ARTICLE / INVESTIGACIÓN

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: The field experiment was conducted during the spring and autumn seasons of 2021 in the Al-Haritha area, AL-Basra Governorate, 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 RCBD 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 the superiority of the Shmoos genotype with the highest average number of leaves that, reached (27.05 and 29.41) leaves. plant^{-1}. while the nitrogen fertilizer effect showed a superior fertilizer level of 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 the 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 the 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.

Key words: Sunflower, genetic structures, nitrogen fertilizer.

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. It is healthy oil because it contains Omega-3 fatty acids and unsaturated fatty acids like Oleic. 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 cholesterol levels[2]. For the 2019 sunflower crop, the estimated cultivated area in Iraq is 450 ha, with an average yield of 2333. 2 tons 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 systems, 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 seed 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.

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Materials and methods

The experimental unit consisted of four harrows, with a distance of 75 cm between each plow 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 batches 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 P2O5) 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 produced 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 are thinned to one per hole. Weed control, hoeing, and weeding were done manually as needed.

Studied Traits

The number of leaves: according to the total number of leaves per plant, which starts from the first leaf on the soil's surface until the last leaf on the plant[9].

Fertility ratio (%): A random seed sample was taken at a rate of 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]:

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

The yield of the individual plant (gm/ plant) was calculated from the average result 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.

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, the 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 - the weight of empty beaker) and its percentage was calculated.

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.

Results

The experimental unit consisted of four harrows, with a distance of 75 cm between each plow and 25 cm between each plant. On the meadow side, planting was done using a complete random.

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

Results in Table 2 showed 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 an average of (21.89 and 25.02) for two seasons, respectively. The local genotypes, Ishaqi 1 and Tarzan, did not differ significantly in this trait for the spring season. In contrast, the local genotypes Ishaqi 1 and Tarzan did not vary greatly in the autumn season. The same Table showed the superiority of the fertilizer level N3, which gave (26.32 and 29.94) for two seasons, respectively, compared to level N0, which gave the lowest average (21.68 and 24.05) leaves—$plant^{-1}$ with a significant difference from the other groups. 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.

Results in Table 3 referred to 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 substantially with the Shmoos genotype. In contrast, in autumn, there were no significant differences between the genotypes (Local, Ishaqi 2 and Tarzan), while Aqmar and Ishaqi 1 did not differ. All genotypes differed significantly from the Shmoos genotype.

The results of the same Table show the 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 a significant difference from the other levels. As for interaction, it was not substantial for the spring season. During the autumn season, the genetic structure of Aqmar and fertilizer level N1 outperformed them with an average of 92.96%.

Results in Table 4 indicated that significant difference between the genotypes among it for the trait of individual plant yield; the Table showed the superiority of the Shmoos genotype with the highest average unique 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. The results of the same Table show 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 a 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

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			

Table 1. Properties of the study soil before planting *Helianthus annuus* L seeds.

Spring season					
genetics	Nitrogen fertilization levels kg ha^{-1}				average
	0	100	200	300	
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

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	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

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

(37.47 and 33.33) gm. plant^{-1} for two seasons, respectively.

The data in Table 5 indicated that there is a significant difference between the genotypes among it for the characteristic of oil percentage, the Table showed the superiority of the local structure which its seeds containing the highest average rate of oil amounted to (39.55) and (41.13%) compared to the Shmoos genotypes and Tarzan, whose seeds had 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 because 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 group N3, which gave the lowest percentage of oil with an average(36.36) and (37.46%), with a significant difference from the other levels.

Results in Table 6 indicated that there is a significant difference between the genotypes in the 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 showed 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 a 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.

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.

Discussion

The reason for the superiority of the local genotypes, Ishaqi 1 and Tarzan, might be due to the nature of the ge-

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

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

notypes for this trait because this trait has a 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 might be due to the increase in the number of leaves for the genetic structure and the increase in the leaf area which the 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 the effect of nitrogen, which is involved in all vital processes that consider as a 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 agrees with what was mentioned[11,17,18]. As well as The reason for the superiority of fertilizer level N3 is that nitrogen is considered the main component in building vital processes, including the leaf area, which helps in the activity and increase of pollen production[4,11,19,20].

The reason behind the significant difference between the genotypes among it the trait of individual plant yield might be due to the increase in fertility rate in Table (3), which resulted in mature seeds and thus led to an increase in the work 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 Table (2) may be attributed to the increase in the number of leaves and, thus increase in the leaf area, which led to raising the efficiency of the plant, including an 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[17,22,23].

The percentage of oil is affected by environmental and genetic conditions because high temperature reduces the rate of oil[19]. These results are consistent with (11,24). They found the difference in the sunflower genotypes in the percentage of oil in the seeds, and these results agree with the findings of (11,19,24).

spring season					
genetics	Nitrogen fertilization levels kg ha^{-1}				
	0	100	200	300	average
Local	41.47	40.26	39.01	37.45	39.55
Aqmar	39.04	38.84	36.86	37.04	37.95
Ishaqi 1	39.24	37.03	36.72	36.39	37.35
Ishaqi2	41.05	39.67	39.33	36.81	39.21
Tarzan	38.23	38.20	37.75	35.81	37.50
Shmoos	36.74	37.04	36.34	34.64	36.69
average	39.63	38.51	37.67	36.36	
Lsd 0.05	= N0.695		= V0.631		=N*V1.280
Autumn season					
genetics	Nitrogen fertilization levels kg ha^{-1}				average
Local	43.87	41.56	39.73	39.36	41.13
Aqmar	40.38	40.16	39.35	38.29	39.54
Ishaqi 1	41.42	38.45	38.60	37.46	38.98
Ishaqi2	43.65	37.94	39.14	37.92	39.66
Tarzan	41.08	37.80	37.49	36.83	38.30
Shmoos	39.41	38.03	36.24	35.18	37.46
average	41.80	38.99	38.42	37.51	
Lsd 0.05	1.066 = N		0.588=V		1.417=N*V

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.

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 the number of sources increases in the plant due to increases in nitrogen, the oil in the seeds will decrease, 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: 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 rate of oil %. All the genotypes showed an apparent response to the fertilizer level N3 in most of the studied traits, and this was reflected positively in 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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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

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.

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