Effect of foliar spraying with nano composite fertilizers and organic fertilizer (Optimus Plus) on growth traits varieties of corn

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Abstract

The experiment was conducted in the field during the 2022 at the Telafer site in two seasons (spring and autumn) to study the effect of two varieties of corn (Furat and Dejla) and eight levels of fertilizers (spraying with water only and adding 120 kg $N_{15}P_{15}K_{15}.ha^{-1}$ of traditional compound fertilizer and spray 1.5 and 3 g.L $^{-1}$ of $N_{20}P_{20}K_{20}$ nano fertilizer and spray 1 and 2 ml.L^{-1} of organic fertilizer Optimus Plus and spray 1.5g.L^{-1} of $N_{20}P_{20}K_{20}$ nano fertilizer +1 ml.L^{-1} of organic fertilizer and spray 3g.L^{-1} of $N_{20}P_{20}K_{20}$ nano fertilizer +2 ml .L^{-1} of organic fertilizer) . Use the R.C.B.D. design According to the split-plate system with three replications. The results showed that the Dejla variety was superior in the percentage of field emergence and plant height, while the Furat variety was superior in leaf area and leaf area index in both seasons and the number of plant leaves in the autumn season. As for fertilizers, the treatment of 2 ml.L^{-1} of organic fertilizer achieved the highest average in plant height and leaf area in the two seasons, the percentage of field emergence in the spring season and stem diameter in the autumn season, while the same treatment achieved the highest rate in the number of plant leaves, and the leaf area index. In the spring season and the treatment of 3g.L^{-1} of $N_{20}P_{20}K_{20}$ nano fertilizer + 2ml.L^{-1} of the organic fertilizer in the number of plant leaves and leaf area index in the autumn season. The effect of bilateral interaction was significant on all growth traits.

Keywords: organic fertilizer, nano fertilizer , NPK .

Introduction

Corn (*Zea mays* L.) comes third after wheat and rice in area and global productivity (1). Corn is used as food for humans, in addition to its entry as one of the basic ingredients in the diets of ruminants and poultry. It is also used in many food industries, such as the manufacture of corn starch, corn oil, sugary corn juice, the manufacture of gums, printing ink, rubber, and cork work (2). Despite its wide importance, the rate of production per unit area in Iraq is still low, as the productivity rate reached 474.1 thousand tons, with an average yield of 918.3 kg. dunum-1, and a cultivated area of 515.2 thousand. Dunum , Compared to the average global production, which amounted to 1174.6 million tons, with an average yield of 5.9 tons.e-1, and a cultivated area of 193.7 million hectares (3). therefore, different methods must be used to develop appropriate solutions to avoid problems and thus improve a high productivity rate, including choosing good varieties that are appropriate to the conditions Each region interacts with the main sources of growth in an optimal way, which is reflected in the growth and productivity of Corn. (4) noted the superiority of variety P3646HY in stem diameter and number of leaves compared to variety 630A37PW Morgan, (5) indicated in their study of three varieties of Corn (30Glg, BH-546, and BH-547) ,30Glg variety achieved an increase in plant height and no.of plant leaves, reaching (201.5 cm and 13.4 leaves. plant-1), while the BH variety scored - 546 The highest value in paper space was (5951.4 cm2) .

Nanotechnology is one of the modern technologies used in recent years in the field of

agriculture, as the use of nano-fertilizers is an effective alternative compared to traditional fertilizers, as it has been observed through many researches that the small size of nanomaterials facilitates an increase in the surface mass of the particles, and thus the nutrient ions are absorbed and released slowly for a period of time, and this leads to a balanced nutrition of crops throughout the growth period, which is reflected in agricultural production (6), as well as the ability of these nano-fertilizers to control orientation and increase the response by the plant as a result of its ability to transport compounds to the basic parts of the plant, whether roots or Stem or any other plant part (7) . (8) when using four concentrations of NPK nano-composite fertilizer (control treatment, 75, 150, and 225 PPM) there was a significant and gradual increase in plant height and number of plant leaves up to the level of 150 PPM compared with the control treatment.

Organic fertilizers are an effective alternative to chemical fertilizers with harmful effects. Organic fertilizers cause organic chemical changes, which in turn encourage plant growth and increase its ability to withstand water stress conditions by secreting growth-encouraging hormones and improving the ability of the root system to absorb a larger amount of nutrients. Water relations, which in turn limit and reduce the effects of water stress, which is reflected in the growth traits of the crop (9 and 10).

(11) indicated when they used six levels of organic and chemical fertilizers (0 and 25 kg.H-1 of organic fertilizer, 50 kg.H-1 of compound fertilizer NPK, 75 kg N.H-1 of urea fertilizer, and 100 kg.H-1 of a mixture of fertilizer Organic, NPK and urea fertilizer and 175 kg.H-1 mixture of organic fertilizer and compound fertilizer NPK. There was a significant increase in plant height, number of leaves and leaf area at the level of 100 kg.H-1 mixture of organic fertilizer, compound fertilizer NPK and urea, compared with other levels of Fertilizer. (12) showed that the addition treatment with organic fertilizer (a mixture of compost + sugar cane plant residues + fish fertilizer) at a concentration of 5 mg.H-1 led to a significant superiority in plant height, stem diameter and leaf area compared to the no-adding treatment. .

Material and methods

This experiment was carried out in two seasons (spring and autumn) during the agricultural season 2022 in one of the fields of the Telafer site, which is about 70 km west of the city of Mosul, in a mixed soil to study the effect of two varieties of corn (Furat and Dejla) and eight levels of fertilizers (spraying with water only which is control treatment and 120 kg.ha-1 of the traditional $N_{15}P_{15}K_{15}$ compound fertilizer and 1.5 and 3 gm.l-1 of the NPK nano-compound fertilizer and 1 and 2 ml-l-1 of the organic fertilizer Optimus Plus and 1.5g.L-1 of the $N_{20}P_{20}K_{20}$ nano-compound fertilizer + 1 ml.L-1 of organic fertilizer and 3g.L-1 of $N_{20}P_{20}K_{20}$ nano-compound fertilizer + 2ml.L-1 of organic fertilizer) , Where the traditional $N_{15}P_5K_{15}$ compound fertilizer was added to the soil and in one batch, while the plants were treated by spraying fertilizers on the leaves until complete wetness and by two sprays. The first spray of $N_{20}P_{20}K_{20}$ nano fertilizer was 40 days after germination, and the second was 14 days after the first spray, while the first is for the organic fertilizer after 47 days of germination and the second is after 14 days of the first spraying, depend on on the information on the envelopes containing the fertilizers. A random complete block design was used split plots system, where varieties occupied the main plots, while fertilizers occupied the secondary plots, with three replications. Duncan's multiple range test was used at a 5% probability level to compare the means. The experimental unit included four fences, each with a length of 300cm, space between each fence was 75cm, and the distance between each hole was 25cm.

Some physical and chemical traits of the soil of the experimental site were analyzed before sowing (Table 1), and data on temperature and relative humidity were obtained from the meteorological station of the Nineveh Agriculture Directorate / Planning Department (Table 2).

Table (1): soil traits for Telafer location.

Clay ($g.kg^{-1}$)	Silt ($g.kg^{-1}$)	Sand ($g.kg^{-1}$	Textural	Available N ($mg.kg^{-1}$)	Available p ($mg.kg^{-1}$)	Available k ($mg.kg^{-1}$)	organic matter $g.kg^{-1}$	pH	EC (dc/m)
51.05	32.5	16.45	mixture	0.03	6.56	13.00	4.76	7.5	0.20

Table (2):Temp. (C°) and Rain (mm) for the year 2022 in Telafer location.

Month	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.
temperature (c°) (Maximum)	21	28	39	40	41	43	37	39	30
temperature (c°) (Maximum)	5	9	12	22	24	25	21	11	9
Rainfall (mm)	23	27	29	30	31	32	36	47	48

- Mosul weather station

Results and discussion

Percentage of field emergence: Table (3) indicate that the Dijla variety achieved significant increase by giving it the highest average for the trait, as it reached (94.07 and 93.93%) for both seasons, respectively, compared to the Furat variety, which gave the lowest average amounting to (91.91 and 92.89%) for both seasons. Respectively, this may be attributed to the genetic variation between the two varieties in the process of seed imbibition and the effect on the effectiveness of vital processes, which leads to cell division and elongation, thus the speed of gall and root formation.This agreed with(13)and (14).

Fertilizers showed a significant variance in this trait for both seasons. In the spring season, the Org. fertilizer 2 ml.L-1 reached the high rate in the trait (95.96%) while control treatment give the lowest rate (90.50%). In the autumn season, the nanocomposite fertilizer recorded 1.5 gm.l-1 + Org. fertilizer 1ml.L-1 has the highest rate (95.83%) compared to the Con. Treat.. that recorded the lowest rate (91.33%).This may be due to the role of the organic fertilizer in increasing the ability of the seed to imbibition and absorb water. and this indicates the activity and quality of enzymes necessary for the germination process, and thus the speed of radical and root formation. This agreed with (15) and (16).

The interaction was a significant in this trait in the two seasons. In spring season, the variety Dejla with the Org. fertilizer 2ml.L-1 achieved the highest rate for the trait (96.91%) compared to the overlap of the variety Furat with the Org. fertilizer 1ml.L-1 ,which was recorded the lowest rate (89.33%), while in the autumn season, the interaction of the variety Degla with the nano composite fertilizer 1.5g.L-1 + Org. fertilizer 1ml.L-1 recorded the highest rate for the trait (96.33%) compared to the interaction of the variety Furat with the nano composite fertilizer 1.5 g.L-1, which recorded the lowest rate reached (90.00%) .

Plant height (cm): The results of table (4) show that the variety Dijla recorded the highest significant mean for the trait (144.25 and 184.12 cm), , while Furat variety, which achieved the lowest rate (139.39 and 182.57 cm) in both seasons. Increase in height of the variety Dijla is due to its superiority in the percentage of field emergence(Table 3),and this enables the seedlings to grow and develop rapidly in a shorter time, and then give them taller and stronger plants .This result is in line with(5) and (17).

Fertilizers had a significant effect on this trait in the two seasons, as the Org. fertilizer 2 ml.L-1 achieved to the highest value (145.16 and 188.70 cm) ,while Con. Treat. , which achieved the minimum value (138.79 and 179.47%) in the two seasons, respectively. The reason for this may be due to the effectiveness of the organic fertilizer in increasing the ability of nitrogen to divide and elongate the cells, as well as its entry into the formation of the amino acid tryptophan, which is important in the elongation of plant cells (18) and thus increasing the elongation of the internodes, which is reflected in plant height. This concur with (12) and (19).

The overlap showed significant differences in this trait in the two seasons. In the spring season, the overlap of the variety Dijla with the Org. fertilizer 2 ml.L-1 achieved the higher rate (152.27 cm) compared to the overlap of the variety Furat with Con. Treat.. (134.33 cm). while in the autumn season, the interaction of the variety Dijla with the Org. fertilizer 2ml.L-1 achieved the highest rate (189.53 cm) compared to the interaction of the variety Dijla with the Con. Treat.. (178.13 cm).

Stem diameter (cm): The results of Table (5) indicate that there are no significant differences between varieties in stem diameter in the two seasons, this agree with (20).

Fertilizer levels did not have reach the level of significance in the trait in the spring season, this goes with (21), while in the autumn season, the Org. fertilizer 2ml.l-1 achieved the higher rate in the trait (3.05 cm) compared to the Con. Treat.., which achieved the lowest rate (2.66 cm) .The reason for this increase may be due to the ability of the organic fertilizer to provide the plant with nutrients, improve the properties of the soil, increase its ability to retain moisture and its role in availability for nitrogen, which increased in vegetative growth of plant and also increase in the number and size of vascular bundles or both, which is reflected in the increase in the division and elongation of plant cells Including the stem. This finding is in line with (4).

This trait was significantly superior in the two-season overlap. In the spring season, the interaction of the Furat variety with the traditional compound fertilizer 120 kg.H-1 recorded the highest rate of the trait (2.14 cm) compared to the interaction of the variety Dejla with the nano composite fertilizer 1.5 g.L-1 + Org. fertilizer. 2ml.L-1, which recorded the lowest rate (1.92 cm), while in the autumn season, the overlap of the Furat variety with nano composite fertilizer 1.5g.L-1 + Org. fertilizer 1ml.L-1 reached the higher rate (3.08 cm) compared to overlapped the variety Dijla with the Con. Treat.., which achievied (2.44 cm).

Number of leaves. Plant-1: Table (6) showed that there were no significant differences between the varieties in the number of leaves. Plant-1 in the spring season. .In the autumn season, the differences were significant, and the variety Furat recorded the highest significant mean for the trait (13.86 leaf.plant-1), while the variety Dijla recorded the lowest mean (13.57 leaf.plant-1). This may be attributed to the nature of the growth of the Furat variety compared to variety Dijla. This is similar with (17) and (22).

Fertilizers showed significant differences in this trait in the two seasons. In the spring season, the Org. fertilizer 2ml.L-1 gave the higher rate (12.92 leaf.plant-1), compared to the Con. Treat.., which achieved the lowest rate (12.30 leaf.plant-1). In the autumn season, the nano composite fertilizer 3g.L-1 + Org. fertilizer 2ml.l-1 achieved higher rate (14.22 leaf.plant-1) compared to the Con. Treat.., which achieved (13.13 leaf.plant-1). This may be attributed to the positive effect of the interaction between the nano-fertilizer and the organic fertilizer, which encouraged the elongation of the internodes of some coronary nodes located below the soil surface and their emergence above the soil surface, which increased number of branches and thus an increased in the no. of plant leaves. The results agreed with (11) and (23).

The overlap shown significant difference in the trait in both seasons. In the spring season, the

overlap of the variety Dejla with the traditional compound fertilizer of 120 kg.H-1 gave it the highest rate for the trait (13.28 leaf.plant-1) compared to the overlap of the variety Furat with the 1.5 nanocomposite fertilizer. gm.l-1 + Org. fertilizer 1ml.L-1, which gave the lowest rate (12.00 leaf.plant-1), while in the autumn season, the interaction of the variety Furat with nanocomplex fertilizer gave 1.5g.L-1 + Org. fertilizer 1ml. L-1 had the highest rate for the trait (14.67 leaf.plant-1), compared to the interaction of the variety Dijla with the Con. Treat.., which gave the lowest rate (12.67 leaf.plant-1).

Table (3): The effect of varieties , fertilizers and interaction on field emergence percentage.

Spring Season			
Fertilizer	Varieties		Fertilizer averages
	Furat	Dejla	
control treatment(Con. Treat..)	90.00 gh	91.00 f-h	90.50 e
$N_{15}P_{15}K_{15}$ Traditional 120kg.ha-1	91.67 e-h	94.00 b-e	92.83 cd
Nano $N_{20}P_{20}K_{20}$ 1.5g.L-1	92.72 c-f	95.68 ab	94.20 bc
Nano $N_{20}P_{20}K_{20}$ 3g.L-1	92.00 d-g	94.33 b-d	93.17 b-d
Org. Fertilizer 1ml.L-1	89.33 h	92.33 d-g	90.83 e
Org. Fertilizer 2ml.L-1	95.00 a-c	96.91 a	95.96 a
Nano $N_{20}P_{20}K_{20}$ 1.5g.L-1+ Org. fertilizer 1ml. L-1	90.67 f-h	92.67 c-f	91.67 de
Nano $N_{20}P_{20}K_{20}$ 3g.L-1 + Org. fertilizer 2ml. $L\text{-}1^{1-}$	93.94 b-e	95.67 ab	94.81 ab
Varieties averages	91.91 b	94.07 a	
Autumn Season			
Fertilizer	Vaarieties		Fertilizer averages
	Furat	Dejla	
control treatment (Con. Treat..)	90.33 fg	92.33 d-g	91.33 d
$N_{15}P_{15}K_{15}$ Traditional 120kg.ha-1	91.67 e-g	93.00 c-e	92.33 cd
Nano $N_{20}P_{20}K_{20}$ 1.5g.L-1	90.00 g	93.00 c-e	91.50 d
Nano $N_{20}P_{20}K_{20}$ 3g.L-1	92.67 d-f	94.67 a-d	93.67 bc
Org. Fertilizer 1ml.L-1	92.67 d-f	94.33 a-d	93.50 bc
Org. Fertilizer 2ml.L-1	95.57 ab	94.23 a-d	94.90 ab
Nano $N_{20}P_{20}K_{20}$ 1.5g.L-1+ Org. fertilizer 1ml. L-1	95.33 a-c	96.33 a	95.83 a
Nano $N_{20}P_{20}K_{20}$ 3g.L-1 + Org. fertilizer 2ml. $L\text{-}1^{1-}$	94.83 a-d	93.53 b-e	94.18 b
Varieties averages	92.89 b	93.93 a	

Similar letters within the factors or overlaps are not significantly different from each other at the probability level of 1 and 5% .

Table (4): Effect of varieties , fertilizers and interaction on plant height (cm).

Spring Season			
Fertilizers	Varieties		Fertilizer averages
	Furat	Dejla	
control treatment (Con. Treat..)	134.33 h	143.24 cd	138.79 d
$N_{15}P_{15}K_{15}$ Traditional 120kg.ha-1	140.94 c-e	142.55 cd	141.69 bc
Nano $N_{20}P_{20}K_{20}$ 1.5g.L-1	139.66 ef	146.39 b	143.02 b
Nano $N_{20}P_{20}K_{20}$ 3g.L-1	142.50 cd	141.39 c-e	141.94 bc
Org. Fertilizer 1ml.L-1	140.50 d-f	140.89 c-e	140.69 c
Org. Fertilizer 2ml.L-1	138.05 fg	152.27 a	145.16 a
Nano $N_{20}P_{20}K_{20}$ 1.5g.L-1+ Org. fertilizer 1ml. L-1	142.05 c-e	140.94 c-e	141.49 bc
Nano $N_{20}P_{20}K_{20}$ 3g.L-1 + Org. fertilizer 2ml. $L\text{-}1^{1-}$	137.05 g	146.33 b	141.69 bc
Varieties averages	139.39 b	144.25 a	
Autumn season			
Fertilizer	Varieties		Fertilizer averages
	Furat	Dejla	
control treatment(Con. Treat..)	180.80 fg	178.13 h	179.47 d
$N_{15}P_{15}K_{15}$ Traditional 120kg.ha-1	180.27 f-h	185.47 cd	182.87 c
Nano $N_{20}P_{20}K_{20}$ 1.5g.L-1	178.93 gh	181.13 fg	180.03 d
Nano $N_{20}P_{20}K_{20}$ 3g.L-1	182.467 ef	185.93 b-d	184.20 bc
Org. Fertilizer 1ml.L-1	179.40 gh	188.33 ab	183.87 bc
Org. Fertilizer 2ml.L-1	187.87 a-c	189.53 a	188.70 a
Nano $N_{20}P_{20}K_{20}$ 1.5g.L-1+ Org. fertilizer 1ml. L-1	190.40 a	179.73 gh	185.06 b
Nano $N_{20}P_{20}K_{20}$ 3g.L-1 + Org. fertilizer 2ml. $L\text{-}1^{1-}$	180.40 f-h	84.67 de	182.53 c
Varieties averages	182.57 b	184.12 a	

Similar letters within the factors or overlaps are not significantly different from each other at the probability level of 1 and 5%.

Table (5): Effect of varieties , fertilizers and interaction on stem diameter (cm).

Spring Season			
Fertilizer	Varieties		Fertilizer averages
	Furat	Dejla	
control treatment (Con. Treat.)	2.04 a-d	1.96 b-d	2.00 a
$N_{15}P_{15}K_{15}$ Traditional 120kg.ha-1	2.14 a	2.00 a-d	2.07 a
Nano $N_{20}P_{20}K_{20}$ 1.5g.L-1	2.06 a-d	1.99 a-d	2.02 a
Nano $N_{20}P_{20}K_{20}$ 3g.L-1	2.08 a-d	1.99 a-d	2.03 a
Org. Fertilizer 1ml.L-1	2.09 a-c	1.95 cd	2.02 a
Org. Fertilizer 2ml.L-1	2.09 a-c	2.07 a-d	2.08 a
+ Nano $N_{20}P_{20}K_{20}$ 1.5g.L-1 Org. fertilizer 1ml. L-1	2.07 a-d	1.92 d	1.99 a
Nano $N_{20}P_{20}K_{20}$ 3g.L-1 + Org. fertilizer 2ml. $L\text{-}1^{1-}$	2.13 ab	1.93 cd	2.02 a
Varieties averages	2.09	1.98	

Autumn Season			
Fertilizer	Varieties		Fertilizer averages
	Furat	Dejla	
control treatment (Con. Treat..)	2.89 a-d	2.44 e	2.66 c
$N_{15}P_{15}K_{15}$ Traditional 120kg.ha-1	2.97 a-c	2.66 d-e	2.82 bc
Nano $N_{20}P_{20}K_{20}$ 1.5g.L-1	2.69 c-e	2.89 a-d	2.79 bc
Nano $N_{20}P_{20}K_{20}$ 3g.L-1	2.87 a-d	2.81 a-d	2.84 bc
Org. Fertilizer 1ml.L-1	2.88 a-d	2.79 a-d	2.84 bc
Org. Fertilizer 2ml.L-1	3.05 ab	3.05 ab	3.05 a
+ Nano $N_{20}P_{20}K_{20}$ 1.5g.L-1 Org. fertilizer 1ml. L-1	2.75 b-d	2.94 a-d	2.85 bc
Nano $N_{20}P_{20}K_{20}$ 3g.L-1 + Org. fertilizer 2ml. $L\text{-}1^{1-}$	3.08 a	2.89 a-d	2.98 ab
Varieties averages	2.89	2.81	

Similar letters within the factors or overlaps are not significantly different from each other at the probability level of 1 and 5%.

Table (6): the effect of varieties, fertilizers and interaction on the number of leaves. plant-1.

Spring season			
Fertilizer	Varieties		Fertilizer averages
	Furat	Dijla	
control treatment (Con. Treat..)	12.49 c-f	12.11 fg	12.30 c
$N_{15}P_{15}K_{15}$ Traditional 120kg.ha-1	12.07 fg	13.28 a	12.67 ab
Nano $N_{20}P_{20}K_{20}$ 1.5g.L-1	12.67 b-d	12.11 fg	12.38 bc
Nano $N_{20}P_{20}K_{20}$ 3g.L-1	12.22 d-g	12.16 e-g	12.19 c
Org. Fertilizer 1ml.L-1	12.22 d-g	12.33 c-g	12.27 c
Org. Fertilizer 2ml.L-1	13.11 ab	12.72 bc	12.91 a
Nano $N_{20}P_{20}K_{20}$ 1.5g.L-1+ Org. fertilizer 1ml. L-1	12.00 f	12.28 c-g	12.14 c
Nano $N_{20}P_{20}K_{20}$ 3g.L-1 + Org. fertilizer 2ml. $L\text{-}1^{1-}$	12.62 c-e	12.72 bc	12.67 ab
Varieties averages	12.42	12.46	
Autumn season			
Fertilizer	Varieties		Fertilizer averages
	Furat	Dijla	
control treatment (Con. Treat..)	13.60 cd	12.67 h	13.13 d
$N_{15}P_{15}K_{15}$ Traditional 120kg.ha-1	14.13 b	13.47 d-f	13.80 bc
Nano $N_{20}P_{20}K_{20}$ 1.5g.L-1	13.27 e-g	14.00 bc	13.63 c
Nano $N_{20}P_{20}K_{20}$ 3g.L-1	14.27 ab	13.60 c-e	13.93 a-c
Org. Fertilizer 1ml.L-1	12.93 gh	13.27 e-g	13.10 d
Org. Fertilizer 2ml.L-1	13.83 b-d	14.27 ab	14.05 ab
Nano $N_{20}P_{20}K_{20}$ 1.5g.L-1+ Org. fertilizer 1ml. L-1	14.67 a	13.00 f-h	13.83 bc
Nano $N_{20}P_{20}K_{20}$ 3g.L-1 + Org. fertilizer 2ml. $L\text{-}1^{1-}$	14.17 ab	14.27 ab	14.22 a
Varieties averages	13.86 a	13.57 b	

Similar letters within the factors or overlaps are not significantly different from each other at the probability level of 1 and 5%.

Leaf area (cm2): Table (7) indicates the significant superiority of the variety Dijla in leaf area in the two seasons (3266.33 and 4624.06 cm2), respectively, compared to the variety Dijla, which gave the lowest rate f (2909.33 and 4174.92 cm2). The supremacy of the Furat variety is due to the increase in number of leaves (Table 6). This agreed with what was found by (24) .

Significant differences were observed between the fertilizers in this trait in the two seasons. In the spring season, the Org. fertilizer 2ml.L-1 was significantly superior in this trait to (3754.70 cm2) compared to the Con. Treat..,which achieved the lowest rate (2597.00 cm2), while in the autumn season it was The two treatments of fertilization with Org. fertilizer 2ml.L-1 and nano composite fertilizer 3g.L-1 + Org. fertilizer 2ml. L-1 achieved the higher significant rate (4464.08 and 4592.52 cm2), respectively, compared to the Con. Treat.., which achieved the lowest rate (4069.52 cm2). The reason for this may be attributed to the superiority in the number of plant leaves (Table 6). This result is in line with (12) and (25).

The interaction showed a significant difference in this trait in the two seasons. In the spring season, the interaction of the variety Furat with the Org. fertilizer 2ml.L-1 recorded the highest rate for the trait (3900.10 cm2), while the interaction of the variety Dejla with the nano composite fertilizer 3g.L-1 recorded the lowest rate (2244.40 cm2). In the autumn season, the interactions between the Furat variety with the Org. fertilizer 2ml.L-1 and the nano composite fertilizer 1.5gm.l-1 + Org. fertilizer 1ml.L-1 and the nano composite fertilizer 3g.L-1 + Org. fertilizer 2ml.l-1 were achieved the higher values (4924.75, 4942.13, and 4955.60 cm2), respectively, while the overlap of the variety Dijla with Con. Treat.. recorded the lowest rate, which amounted to (3893.30 cm2).

Leaf area index: Show table (8) the variety Furat excelled in this trait (1.74 and 2.44) in the two seasons, respectively, while variety Dijla, which achieved the minimum mean (1.55 and 2.23). The reason for the significant increase in this trait in the variety Furat may be attributed to the significant increase in its leaf area (Table 7). The results agreed with (26) and (27).

This trait was affected significantly by the different fertilizers used in the two seasons. In the spring season was observed a significant increase in this trait when the Org. fertilizer was treated with 2 ml. L-1 (2.00) while to Con. Treat. achieved minimum rate (1.39), while in the autumn season, the nano composite fertilizer recorded 3 g. L-1 + Org. fertilizer 2 ml. L-1 had the highest rate for the trait (2.45), while the Con. Treat. gave (2.17). The reason for the increase may be due to the increase in leaf area (Table 7). The results are in line with (28) and (29).

The interaction showed significant differences in this trait in the two seasons. In the spring season, the interaction of the variety Furat with the Org. fertilizer 2 ml .l-1 achieved the highest value for the trait, which was equal to (2.08) compared to the interaction of the variety Dijla with the nanocomposite fertilizer 3 gm.l - 1, which achieved the lowest rate, which was equal to (1.20), while in the autumn season, the interaction of the variety Furat with the nanocomposite fertilizer 1.5 g was recorded. L-1 + Org. fertilizer 1 ml. L-1 and the interaction of the variety Furat with nanocomposite fertilizer 3 g. L-1+ Org. fertilizer 2 ml. L-1 had the highest mean for the trait (2.63, 2.64), respectively, compared to the interaction of the variety Dijla with the Con. Treat., which recorded the lowest mean (2.08).

Table (7): Effect of cultivars, fertilizers and interaction on leaf area (cm2).

Spring Season			
Fertilizer	Varieties		Fertilizer averages
	Furat	Dijla	
control treatment (Con. Treat..)	2737.0 gh	2457.0 hi	2597.0 e
$N_{15}P_{15}K_{15}$ Traditional 120kg.ha-1	2866.7 fg	2994.9 d-g	2930.8 cd
Nano $N_{20}P_{20}K_{20}$ 1.5g.L-1	3204.6 c-e	2489.9 hi	2847.3 c
Nano $N_{20}P_{20}K_{20}$ 3g.L-1	3269.1 cd	2244.4 i	2756.7 cd
Org. Fertilizer 1ml.L-1	3211.8 c-e	3400.7 bc	3306.3 c
Org. Fertilizer 2ml.L-1	3900.1 a	3609.3 ab	3754.7 a
+ Nano $N_{20}P_{20}K_{20}$1.5g.L-1 Org. fertilizer 1ml. L-1	3262.9 cd	2912.7 e-g	3087.8 c
Nano $N_{20}P_{20}K_{20}$3g.L-1 + Org. fertilizer 2ml. L-1[1-]	3678.4 ab	3165.3 c-f	3421.9 b
Varieties averages	3266.33 a	2909.29 b	
Autumn Season			
Fertilizer	Varieties		Fertilizer averages
	Furat	Dijla	
control treatment (Con. Treat..)	4245.53 fg	3893.50 i	4069.52 e
$N_{15}P_{15}K_{15}$ Traditional 120kg.ha-1	4324.40 d-f	4183.05 g	4253.73 d
Nano $N_{20}P_{20}K_{20}$1.5g.L-1	4413.47 cd	4279.52 e-g	4346.49 c
Nano $N_{20}P_{20}K_{20}$3g.L-1	4816.47 b	3999.85 h	4408.16 bc
Org. Fertilizer 1ml.L-1	4370.12 de	4498.60 c	4434.36 b
Org. Fertilizer 2ml.L-1	4924.75 a	4329.40 d-f	4627.08 a
+ Nano $N_{20}P_{20}K_{20}$1.5g.L-1 Org. fertilizer 1ml. L-1	4942.13 a	3986.00 hi	4464.07 b
Nano $N_{20}P_{20}K_{20}$3g.L-1 + Org. fertilizer 2ml. L-1[1-]	4955.60 a	4229.43 fg	4592.52 a
Varieties averages	4624.06 a	4174.92 b	

Similar letters within the factors or overlaps are not significantly different from each other at the probability level of 1 and 5%.

Table (8): Effect of cultivars, fertilizers and interaction on leaf area index.

Spring Season			
Fertilizer	Varieties		Fertilizer averages
	Furat	Dijla	
control treatment (Con. Treat..)	1.46 fg	1.31 gh	1.39 e
$N_{15}P_{15}K_{15}$ Traditional 120kg.ha-1	1.53 ef	1.60 d-f	1.57 cd
Nano $N_{20}P_{20}K_{20}$ 1.5g.L-1	1.71 c-e	1.33 gh	1.52 cd
Nano $N_{20}P_{20}K_{20}$3g.L-1	1.74 cd	1.20 h	1.47 de
Org. Fertilizer 1ml.L-1	1.71 c-e	1.81 bc	1.76 b
Org. Fertilizer 2ml.L-1	2.08 a	1.93 ab	2.00 a
+ Nano $N_{20}P_{20}K_{20}$1.5g.L-1 Org. fertilizer 1ml. L-1	1.74 cd	1.53 ef	1.64 c
Nano $N_{20}P_{20}K_{20}$3g.L-1 + Org. fertilizer 2ml. L-1^{1-}	1.96 ab	1.69 c-e	1.83 b
Varieties averages	1.74 a	1.55 ب	
Autumn Season			
Fertilizer	Varieties		Fertilizer averages
	Furat	Dijla	
control treatment (Con. Treat..)	2.26 de	2.08 f	2.17 c
$N_{15}P_{15}K_{15}$ Traditional 120kg.ha-1	2.31 cd	2.23 ef	2.27 bc
Nano $N_{20}P_{20}K_{20}$1.5g.L-1	2.35 cd	2.28 c-e	2.32 b
Nano $N_{20}P_{20}K_{20}$3g.L-1	2.57 ab	2.13 ef	2.35 ab
Org. Fertilizer 1ml.L-1	2.33 cd	2.40 cd	2.36 ab
Org. Fertilizer 2ml.L-1	2.45 bc	2.31 cd	2.38 ab
+ Nano $N_{20}P_{20}K_{20}$1.5g.L-1 Org. fertilizer 1ml. L-1	2.63 a	2.13 ef	2.38 ab
Nano $N_{20}P_{20}K_{20}$3g.L-1 + Org. fertilizer 2ml. L-1^{1-}	2.64 a	2.26 de	2.45 a
Varieties averages	2.44 a	2.23 b	

Similar letters within the factors or overlaps are not significantly different from each other at the probability level of 1 and 5%.

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