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Response genotypes of sunflower (*Helianthus annuus* L.) and amount of nitrogen fertilizer on growth characteristics, oil yield, and its percentage.

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Abstract: field experiment was conducted during spring and autumn seasons of 2021 in Al-Haritha area, AL-Basra Governorate, in order to study the response of six genotypes of sunflower (Local, Aqmar , Ishaqi 1, Ishaqi 2, Turki Tarzan and Shmoos) and four levels of nitrogen fertilizer control treatment N0, N1 = (N100 kg.ha -1), N2 = (N200 kg.ha-1) and N3 = (N300 kg.ha-1) according to the complete randomized block design R.C.B.D. with three replications in the order of the split plot design (the levels of nitrogen fertilization were distributed in the main plot and the varieties in the secondary Sub-plot). Results showed superiority of Shmoos genotype with the highest average number of leaves that reached (27.05 and 29.41) leaves.plant-1 . while nitrogen fertilizer effect showed superior of fertilizer level N3, which gave (26.32 and 29.94) leaves.plant-1. As for characteristic of fertility percentage , there were no significant differences between the genotypes (Local, Aqmar , and Tarzan) for spring season; it appears the superiority of fertilizer level N3, which gave (93.79 and 91.79), Shmoos genotype was superior with the highest average yield of an individual plant (78.50 and 84.73) gm.plant-1 compared to the local genotype, which gave the lowest average of (44.80, and 51.23) gm.plant-1 for the two seasons, respectively, and N3 level of fertilizer, which gave average (77.82 and 88.88) gm.plant-1 and local composition outperformed the proportion of oil (39.55 and 41.13%) and the Shmoos genotype in the total oil yield (1161.4 and 1461.3) kg.ha-1, while this study showed superiority of the fertilizer level N0 with the oil percentage, which gave (39.63 and 43.65%) . As for the total oil yield, the composition was superior to Shamus by giving the highest mean of oil yield (1161.4 and 1461.3) kg.ha-1 for two seasons, respectively, and the superiority of the fertilizer level N3, which gave the highest oil yield (1,247.6 and 1673.6) kg.ha-1, for two seasons, respectively.

Keywords: sunflower, genetic structures, nitrogen fertilizer

1. Introduction

Due to its short growth period and high economic returns, the sunflower crop Helianthus annuus L is one of the most important oil crops in the world. Its seeds contain a high percentage of oil, reaching up to 55 percent in some varieties. Because it contains Omega-3 fatty acids and unsaturated fatty acids like Oleic, it is healthy oil. Linoleic acid has low oxidation sensitivity during the packing and storage process[1].

Vitamins A, D, E, and K are found in sunflower seeds. They also contain about 27% protein and 60% polyunsaturated fatty acids, ideal for heart patients who want to lower their blood cholestero[1] levels[2]. For the 2019 sunflower crop, the estimated cultivated area in Iraq is 450 ha, with an average yield of 2333. 2 ton in hiktar[3]. Sunflower oil was the first to be used in Iraq, and its productivity is still limited due to a failure to follow proper scientific methods in serving the soil and crop, as it is determined by genetic structures and environmental conditions, as well as their interaction. Many factors, including genetic structures, environmental factors, and pre- and post-cultivation processes like plowing and fertilization, particularly nitrogen fertilization, have been shown to affect sunflower growth and productivity[4].

According to studies, phenotypic traits in general, and yield components in particular, are good criteria for selecting plants from various genotypes, whether to improve quality or yield, and its components represented

in disc diameter, seeds number in the disc, and seeds weight[5]. Schoeman[6] demonstrated in his study that the stability of genotype productivity in different environments has become increasingly important to plant breeders, as stable varieties are one of the most important aspects of modern agriculture. After all, knowing their behavior and response to various environmental conditions leads to understanding environmental and genetic interference. Different levels of nitrogen fertilizer had a significant impact on yield and components[7]. Due to a lack of high-yield seed varieties and a reliance on the cultivation of local cultivars, it is necessary to investigate compositions with high yield and good quality under southern conditions.

As a result, this study was conducted to assess the performance of various sunflower genotypes under Basra region conditions, determine the level of nitrogen fertilizer that yields the highest yield, and investigate the interaction between genotypes and nitrogen fertilizer levels.

2. Materials and Methods

The experimental unit consisted of four harrows, with a distance of 75 cm between each harrow and 25 cm between each plant. On the meadow side, planting was done using a complete random block design and splintered plots to achieve a plant density of 53,333 plants/ ha (RCBD). The experiment had two components: the first was a set of six Sunflower genotypes (Local, Aqmar, Ishaqi 1, Ishaqi 2, Tarzan, and Shmoos). Baghdad's Agricultural Research Department is the source of the seeds. The second factor was the amount of nitrogen fertilizer in urea (46 percent N) added in two batches (0,100, 200, 300 kg N/ha). The first was the appearance of four true leaves, and the second was the appearance of four true leaves batch at the beginning of the emergence of flower buds[8]. Phosphorous and potassium fertilization operations were carried out according to the fertilizer recommendation. Phosphate fertilizer was added in the form of P_2O_5) 110 kg/ ha and potassium sulfate 120 kg/ha, in the form of K_2SO_4. Add it all at once when planting.
Before planting seeds, some properties of the study soil were screened as pH, EC, minute volume analysis and soil texture. The experimental field was planted in the spring season on 16.02.2021 and the fall season on 27.07.2021 [8] by placing 3-4 seeds in one hole at a depth of 3-5 cm. After two weeks of planting, the plants is thinned to one plant per hole. Weed control, hoeing, and weeding were done manually as needed.

Studied Traits

2.1.1. Number of leaves: according to the total number of leaves per plant, which starting from the first leaf on the surface of the soil until the last leaf on the plant [9].

2.1.2. Fertility ratio (%): A random seed sample was taken at rate 50 gm from each experimental unit and according to the number of empty and filled seeds. Then the fertility rate was calculated according to the following equation[10]:

$$\text{Fertility percentage} = \frac{number\ of\ full\ seeds}{number\ of\ empty\ seeds + number\ of\ full\ seeds)} * 100$$

2.1.3. The yield of the individual plant (gm/ plant) was calculated from the average yield of one plant after extracting the seeds from the flowering disc of ten plants randomly selected from the two middle lines, separating their seeds, and weighing each plant separately.

2.1.4. Oil percentage: The oil percentage was measured by taking a sample of 5 gm of ground sunflower seeds with their husks and using Soxhlet apparatus with Petroleum Ether solvent, boiling point of 60-80 C°, then it was dried in the oven at 90 C° [11] then weighed the oil that produced from the extraction process
(weight of oil = weight of the beaker with oil - weight of empty beaker) and its percentage was calculated.

2.1.5. Oil yield (kg.h-1): According to the following equation-:

Oil yield = % oil percentage x total seed yield.

The data were analyzed using the GenStat procedure Library release PL 18.2 software and an analysis of variance (ANOVA) spreadsheet.

3. Results

Results presented in Table (1) showed the soil characteristics for the two planted seasons.

Results in Table (2) showed that a significant difference between the genotypes among it for the characteristic of leaves number per plant, as between the Table the superiority of the genotype is Shmoos with the highest average number of leaves that reached (27.05 and 29.41) leaves. Plant^{-1} for two seasons respectively compared to the local genetic structure, which gave the lowest number of leaves per plant, with average of (21.89 and 25.02) for two seasons, respectively. The local genotypes, Ishaqi 1 and Tarzan did not differ significantly among it in this trait for the spring season, while in the outmen season the local genotypes Ishaqi 1 and Tarzan did not differ significantly. Same Table showed the superiority of the fertilizer level N3, which gave (26.32 and 29.94) for two seasons respectively compared to the level N0, which gave the lowest average (21.68 and 24.05) leaves. plant^{-1} with significant difference from the other levels. As for the interaction , the Shmoos genotype and N3 fertilizer level showed the highest mean (31.52 and 33.85) leaf.plant^{-1} compared with the fertilizer level N0 and the local genotype, which gave the lowest mean (20.26 and 22.63) leaf.plant^{-1} for two seasons.

Table (1) Properties of the study soil before planting Helianthus annuus L seeds

Adjective		Quantity		Unit
PH		**spring season**	**Autumn season**	_
		7.24	7.80	
EC		6.6	6.3	**dSm $^{-1}$**
Minute volume analysis	sand	46.50	44.30	**gm Km $^{-1}$ soil**
	silt	535.80	537.70	
	clay	417.70	418.00	
soil texture	Silty clay loam			

Results in Table (3) referred to that no significant difference between the genotypes (Local, Aqmar, and Tarzan) for the percentage fertility characteristic in the spring season and it differed significantly with the Shmoos genotype. In contrast, the two genotypes (Ishaqi 1 and Ishaqi 2) did not differ between it respectively and differed significantly with Shmoos genotype. In contrast, autumn season, there were no significant differences between the genotypes (Local, Ishaqi 2 and Tarzan), while Aqmar and Ishaqi 1 did not differ between it. All genotypes differed significantly with the Shmoos genotype .

From the results of same Table which shows superiority of fertilizer level N3 which gave (93.79 and 91.79)% for two seasons respectively , compared with control treatment N0, which gave the lowest average (91.56 and 88.83) % for the two levels respectively and with significant difference from the other levels. As for interaction, it was not significant for spring season. While outmen season, the genetic structure of Aqmar and fertilizer level N1 outperformed them with average 92.96%.

Table 2. The effect of sunflower genotypes and nitrogen fertilizer levels and their interaction on the number of leaves in plants for the spring and autumn seasons 2021.

Spring season					
genetics	**Nitrogen fertilization levels kg ha^{-1}**				
	0	100	200	300	**average**
Local	20.26	21.59	22.18	23.52	21.89
Aqmar	21.85	23.59	25.92	28.59	25.32
Ishaqi 1	19.92	21.92	23.26	24.18	22.32
Ishaqi2	25.59	23.92	24.59	26.59	24.42
Tarzan	20.18	22.52	22.78	23.52	22.25
Shmoos	22.26	24.26	27.18	31.52	27.05
average	21.68	23.13	24.32	26.32	
Lsd $_{0.05}$	0.427= N		0.544= V		1.050=N*V
Autumn season					
genetics	**Nitrogen fertilization levels kg ha^{-1}**				**average**
Local	22.63	24.66	25.59	27.18	25.02
Aqmar	24.96	26.66	31.26	33.00	28.97
Ishaqi 1	22.66	24.52	26.26	27.18	25.16
Ishaqi2	25.77	26.59	29.00	31.59	28.24
Tarzan	23.00	25.00	26.00	26.85	25.21
Shmoos	25.26	26.66	31.85	33.85	29.41
average	24.05	25.68	28.32	29.94	
Lsd $_{0.05}$	0.7398= N		0.6477= V		1.3277=N*V

Results in table 4 indicated that significant difference between the genotypes among it for the trait of individual plant yield, Table showed superiority of the Shmoos genotype with the highest average individual plant yield amounted to (78.50 and 84.73) gm.plant^{-1} for two seasons respectively compared to the local genotype which gave the lowest average (44.80 and 51.23) gm. plant^{-1} for two seasons. From the results of same Table that shows the superiority of fertilizer level N3, which gave (77.82 and 88.88) gm. plant^{-1} for two seasons, respectively, compared to control treatment N0, which gave the lowest average (44.07 and 43.78) gm. plant^{-1} with significant difference from other treatments , As for the interaction, Shmoos genotype and the fertilizer level N3 showed the highest average (103.07 and 108.33 gm) compared with the fertilizer control level N0 and the local genotype, which gave the lowest average (37.47 and 33.33) gm. plant^{-1} for two seasons, respectively.

Table 3. The effect of sunflower genotypes and nitrogen fertilizer levels and the interaction between them on the fertility percentage% characteristic of the spring and autumn seasons 2021.

spring season					
genetics	**Nitrogen fertilization levels kg ha^{-1}**				
	0	100	200	300	**average**
Local	92.68	93.55	93.71	93.88	93.45
Aqmar	90.39	91.86	92.65	93.70	92.15
Ishaqi 1	91.20	92.11	93.49	93.65	92.61
Ishaqi2	92.05	93.27	93.64	93.97	93.23
Tarzan	92.24	93.59	93.96	94.32	93.53
Shmoos	90.78	90.58	91.36	93.24	91.49
average	91.56	92.49	93.14	93.79	
Lsd $_{0.05}$	0.5194= N		0.5237= V		=N*V S. N
Autumn season					
genetics	**Nitrogen fertilization levels kg ha^{-1}**				**average**
Local	90.16	92.96	91.69	91.55	91.59
Aqmar	89.39	89.55	90.46	92.01	90.35
Ishaqi 1	88.76	90.91	92.04	91.65	90.84
Ishaqi2	87.83	91.78	92.03	92.55	91.05
Tarzan	90.11	92.02	91.49	91.68	91.33
Shmoos	86.76	87.89	88.17	91.29	88.53
average	88.83	90.85	90.98	91.79	
LSD $_{0.05}$	0.7149= N		0.4574= V		1.0286=N*V

The data in Table (5) indicated that there is significant difference between the genotypes among it for the characteristic of oil percentage, the Table showed superiority of the local structure which its seeds containing the highest average percentage of oil amounted to (39.55) and (41.13%) compared to the Shmoos genotypes and Tarzan, whose seeds contained the lowest percentage oil averaged (36.69%, 37.46% and 37.50%, 38.30%) respectively for two structure and two seasons, and the reason for the superiority of the compositions in the oil percentage may be due to the fact that the quality of the sunflower seeds.

From the results of the same Table, it appears that the fertilizer level N0, which gave (41.47 ، 43.87%) for two seasons respectively , compared with the level N3, which gave the lowest percentage of oil with average(36.36) and (37.46%), with a significant difference from the other levels.

Results in Table (6) indicated that there is significant difference between the genotypes in total oil yield trait , Shmoos composition outperformed by giving the highest mean of oil yield (1161.4 and 1461.3 kg.ha^{-1}) compared to the local genotype, which gave the

lowest average (906.8 and 1185) kg.ha^{-1} for two seasons respectively. From the results of the same Table, it appears that the fertilizer level N3, which gave the highest oil yield (1,247.6 and 1673.6) kg.ha^{-1}, compared with the control N0, which gave the lowest oil yield with an average (619.6 and 885.3) kg.ha^{-1} for two seasons, respectively, with significant difference from the other levels. and the reason for the superiority of fertilizer N3 is due to the abundance of the total seed yield ton.ha^{-1} in addition to the percentage of oil.

Table 4. Effect of genotypes from sunflower and nitrogen fertilizer levels and the interaction between them on the trait of individual plant yield in grams for the spring and autumn seasons 2021.

spring season					
genetics	**Nitrogen fertilization levels kg ha^{-1}**				
	0	**100**	**200**	**300**	**average**
Local	**37.47**	**41.20**	**46.93**	**53.60**	**44.80**
Aqmar	**52.93**	**57.42**	**64.63**	**92.60**	**66.90**
Ishaqi 1	**35.13**	**46.87**	**50.93**	**61.00**	**48.48**
Ishaqi2	**43.13**	**51.07**	**63.47**	**85.53**	**60.80**
Tarzan	**41.33**	**54.27**	**59.60**	**71.13**	**56.58**
Shmoos	**54.43**	**70.47**	**86.03**	**103.07**	**78.50**
average	**44.07**	**53.55**	**61.93**	**77.82**	
Lsd $_{0.05}$	**2. 684= N**		**3.348= V**		**6.477=N*V**
Autumn season					
genetics	**Nitrogen fertilization levels kg ha^{-1}**				**average**
Local	**33.33**	**45.10**	**57.13**	**69.37**	**51.23**
Aqmar	**45.30**	**63.37**	**82.60**	**91.67**	**70.73**
Ishaqi 1	**40.20**	**58.03**	**72.87**	**86.00**	**64.27**
Ishaqi2	**45.60**	**62.67**	**74.33**	**88.40**	**67.75**
Tarzan	**40.93**	**56.50**	**77.70**	**89.53**	**66.17**
Shmoos	**57.30**	**81.53**	**91.77**	**108.33**	**84.73**
average	**43.78**	**61.20**	**76.07**	**88.88**	
Lsd $_{0.05}$	**0.800= N**		**1.619= V**		**3.021=N*V**

The Shmoos genotype and the fertilizer level N3, gave the highest mean of oil yield which reached (1350.5 and 1778.7) compared with the local genotype and fertilizer level N0 with the lowest average (558.0 and 758.0) kg.ha^{-1} for two seasons, respectively.

Table 5 Effect of sunflower genotypes and nitrogen fertilizer levels and their interaction on the percentage of oil content for the spring and autumn seasons 2021.

Table 6. Effect of sunflower genotypes and nitrogen fertilizer levels and the interaction between them on the characteristic of total oil yield kg.ha^{-1} for the spring and autumn seasons 2021.

spring season					
genetics	**Nitrogen fertilization levels kg ha^{-1}**				
	0	100	200	300	**average**
Local	558.0	835.4	1032.8	1200.8	906.8
Aqmar	595.6	1036.6	1098.9	1309.3	1010.1
Ishaqi 1	556.5	871.1	989.3	1191.0	902.0
Ishaqi2	605.1	960.6	1186.1	1245.0	999.2
Tarzan	533.9	918.9	1042.4	1189.2	921.1
Shmoos	868.5	1131.9	1294.6	1350.5	1161.4
average	619.6	959.1	1107.3	1247.6	
Lsd $_{0.05}$	24.56=N		29.13=V		56.69=N*V
Autumn season					
genetics	**Nitrogen fertilization levels kg ha^{-1}**				**average**
Local	758.0	1056.8	1342.3	1584.3	1185.3
Aqmar	832.7	1354.3	1509.1	1743.6	1359.9
Ishaqi 1	835.5	1182.8	1394.5	1640.0	1263.2
Ishaqi2	916.3	1174.3	1418.3	1705.6	1303.6
Tarzan	815.2	1196.0	1365.6	1589.3	1241.5
Shmoos	1153.9	1368.4	1544.3	1778.7	1461.3
average	885.3	1222.1	1429.0	1673.6	
Lsd $_{0.05}$	= N 55.63		= V 74.39		= N*V31.41

4. Discussion

The reason for the superiority of the local genotypes, Ishaqi 1 and Tarzan might be due to the nature of the genotypes for this trait, because this trait has high response in variable

to sunflower cultivars [12] and these results are in agreement with the researches [13,15]. Also, the superiority of these genotypes that might due to increase the number of leaves for the genetic structure and increase the leaf area which photosynthesis process occurs through it , as well as the nature and extent of its effect on environmental conditions, including the high temperature that accompanies the process of pollination and fertilization [11,16].

The superiority of the fertilizer level N3, which gave (26.32 and 29.94) for two seasons respectively compared to the level N0, could be explained by effect of nitrogen, which is involved in all vital processes that consider as basis for building proteins and nucleic acids and encouraging rapid growth as well as the process of cell division and thus positively reflected on the height of the plant, which in turn leads to an increase in the number of leaves[13], and this agree with what was mentioned [11,17,18]. As well as The reason for the superiority of fertilizer level N3 is due to the nitrogen that is considered the main component in building vital processes including the leaf area, which helps in the activity and increase of pollen production [4,11,20,19].

The reason behind significant difference between the genotypes among it for the trait of individual plant yield might be due to increase in fertility rate in Table (3) which resulted in mature seeds and thus led to increasing in the yield of the individual plant, as well as to the different transformative nature of foodstuffs as a result of the different genetic structures [21].These results are consistent with [17, 20]. The results in in Table (2) may be attributed to increase the number of leaves and thus increase the leaf area, which led to raising the efficiency of the plant, including increase in the concentration of elements, increasing the concentration of nutrients inside the plant and converting it into carbohydrates and protein materials that transferred to the seeds in the phase of filling the seeds [22, 17,23].

The percentage of oil is affected by environmental and genetic conditions, because high temperature leads to reduce the percentage of oil19. These results are consistent with [11,24] they found the difference in the genotypes of sunflower in the percentage of oil in the seeds and these results are in agreement with the findings of [11,19,24].

Because nitrogen is the main component in building plant tissue units and increasing these tissues at the expense of the percentage of oil in seeds according to the well-known inverse relationship between oil and nitrogen, when number of seeds increases in the plant due to increase in nitrogen, the oil in the seeds will decreases, these results are in agreement with the findings of19. While interaction showed , the local genotype and N0 fertilizer level showed the highest average oil content (41.47 and 43.87%) compared to the N3 level and the Shamoos genotype , which gave the lowest average (34.64) and (35.18%) for two seasons respectively

Conclusions:

In this study, we can conclude the following:

1- The superiority of the genotype of Suns for two seasons in most of the studied traits of the number of leaves per plant and yield of the individual plant, as well as, the highest total oil yield, and the superiority of the local genotype in the percentage of fertility and percentage of oil %.

2- All the genotypes showed a clear response to the fertilizer level N3 in most of the studied traits, and this was reflected positively on the increase in the number of leaves in the plant, the yield of the individual plant, the percentage of fertility and the total oil yield.

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