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The Effect Of Planting Distances And Different Fertilizer Combinations On Some Growth Traits Of Sunflower Crop (Helianthus Annuus L.)

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Abstract:

A field experiment was carried out during the spring season 2021 in an agricultural field in Al-Rumaitha district, 25 km from the center of Al-Muthanna Governorate, to study the effect of planting distances and different fertilizer combinations on the purchasing value and the size of sunflower seeds (Shmoos). A factorial experiment using the split plot design method, according to a randomized complete block design, R.C.B.D, with three replicates. The experiment included the study of two factors, the first factor was four planting distances: (55, 45, 35 and 25) cm, the second factor was four different fertilizer combinations of NPK and organic acids: (100%, 1/4, 1/2 and 3/4) kg ha^{-1}. The seeds were sown at 3/15/2021 with different distances between one plant and another and 75 cm between one line and another. The results show that the wide planting distance between sunflower plants significantly affected most of the vegetative growth characteristics, the distance of 55 cm was superior in giving the highest average of leaf area, stem diameter and seed length, the planting distance of 25 cm was significantly superior in giving the highest average plant height. The addition of different fertilizer combinations affected all vegetative growth characteristics, the fertilizer level exceeded F3 (120 kg N ha^{-1},75 kg P2O5 ha^{-1},120 kg K2O ha^{-1} +30 kg ha^{-1} humic and fulvic) on plant height, leaf area, stem diameter, and seed length. The effect of the interaction between the two factors of the study was significant on most of the studied traits, the treatment F3D4 was significantly superior by giving it the highest mean of leaf area, stem diameter and seed length.

Keywords: planting distances, NPK, organic acids, growth traits, sunflower (Helianthus annuus L.).

Introduction :

Sunflower crop (Helianthus annuus L.), one of the most important and strategic oilseed crops of the compound family Asteraceae, worldwide adaptation, it is successful in its cultivation in different environmental and climatic conditions (Al-Jiashi, 2014).

The sunflower crop is characterized by its dual purpose, either oily or non-oily, its oil varieties are a raw material for most industries, such as the manufacture of vegetable butter, bread products, biscuits, the manufacture of soap, dyes and other industries (Al-Badri, 2013). As for its non-oily varieties, its importance and consumption are concentrated in human nutrition, it is palatable, has a high nutritional value and has a very distinctive flavor after roasting (Al-Rawi et al., 2013).

Each 46 grams of dry sunflower seeds contains 370 calories, it has a high nutritional value, contains a range of nutrients, including phosphorous, calcium, copper, iron, zinc, and a group of vitamins (A, B6, D, E), the availability of dietary fiber and fatty acids (Nandha, 2014; Anjum et al, 2010). The crop cake is also used as fodder for farm animals, contains 30-30% protein and carbohydrates as for the stems, they can be used as fuel (Al-Baldawi, 2014).

Determining planting distances between plants is one of the most important agricultural operations, it has a significant effect in reducing competition between plants, has to do with plant growth and the depletion of nutrients from the soil, affects the light transmitted and the heat available to plants, for their direct impact on the completion of the process of carbon metabolism, reflects on most of the physiological processes that contribute to increasing seed production (Al-Hasawi, 2014).

The use of different fertilizer combinations of N, P, K and organic acids (humic and fulvic), important than determining the agricultural distances between plants, the process of adding fertilizer mixtures is considered the important and influential agricultural processes in increasing production (Al-Zubaidi and Al-Awsi, 2017). The abundance of vegetative growth is positively reflected on the increase in yield per unit area, using many means, including the use of different fertilizer combinations, the addition of nitrogen fertilizer treatment at a level of 150 kg N e^{-1} gave the highest mean of both plant height and leaf area index (Awais et al, 2015). Al-Araji and Al-Tamimi (2020) indicated the superiority of the second level of humic acid 50 kg ha^{-1} significantly in giving the highest average plant height and leaf area compared to the comparison treatment that gave the lowest average. Abd El-Satar et al(,2017) when using different levels of nitrogen showed a significant increase in plant height and stem diameter at the level of 45 kg N ha^{-1} compared to the fertilizer level 15 kg N ha^{-1}, which gave the lowest average. Al-Mughair (2019) indicated in a study conducted on sunflower plants that there was a significant increase in the mean of plant height, stem diameter, leaf area and leaf area index, the treatment of adding F3 fertilizer gave the highest average for the two study seasons compared to the treatment of adding F1 fertilizer, which gave the lowest average.

This study aims to determine the best distance between plants to get full and large seeds, and determining the best fertilizer combinations of NPK fertilizer and organic acids (humic and fulvic) affecting in increasing the size and number of seeds per disc.

Materials and Methods:

Experiment site

A field experiment was conducted at Al-Rumaitha district (25 km north of Al-Muthanna governorate center) in the land belonging to a farmer during the spring season 2021 to determine the effect of planting distances and different fertilizer combinations on the purchasing value and the size of sunflower seeds.

Factors of the Study:

The experiment involved studying two factors:

The first factor: four planting distance between plants and symbolized by the letter D, were:

D1: 25 cm/plant density 53.333 plants ha^{-1}

D2: 35 cm/plant density 38.095 plants ha^{-1}
D3: 45 cm / plant density 29.629 plants ha^{-1}
D4: 55 cm / plant density 24.242 plants ha^{-1}
The second factor: Four fertilizer combinations of NPK and organic acids (humic and fulvic) and symbolized by the letter F, namely:
1/4 Fertilizer Recommendation: F1(40 kg N ha^{-1},25 kg P_2O_5 ha^{-1},40 kg K_2OH-1)+ 30 kg ha^{-1} humic and fulvic.
1/2 Fertilizer Recommendation: F2 (80 kg N ha^{-1}, 50 kg P_20_5 ha^{-1}, 80kg K_2O ha^{-1}) + 30 ha^{-1} humic and Fulvic.
3/4 Fertilizer Recommendation: F3(120 kg N ha^{-1}, 75 kg P_2O_5 ha^{-1}, 120 kg K_2O H^{-1})+ 30 kg ha^{-1} humic and fulvic.
100% Fertilizer Recommendation: F4 (160 kg N ha^{-1}, 100 kg P_2O_5 ha^{-1}, 160 kg K_2O H^{-1}).

Design of the experiment:
The experiment was conducted according to the design of factorial trials within a slit using the randomized complete block design (R.C.B.D) with three replicates. The experiment included 48 experimental units that represented all the combinations between the studied factors and their frequencies. The different fertilizer combinations represented the main plots (Main Plot) and the agricultural distances represented the secondary plots (Sub Plot).

Soil analysis:
Samples were taken from the field soil before planting and from different locations of the ground at a depth of 0-30 cm after removing plant residues. The soil was pneumatically dried, crushed, then sieved into a sieve with holes 2 mm in diameter and mixed well to homogenize it, take representative samples, physical and chemical analyzes were performed on it, the results of which are shown in table (1).

Planting operations:
After selecting the appropriate land for the experiment, after conducting physical and chemical analyzes of the field soil, the experimental land was plowed perpendicularly using the inverted plow, it was smoothed and smoothed. The field was divided into three blocks, each block divided into 16 experimental units, the area of each experimental unit 12 m^2 (4 * 3 m), included 4 lines, the length of the lines was 4 m, and the distance between one line and another was 75 cm, given irrigation and left until the appropriate drought to carry out the cultivation process, Shmoos cultivar seeds were sown on 15/3/2021 at a depth of 3 cm, by three seeds per hole (Al-Sahoki, 1994). At the upper third of the line, the thinning process was carried out after the emergence of seedlings and the formation of the first pair of true leaves, one seedling was left in each hole, the field was irrigated by 8 irrigations, distributed over the growing season. Weeding was also carried out as needed. Use urea fertilizer (46% N) as a source of nitrogen, triple Super Phosphate (P_2O_5) 46% as a source of phosphorous, Potassium sulfate 50% (K2O) as a source of potassium, with a fertilizer recommendation of 160 kg (N ha^{-1}), 100 kg (P_2O_5 ha^{-1}) and 160 kg (K_2O ha^{-1}) (Al-Abedy, 2011). The plant was harvested on 23/6/2021 when signs of full maturity appeared and the back of the tablets turned yellow, and the beginning of the coloration of the outer rings in brown.

Traits studied

The data of growth traits were taken as an average of ten plants taken randomly from the experimental units and from the two average values at the 50% flowering stage.

Plant height (cm): measured from the surface of the soil to the base of the disc.

Leaf area (cm²): It was calculated using the equation mentioned (Hardan and Al-Sahoki, 2014).
The sum of the squares of the width of the fifth roll leaf × 4.04

Stem Diameter (cm): Measure at the center of the stem of the plant using the Vernier Foot Machine.

Seed length (mm): Calculated using Vernier.

Statistical analysis:

The data was analyzed for the studied traits, statistically analyzed according to the used design and using the statistical program Genstat, the mean differences were tested using the least significant difference (LSD) at the level of significance (0.05) (Al-Rawi and Khalaf Allah, 1980).

Table (1): Physical and chemical properties of soil before planting.

Parameters	Unit	Value
ECe	dS . m-1	3.70
pH	-	7.10
Available nitrogen	mg kg^{-1} soil	27.50
Available phosphorous		13.50
Available potassium		138.00
Organic matter	g kg^{-1} soil	11.00
Soil properties		
Sand	g kg^{-1} soil	235.00
Clay		470.00
Silt		295.00
Soil texture	Silty clay loam	

The analyzes were carried out in the Soil Physics Laboratory, Agriculture College, Al-Muthanna University.

Results and discussion

Plant height (cm)

The results of the analysis of variance indicate that there are significant differences between planting distances and different fertilizer combinations, while the interaction between the two factors of the study had no significant effect on the plant height trait.

Table (2) indicated that there are significant differences between the cultivation distances. The narrow planting distance D1 gave the highest average plant height of 235.59 cm, this outperformed each of the distances D2 and D3, which were given an average of 229.29 cm and 224.05 cm, respectively, the wide distance D4 recorded a significant decrease in which the average plant height was 220.30 cm. The reason for this may be due to the increased competition between plants, the narrow distance D1 to obtain light, this prompted the plant to increase vegetative growth, increasing the shading between plants allows the auxin to work in cooperation with the gibberellins on the elongation of cells and phalanges, an increase in the speed of the division process and the expansion of cells and thus reflected on the increase in the height of the plant, agree with Al-Hasawi (2014) and Demir (2020), differed with Khamjan (2019).

There were significant differences in the different fertilizer combinations used, F3 fertilizer combination gave the highest average plant height of 233.36 cm, the fertilizer combination F1 gave the lowest average for the trait, which was 223.00 cm. The reason for the increase may be attributed to the role of fertilizer combinations and adding them in sufficient quantities to plants, in addition to the contents of these combinations of N, P, K. Through its availability in the soil solution and its absorption and transmission by the roots, creating a state of balance between them within the plant tissue, at appropriate concentrations to activate the necessary physiological processes, its role in increasing cell division and elongation, reflected positively on the increase in plant height, as well as the role of organic acids (humic and fulvic) in increasing the readiness of the elements, its role in creating nutrients in the soil and increasing its readiness and effective absorption by the roots, increases the activity of the vital processes of the plant and works on cell division and elongation and increase its size, increases the height of the plant, agree with Al-Mughair (2019) and Al-Araji and Al-Tamimi (2020).

The same table shows that there is no significant interaction between planting distances and different fertilizer combinations in the plant height.

Table (2): Effect of planting distances and different fertilizer combinations and the interaction between them on plant height (cm).

Planting distance (D)	**Fertilizer combinations (F)**				**Means**
	F1	**F2**	**F3**	**F4**	
D1	230.09	235.30	243.67	233.31	235.59
D2	224.64	229.09	234.63	228.82	229.29
D3	220.67	223.47	229.03	223.05	224.05
D4	216.62	219.13	226.12	219.34	220.30
Means	223.00	226.75	233.36	226.13	
l.S.D$_{0.05}$	**D**		**F**		**D×F**
	2.61		1.33		N.S

Leaf area (cm^2)

The importance of the leaf area in the plant is highlighted because it affects the yield of the plant through its ability to manufacture dry matter in the different parts of the plant (Al-Rawi et al., 2013). Table (3) shows that there were significant differences between planting distances and different fertilizer combinations, and the interaction between them in the characteristic of leaf area.

The distance D4 outperformed in achieving the highest average leaf area of 8526 cm^2, this was superior to the distances D2 and D3, which gave an average of 6987 cm^2 and 7583 cm^2, respectively, compared to the distance D1, which gave the lowest average of 6097 cm^2. The reason for the increase may be attributed to the lack of competition between plants over a wide distance due to the small number of plants in them and their ability to obtain their needs of growth requirements (light, nutrients and water) without competition, in addition to the lack of crowding between the roots of plants for nutrients, which allowed each plant to take a sufficient amount of different growth requirements as well as the low percentage of shading between plants, creating a greater opportunity to receive light and stimulate chlorophyll, reflected in the increase in the products of carbon representation, all of this reflected positively on the increase in the leaf area, agree with Abdullah (2008) and Khamjan (2019).

The same table notes that there is a gradual and moral increase in the leaf area with the increase of fertilizer combinations, F3 fertilizer combination excelled in giving the highest average for this trait, which amounted to 9800 cm^2, compared to the F1 fertilizer mixture, which gave the lowest average of 5581 cm^2. The reason for the increase may be attributed to the availability of the essential nutrients N, P, K in sufficient quantities, increased the plant's absorption of nutrients, positively reflected in the increase in the activation of the vegetative system, cell division, elongation, leaf expansion, increase in number, and increase in chlorophyll content in leaves, led to an increase in the products of carbon representation, which was positively reflected on the increase in the leaf area, the role of organic acids and the nutrients they contain necessary for plant growth and development, because of the high ability of these acids to increase the growth of roots and root hairs, contributes to the plant benefiting from the soil elements and increasing its absorption and increasing its proportion in the leaves, this effectively affects the increase in cell division and the increase in the number and breadth of leaves, thus increasing the leaf area (Atiyeh et al, 2002), agree with Al-Mughair (2019) and Al-Araji and Al-Tamimi (2020).

There was a significant interaction between the two factors of the study, as the two treatments F3D4 and F3D3 outperformed in giving the highest average for the trait, it reached 11,904 cm^2 and 10493 cm^2, respectively, compared to the F1D1 treatment, which recorded the lowest average for the trait, it was 4939 cm^2.

Table (3): Effect of planting distances and different fertilizer combinations and the interaction between them on leaf area (cm^2).

Planting distance (D)	Fertilizer combinations (F)				Means
	F1	F2	F3	F4	
D1	4939	5926	7656	5867	6097
D2	5321	6942	9148	6538	6987
D3	5631	7506	10493	6700	7583

D4	6430	8620	11904	7150	8526
Means	5581	7249	9800	6564	
l.S.D$_{0.05}$	**D**		**F**		**D×F**
	299.9		221.4		455.8

Stem Diameter (mm):

The diameter of the stem has an effective role by increasing the vascular bundles and vessels carrying nutrients, which are derived from the increase in the thickness of the layers of bark and wood, leads to an increase in the utilization of nutrients absorbed by the root (Ahmed, 2012). The results of Table (6) indicated that there were significant differences between planting distances and different fertilizer combinations, and the interaction between them in the trait of stem diameter.

The planting distance D4 achieved significant superiority by giving the highest average for the cultivar reached 35.73 mm, while the distances D2 and D3 gave an average of 29.23 mm and 31.9 mm respectively, compared to the distance D1 which gave the lowest average of 24.39 mm. The reason for this may be due to the lack of competition between plants of a wide distance with a low plant density for available growth factors, which helped in the penetration of light, reflection on the increase in the growth of roots and root hairs and an increase in the absorption of elements and their transfer to the plant, contributed to stimulating the division of meristematic cells of the leg, led to an increase in the number of vascular bundles and vessels carrying nutrients resulting from the increase in the thickness of the layers of bark and wood in addition to the pulp tissue to absorb this abundance of nutrients that it absorbs from the root, all this has a positive effect by increasing the diameter of the stem, agreed with Al-Hasawi (2014) and Abd El-Satar et al. (2017).

The same table shows that there are significant differences in the different combinations of fertilizers added, F3 fertilizer blend excelled in achieving the highest average of the trait, which reached 39.38 mm, compared to the F1 fertilizer blend, which gave the lowest average of 24.17 millimeters.The reason for the increase in the diameter of the stem may be due to the addition of different fertilizer combinations, may be caused by the high susceptibility to these fertilizer combinations of N, P, K and organic acids and the elements they contain have the ability to increase the growth of roots and root hairs and an increase in the availability of elements and nutrients in the soil (Atiyeh et al, 2002). Which increased the efficiency of plant absorption of these elements and the possibility of the plant benefiting from these nutrients and then accumulating them within the plant tissue, contributed to an increase in cell activity and division, and an increase in vascular bundles and carrier vessels, the accompanying increase in xylem and phloem, and this seems to have been positively reflected in the increase in the diameter of the stem. This result is consistent with the findings of Abd El Satar et al (2017) and (Al-Mughair, 2019).

The results of the same table indicate that there is a significant interaction between the two factors of the study, as treatment F3D4 gave the highest mean of the trait amounted to 52.16 mm, while treatment F1D1 gave the lowest mean of this trait amounted to 22.25 mm.

Table (4): Effect of planting distances and different fertilizer combinations and the interaction between them on stem diameter (mm).

Planting distance (D)	Fertilizer combinations (F)				Means
	F1	F2	F3	F4	
D1	22.25	24.23	26.49	24.61	24.39
D2	23.08	29.02	35.77	29.03	29.23
D3	24.39	29.74	43.08	30.48	31.92
D4	26.97	32.30	52.16	31.50	35.73
Means	24.17	28.82	39.38	28.91	
l.S.D$_{0.05}$	D		F		D×F
	1.99		.153		3.11

Seed length (mm)

The results of the study showed that the planting distances and the different fertilizer combinations and the interaction between them had a highly significant effect as shown in the results of (Table 5).

The wide planting distance D4 was significantly superior by giving it the highest average seed length of 17.71 mm, superior to the distances D2 and D3 which gave an average of 16.14 mm and 16.78 mm respectively, compared to the distance D1 which gave the lowest average of 14.82 mm. The reason for this may be due to the lack of competition between plants of a wide distance with low plant density for available growth factors and the low percentage of shading between plants, positively reflected on the inputs of carbon representation from the source to the estuary and to the existence of a positive relationship between disc diameter, weight and size of seeds and plant density. The weights and sizes of the seeds increased with the increase in the diameters of the tablets, as it resulted in an accumulation of dry matter, which was reflected in an increase in the filling of the seeds and an increase in their sizes, agreed with Jiad (2013) and Al-Rawi et al. (2013).

As for the effect of fertilizer combinations on seed length, the results in the same table indicate that there are significant differences between the averages of the trait, F3 blend excelled in giving the highest average for the trait, which was 18.45 mm, compared to the fertilizer combination F1, which gave the lowest average of 14.84 mm. The reason for the increase may be due to the effect of fertilizer combinations of N, P, K and humic and fulvic organic acids in increasing the root total, contributed to an increase in the leaf area (Table 3) and the diameter of the disc, which affected the fullness of the seed, and this was confirmed by Al-Rawi et al. (2013), the weights and sizes of sunflower seeds increase with increasing diameters of the resulting discs.

The same table also indicated that there was a significant interaction between the two study factors in the characteristic of seed length, whereas, treatment F3D4 gave the highest mean of the trait, which was 21.13 mm, while treatment F1D1 gave the lowest mean of the trait, which amounted to 14.29 mm.

Table (5): Effect of planting distances and different fertilizer combinations and the interaction between them on seed length (mm).

Planting	Fertilizer combinations (F)	Means

distance (D)	F1	F2	F3	F4	
D1	14.29	14.33	15.22	15.43	14.82
D2	14.82	15.87	18.03	15.85	16.14
D3	14.86	16.54	19.43	16.31	16.78
D4	15.40	17.21	21.13	17.09	17.71
Means	14.84	15.99	18.45	16.17	
l.S.D$_{0.05}$	**D**		**F**		**D×F**
	0.42		0.39		0.75

Conclusions

Most of the vegetative growth traits increased significantly when planting with wide distances, as the distance of 55 cm between one plant and another excelled in increasing the leaf area, stem diameter and seed length. There was a great response of sunflower plants to different fertilizer combinations, as the combination F3 outperformed in most of the growth indicators of sunflower plants.

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