the best plant length of 63.91 cm, followed by the local variety V₂ (60.68 cm) without a significant difference, while the V₄ variety had the lowest length of 51.18 cm. Both local varieties V₂ and V₄ were significantly distinguished by the best number of leaves, which reached 19.85 and 19.40 leaves per plant-1, respectively, while it was reduced to 16.04 leaves in plants of variety V₃. In the leaf area, the V₄ variety was

significantly superior, with the highest value reaching 213.28 dm² plant⁻¹, while this area decreased to 156.84 dm² in the V1 variety plants. The V3 and V2 varieties were significantly superior, with no significant difference, with the best leaf length reaching 57.35 and 56.73 cm, respectively. The length of the leaves of the V4 variety decreased to 43.48 cm. The local variety V2 was significantly distinguished by the highest leaf width value of 27.27 cm, while this value decreased to 21.17 cm in the leaves of the V1 variety. It was significantly superior to the V3 variety with the highest value of total chlorophyll, which amounted to 2.863 mg g⁻¹ fresh weight, while it decreased to 2.684 in the plants of the local variety. The V1 and V4 varieties were significantly distinguished by the highest percentage of dry matter in the leaves, reaching 18.34 and 17.79%, respectively. In contrast, the V3 variety gave the lowest percentage, 16.42%. No significant differences were recorded between the varieties in root length, and the local variety V2 excelled with the highest value for root diameter. It reached 2.569 cm, while this value decreased in the roots of the V1 variety to 1.783 cm.

Effect of spraying with Optimus-plus nano fertilizer

Table 3. Effect of Spraying with Optimus-plus Nano lotion on vegetative growth characteristics of Kohlrabi crop*

Optimus-plus Nano	Plant length (cm)	leaves number (leaf plant ⁻¹)	Leaf area (dm ²)	Leaf length (cm)	Leaf width (cm)	Chlorophyll content ml/g	dry matter % percentage of leaves	Root length (cm)	Root diameter (cm)
Comparison Distilled water (F1)	52.75 B	15.46 b	134.83 b	46.49 b	20.36 b	2.524 c	16.45 c	8.063 b	1.731 b
Concentration 1.0 mL L⁻¹ (F2)	60.07 A	18.93 a	201.40 a	52.55 a	25.66 a	2.838 a	18.01 a	10.664 a	2.202 a
Concentration 2.0 mL L⁻¹ (F3)	60.03 A	19.42 a	208.31 a	54.50 a	26.42 a	2.935 a	17.60 b	10.632 a	2.342 a

*Means that share the same letters are not significantly different from each other according to Tukey's multinomial test at the probability level of 0.05.

The V3 variety had the best plant length of 63.91 cm, followed by the local variety V2 (60.68 cm) without a significant difference, while the V4 variety had the lowest length of 51.18 cm. Both local varieties V2 and V4 were significantly distinguished by the best

number of leaves, which reached 19.85 and 19.40 leaves per plant-1, respectively, while it was reduced to 16.04 leaves in plants of variety V3. In the leaf area, the V4 variety was significantly superior, with the highest value reaching 213.28 dm² plant-1, while this area decreased to 156.84 dm² in the V1 variety plants. The V3 and V2 varieties were significantly superior, with no significant difference, with the best leaf length reaching 57.35 and 56.73 cm, respectively. The length of the leaves of the V4 variety decreased to 43.48 cm. The local variety V2 was significantly distinguished by the highest leaf width value of 27.27 cm, while this value decreased to 21.17 cm in the leaves of the V1 variety. It was significantly superior to the V3 variety with the highest value of total chlorophyll, which amounted to 2.863 mg g⁻¹ fresh weight, while it decreased to 2.684 in the plants of the local variety. The V1 and V4 varieties were significantly distinguished by the highest percentage of dry matter in the leaves, reaching 18.34 and 17.79%, respectively. In contrast, the V3 variety gave the lowest percentage, 16.42%. No significant differences were recorded between the varieties in root length, and the local variety V2 excelled with the highest value for root diameter. It reached 2.569 cm, while this value decreased in the roots of the V1 variety to 1.783 cm.

Effect of bilateral interaction between the variety and spraying with Optimus-plus Nano preparation

The data in Table 4 show a significant effect of the two-way interaction between the variety and spraying with Optimus-plus in all the studied traits. The F3 V3 and F2 V3 treatments excelled, with the best plant height reaching 66.45 and 65.72 cm, respectively, while the F1 V4 treatment gave the lowest value of 45.89 cm. The second interaction significantly affected the number of leaves per plant, and the F3 V4 treatment was characterized by the highest number reaching 21.64 leaves per plant. It decreased to 13.88 leaves in the F1 V3 treatment plants. In leaf area, the F3V4 treatment excelled, with the highest value reaching 253.17 dm², while the F1 V1 treatment gave the minimum leaf area of the plant at 116.73 dm². The F3V3 interaction treatment was significantly superior, with the highest values for leaf length and total chlorophyll traits reaching 62.13 cm and 3.084 mg g⁻¹ fresh weight. In comparison, the values for both leaf length traits decreased to 37.46 cm in the F1 V4 treatment, and the chlorophyll percentage reached 2.428 mg g⁻¹. In treatment V2F1, as for the width of the paper, treatment V2F3 excelled with the highest value, amounting to 29.76 cm, while treatment V1F1 gave the lowest value, amounting to 18.64 cm. As for the percentage of dry matter in the leaves, the F2V1 treatment was significantly higher, reaching 19.27%, while this percentage decreased to 15.48% in the plants of the F1V3 treatment. It was significantly superior to the F3V1 intervention treatment, with the largest root length reaching 11.403 cm, while the F1V4 treatment gave less. The root length reached 7.627 cm, and the second intervention treatment, F3V2, was

significantly superior to the best root diameter of 2.760 cm, while this value decreased to 1.437 cm in the roots of the plants of the V3F1 treatment.

Table 4. Effect of interaction between variety and spraying with Optimus-plus nano preparation on vegetative growth characteristics of Kohlrabi crop

Interactions treatments	Plant length (cm)	leaves number (leaf plant ⁻¹)	Leaf area (dm ²)	Leaf length (cm)	Leaf width (cm)	Chlorophyll content ml/g	dry matter % leaves	Root length (cm)	Root diameter (cm)
V ₁ F ₁	49.19 fg	13.88 d	116.73 f	43.73 e	18.64 e	2.509 h	17.26 c	7.937 bc	1.490 g
V ₁ F ₂	57.78 bcde	15.80 cd	150.87 def	49.67 cd	21.80 bcd	2.787 ef	19.27 a	9.863 abc	1.943 ef
V ₁ F ₃	57.12 cde	19.75 ab	202.93 abcd	48.07 cde	23.06 bc	2.856 cd	18.50 b	11.403 a	1.917 ef
V ₂ F ₁	56.35 de	17.88 bc	145.67 ef	52.22 bc	22.67 bc	2.428 i	16.53 d	8.863 abc	2.307 bcd
V ₂ F ₂	62.31 abc	21.22 a	197.97 bcd	56.75 b	29.39 a	2.777 f	17.15 cd	11.390 a	2.640 ab
V ₂ F ₃	63.37 ab	20.43 a	204.00 abc	61.23 a	29.76 a	2.846 de	16.93 cd	11.380 a	2.760 a
V ₃ F ₁	59.58 bcd	14.75 d	134.77 ef	52.55 bc	20.82 cde	2.587 g	15.48 e	7.823 bc	1.437 g
V ₃ F ₂	65.72 a	17.50 bc	212.27 abc	57.36 ab	27.39 a	2.918 bc	16.93 cd	11.210 a	2.010 def
V ₃ F ₃	66.43 A	15.86 cd	173.13 cde	62.13 a	28.45 a	3.084 a	16.84 cd	10.493 ab	2.333 abcd
V ₄ F ₁	45.89 g	15.35 cd	142.17 ef	37.46 f	19.32 de	2.570 gh	16.53 d	7.627 c	1.690 gf
V ₄ F ₂	54.44 def	21.21 a	244.50 ab	46.40 de	24.05 b	2.869 cd	18.70 ab	10.193 abc	2.213 cde
V ₄ F ₃	53.22 ef	21.64 a	253.17 a	46.57 de	24.43 b	2.953 b	18.15 b	9.253 abc	2.360 abc

*Means that share the same letters are not significantly different from each other according to Tukey's multinomial test at the probability level of 0.05.

*Second. Characteristics of the yield and its components**Effect of the variety*

The results of Table 5 indicate a significant effect of the variety on all the yield traits studied except for the enlarged stem length trait. The V4 variety was significantly distinguished by the enlarged stem traits (0.601 kg), the total yield of 32.03 tons/ha⁻¹, the stem diameter (11.36 cm), and the stem length (10.51 cm). even if it does not differ morally from other types in this capacity. The local variety V2 was significantly distinguished by the highest total plant weight of 1.118 kg. In contrast, the V1 variety was distinguished by the best percentage of dry matter in the enlarged stem, which amounted to 11.71%. The V3 variety was significantly distinguished by the specific weight of the enlarged stem, which was recorded at 1.243 g cm⁻³, while the lowest values were recorded for the weight of the enlarged stem. The total plant value in the V1 variety reached 0.964 kg. The weight of the enlarged stem and the total yield decreased to 0.533 kg and 28.42 tons ha⁻¹, respectively, in the V3 variety, and the V2 variety gave the smallest stem size and the lowest dry matter percentage, amounting to 407.8 cm³ and 8.12%. Straight. The V4 variety gave the lowest specific weight of the enlarged stem, which amounted to 1.041 g cm⁻³, and the largest diameter of the enlarged stem, amounting to 11.36 cm.

Table 5. Effect of cultivar on Characteristics yield and components of Kohlrabi crop

Varieties	Total plant weight (kg)	Weight of enlarged stem (kg)	total yield (t ha ⁻¹)	Enlarged stem volume (cm ³)	Inflated stem length (cm)	Enlarged stem diameter (cm)	dry matter % in enlarged stem	The specific weight of enlarged stem g cm ⁻³
Green delicacy V₁	0.964 _b	0.569 _b	30.34 _b	538.9 _b	9.78 _a	10.67 _b	11.71 _a	1.049 _c
local V₂	1.118 _a	0.460 _d	24.53 _d	407.8 _c	9.07 _a	10.36 _b	8.12 _c	1.129 _b
Purple delicacy V₃	0.977 _b	0.533 _c	28.42 _c	428.3 _c	9.49 _a	10.65 _b	8.51 _c	1.243 _a
White Vienna V₄	1.005 _b	0.601 _a	32.03 _a	580 _a	10.51 _a	11.36 _a	10.74 _b	1.041 _c

***Means that share the same letters are not significantly different from each other according to Tukey’s multinomial test at the probability level of 0.05.**

Effect of spraying with Optimus-plus Nano fertilizer

The data in Table 6 showed a significant effect of spraying with the Optimus-plus preparation on all the studied traits. The F1 and F2 treatments were significantly different compared to the comparison treatment. Except for the total plant weight trait, which was distinguished by the F2 treatment plants, which amounted to 1.085 kg, it significantly differed from the F1 treatment, which gave 1.941 kg. In the rest of the traits, the differences were not significant between the F1 and F2 treatments, as the values of the enlarged stem traits for the two treatments were, respectively, as follows: For stem weight 0.500 kg and 0.577 kg, for total yield 30.93 and 30.78 kg, for stem volume 0.510.4 and 525.00 cm³, for stem length 10.29 and 10.21 cm, for stem diameter 11.70 and 11.88 cm, for dry matter percentage 10.33 and 10.15%, and specific gravity 1.151 and 1.113 g cm⁻³. The comparison treatment showed the lowest values for the above characteristics, as shown in the table.

Table 6. Effect of Spraying with Optimus-plus Nano lotion on Characteristics yield and its components of Kohlrabi crop

Optimus-plus Nano	Total plant weight (kg)	Weight of enlarged stem (kg)	total yield (t ha-1)	Enlarged stem volume (cm ³)	Inflated stem length (cm)	Enlarged stem diameter (cm)	dry matter % in enlarged stem	The specific weight of enlarged
Comparison Distilled water (F1) c	0.941	0.465	24.78	430.8	8.34	8.70	8.83	1.083
Concentration1.0 mL L-1 (F2) b	1.022	0.500	30.93	510.4	10.59	11.70	10.33	1.151
Concentration2.0 mL L-1 (F3) a	1.085	0.577	30.78	525.0	10.21	11.88	10.15	1.113

***Means that share the same letters are not significantly different from each other according to Tukey’s multinomial test at the probability level of 0.05.**

The effect of bilateral interaction between variety and the Optimus-plus Nano preparation

It is noted from the results of Table 7 that there is a significant effect of the binary interaction between the variety and spraying with the Optimus-plus preparation in all the studied traits. The F3 V2 treatment gave the best total plant weight, amounting to 1.227 kg,

while the V3F1 treatment recorded the lowest values for this trait, amounting to 0.900 kg. The two V1 treatments were distinguished. F3 and V4F2 had the best weight of the enlarged leg, reaching 0.647 and 0.640 kg, respectively. The lowest weight of the trait was recorded in treatment V3F1, which gave 0.405 kg. Treatments V1F3 and V4F2 excelled with the highest total yield of 34.51 and 34.13 tons ha⁻¹, respectively, while the yield declined to 21.62 tons e⁻¹ in treatment V2F1. The V4F3 treatment was characterized by the highest enlarged stem volume, which reached 635.0 cm³, while it decreased to 376.7 cm³ in the V2F1 treatment plants. The V4F2 treatment recorded the best length of the enlarged stem, reaching 11.16 cm, while it decreased to 7.45 cm in the V1F1 treatment plants. Treatment V4F3 showed the largest diameter of the enlarged stem, reaching 12.65 cm, while it decreased to 8.52 cm in treatment V1F1. The V1F2 intervention treatment gave the best dry matter percentage in the enlarged stem, reaching 12.46%, while this percentage decreased to 7.43% in the V2F1 treatment plants. The V3F2 treatment was characterized by the best specific weight of the enlarged stems, which amounted to 1.282 g cm⁻², while it decreased to 0.957 in the V1F1 treatment plants.

Table 7. Effect of interaction between variety and spraying with Optimus-plus nano preparation on vegetative growth characteristics of Kohlrabi crop

Interactions treatments	Total plant weight (kg)	Weight of enlarged stem (t _{cr})	total yield (t ha ⁻¹)	Enlarged stem volume (cm ³)	Inflated stem length (cm)	Enlarged stem diameter (cm)	dry matter % percentage in enlarged stem	The specific weight of enlarged stem g
V ₁ F ₁	49.19 Fg	13.88 d	116.73 f	43.73 e	18.64 e	2.509 h	17.26 c	7.937 bc
V ₁ F ₂	57.78 bcde	15.80 cd	150.87 def	49.67 cd	21.80 bcd	2.787 ef	19.27 a	9.863 abc
V ₁ F ₃	57.12 Cde	19.75 ab	202.93 abcd	48.07 cde	23.06 bc	2.856 cd	18.50 b	11.403 a
V ₂ F ₁	56.35 De	17.88 bc	145.67 ef	52.22 bc	22.67 bc	2.428 i	16.53 d	8.863 abc
V ₂ F ₂	62.31 abc	21.22 a	197.97 bcd	56.75 b	29.39 a	2.777 f	17.15 cd	11.390 a
V ₂ F ₃	63.37 ab	20.43 a	204.00 abc	61.23 a	29.76 a	2.846 de	16.93 cd	11.380 a
V ₃ F ₁	59.58 bcd	14.75 d	134.77 ef	52.55 bc	20.82 cde	2.587 g	15.48 e	7.823 bc
V ₃ F ₂	65.72 a	17.50 bc	212.27 abc	57.36 ab	27.39 a	2.918 bc	16.93 cd	11.210 a
V ₃ F ₃	66.43	15.86	173.13	62.13	28.45	3.084	16.84	10.493

	A	cd	cde	a	a	a	cd	ab
V₄F₁	45.89	15.35	142.17	37.46	19.32	2.570	16.53	7.627
	g	cd	ef	f	de	gh	d	c
V₄F₂	54.44	21.21	244.50	46.40	24.05	2.869	18.70	10.193
	def	a	ab	de	b	cd	ab	abc
V₄F₃	53.22	21.64	253.17	46.57	24.43	2.953	18.15	9.253
	ef	a	a	de	b	b	b	abc

*Means that share the same letters are not significantly different from each other according to Tukey's multinomial test at the probability level of 0.05.

B. Discussion

The results presented in Tables 2,3,4,5,6,and 7 show large differences between the varieties in most vegetative growth and yield characteristics. indicates the presence of hereditary (genetic) variation between these varieties, which in turn led to a difference in gene expression between the varieties despite The environmental factors being the same within one treatment; addition to the difference between the varieties may be due to the difference in the extent of the physiological response of the genes of these varieties when treated with Nano fertilizer and their efficiency in converting the products of the carbon assimilation process for the benefit of cell growth and elongation, which was reflected in the indicators of vegetative growth and yield. This result is consistent with what was found by ([9], [20], [10], and [8]) on Kohlrabi crop, and [1] on the Cabbage crop, and [2] on the cauliflower crop that the varieties They vary greatly in their growth and yield due to their varying genetic makeup.

As is clear from the data in the tables above, the foliar fertilization treatments with the Optimus-plus nano preparation F2 and F3 are superior in all vegetative growth and yield characteristics. This is due to the major role played by the nitrogen fertilizer, as it enters into the construction of chlorophyll, contributes to the vital reactions of amino and nuclear acids, builds proteins and is involved in all processes. The reactions associated with protoplasm, the enzymatic reactions, the process of photosynthesis, and stimulating the production of growth regulators make the parts of the plant juicy and prolongs their stay green for a longer period, especially since preparation is manufactured with Nano-specifications and that the nanoparticles have a high ability to penetrate and enter the various plant tissues, especially those added as a spray on the shoots ([15]; [13]; [17]).

CONCLUSION

The results showed that the characteristics yield of Kohlrabi of plant height, leaf length, chlorophyll content in the leaves, and the length and weight of the enlarged stem distinguished the Purple Delicacy variety. At the same time, the local variety gave the largest number of leaves, the largest leaf width, the highest length and diameter of the root, and the largest fresh weight of the plant. The White Vienna variety is distinguished by the

largest leaf area of the plant, the best diameter, size and weight of the enlarged stem, and the highest total yield. The two foliar spray treatments of 1.0 and 2.0 ml L⁻¹ of the Optimus-plus Nano preparation excelled without significant differences between them in all vegetative growth and yield

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*Conflict of Interest Statement:*The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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