

THE EFFECTS OF NITROGEN DOSES APPLIED AT DIFFERENT GROWING PERIODS ON THE QUALITY AND YIELD OF OIL TYPE SUNFLOWER (*Helianthus annuus* L.) VARIETIES

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Received: 15.05.2018

ABSTRACT

This study was conducted at Erzurum in 2013 and 2014 to determine the effects of nitrogen fertilizer applied three different varieties oil type sunflower (*Helianthus annus* L.) at different developmental periods on quality and yield. Three sunflower types (Tarsan, L65400 and Imeria), three application times (stage of sowing, emergence and head formation) and four doses of nitrogen (0, 30, 60 and 90 kg ha⁻¹) was set up in three repetitions at the arrangement of "Split Plot". Oil and protein content and grain and oil yields were investigated in the study. While the effect of N application on oil and protein contents of the experimental years was not significant, its the effect on grain and oil yield was significant. Nitrogen fertilizers applied at the time of sowing had more effect on the other characters than the fertilizer application at the time of flowering and plate formation. The effect of nitrogen doses on all the characters studied was significant. The 30 kg nitrogen application and the rate of protein in 90 kg nitrogen application per ha⁻¹ were higher than other doses of grain and oil. Except for the oil content, there was a significant difference between protein content and varieties for grain and oil yield. As a result of this study, it could be concluded that 60 kg of nitrogen applied at the time of sowing, 90 kg ha⁻¹ of nitrogen dose, early and late sunflower varieties (Imeria and Tarsan) at the time of harvesting to obtained high the grains and oil content.

Keywords: Developmental stage, nitrogen fertilization, sunflower, yield, yield components

INTRODUCTION

Oils are essential nutrients and have an important place in human nutrition. Oils are provided from animal and vegetable sources. Demand for vegetable oils, which are inexpensive due to the limited and expensive oil of animal origin, has increased.

For vegetable oil production in Turkey, cotton, sunflower, peanut, sesame, soybean, flax, hemp, rapeseed, safflower and also olive cultivation is made. In the Eastern Anatolia Region, the most sunflower farming is made from oilseed plants. Cultural practices should be emphasized in order to get more yield from the unit area of the sunflower in the region. One of the cultural practices is fertilizing.

Sunflower removes too much plant nutrients from the soil compared to other cultivated plants so fertilization becomes more important. Fertilizers can be obtained in desired form and quality with the application in the form, quantity and time required by the plants.

One of the most important fertilizers for oil seed plants is nitrogenous fertilizers. Nitrogenous fertilizer seeds are important contributors in all the processes from throwing to the soil to maturing and harvesting. Excess nitrogen in sunflower farming accelerates vegetative growth in plants, causing the stems to become too dense and scarce, and thickening the seed husk causing the oil content in the seeds to decrease (Arioglu, 2007).

In the studies carried out on the subject, Caliskan (1994) conducted a study on the application of 100 kg / ha nitrogen seeds which were taken constantly in all applications and in the other half when the plants were 15 cm in circulation, the maximum grain (3385,5 kg ha⁻¹) and oil yield (1297,4 kg ha⁻¹). Herdem (1999) stated that increased nitrogen dosages decreases the amount of oil, but in turn increases oil yield and protein content. Javier et al. (2002) determined that the doses of nitrogen were lower in the proportion of oil in the residual seed and that the effectiveness of the nitrogen doses varied according to the varieties. De Giorgio et al. (2007) in a study he conducted with different nitrogen doses in sunflower, found that seed, oil and protein production differed according to N doses and varieties. Maltas et al.(2018) indicated the effect of N on yield and large tuber formation.

The purpose of this study was to the effects of nitrogen fertilizer doses applied at different growth periods on the quality components and yield of varieties of oil type sunflower (*Helianthus annuus* L.) with different developmental periods.

MATERIALS AND METHODS

This research was carried out in 2013 and 2014 at the Ataturk University experimental farm. Tarsan (early), LG5400 (middle) and Imeria (latish) hybrid sunflower varieties and 21% ammonium sulphate and 45% triple super phosphate were used.

Climatical Conditions

The amount of precipitation from April to September was 151.4 mm in 2013, and 271.6 mm in 2014. The maximum rainfall was recorded in May (36.3 / 115.9 mm) and the lowest in August (7.8 / 4.8 mm) in both study years.

The average temperature was 14.4 0 C in the first study and 15.7 0 C in the second year while the highest temperature values in both study years were in August (19.5 and 22.2 0 C). The lowest temperature values (7.2 and 7.7 0 C) were in study years respectively.

The highest relative humidity was detected in April (64.4%) in the first study year, in May (64.8%) in the second study year, and in August (45.7% / 64.8%) in the first and second study years.

Soil properties

The pH of the soil was clayey-loamy, pH value was 7.77 to 7.80, organic matter was 1.10-0.77%, lime content was

2.15-7.84% and phosphorus content was 66,3-73,2 kg ha⁻¹.

Study Design

The experiment was in RCBD with in split plot arrangement with three replication.. Three oil type sunflower varieties (Tarsan, LG5400 and Imeria) used in the trial were divided into main parcels and so that 3 different application times (sowing, emergence and head formation time) and 4 different nitrogen doses (0, 30, 60 and 90 kg N / ha) was divided into sub plots. The determined amounts of nitrogenous fertilizers and 60 kg ha⁻¹ phosphorous fertilizer were applied to the test area during sowing.

Each plot was 6 m in length, 3.5 m in width and consisted of 6 rows, the parcel area is 21.0 m². Sowing was made such that the distance between rows was 70 cm and the distance above rows was 25 cm. One plant from the beginning of parcels and one row each from side of parcels was discarded as side effect and 16 plants were harvested in each plot.

RESULTS AND DISCUSSION

Oil content (%)

The result of variance analysis are given in Table 1 and the means are given in Table 2.

According to the mean of the experimental factors, oil percentage was 46.3% in the first trial year and 39.8% in the second trial year (Table 2). Although there was a numerical difference in oil percentage between the trial years, there was no statistical difference (Table 1).

			Oil co	ntent				Protein c	ontent	
Variation Source	d.f		F va	lues		d.f		F valı	ies	
variation Source	u.1	Yea	ars	Ave. Years		a.1	Y	ears	Ave. Years	
		2013	2014	d.f	F values		2013	2014	d.f	F values
Yearl (A)	-	-	-	1	10,020	-	-	-	1	10,141
Error ₁	-			2		-			2	
Nitrogen doses (B)	3	0,740	2,080	3	1,794	3	0,857	2,622	3	1,989
A x B	-			3	0,068	-			3	0,511
Error ₂	6			12		6			12	
Applicatio time (C)	2	3,276*	0,302	2	1,550	2	0,428	1,329	2	1,371
AxC	-			2	1,273	-			2	0,360
BxC	6	1,252	0,266	6	0,225	6	3,543*	0,853	6	2,543*
AxBxC	-			6	1,111	-			6	1,929
Error ₃	16			32		16			32	
Variety (D)	2	2,207	2,201	2	2,784	2	1,162	5,299**	2	4,189*
A x D	-			2	1,624	-			2	0,024
B x D	6	0,193	1,073	6	0,687	6	1,566	1,612	6	1,149
A x B x D	-			6	0,501	-			6	2,005
CxD	4	1,377	1,242	4	1,820	4	1,544	1,475	4	1,568
AxCxD	-			4	0,811	-			4	1,489
BxCxD	12	0,993	1,206	12	1,236	12	0,713	1,777*	12	0,831
AxBxCxD	-			12	0,944	-			12	1,081
Error4	48			96		48			96	

Table 1. Variance analysis results of oil and protein contents of sunflowers according to the average of the experimental factors

** Marked F values are 1%, * marked F values are significant in 5% level.

Varia	Nitrogen	Application		Oil content		A	Pı	rotein conte Varieties	nt	A
Years	doses	time	T	Varieties	† • .	Average		Average		
		Planting	Tarsan	LG5400	İmeria		Tarsan 10,9	LG5400 12,7	İmeria 12,3	
			46,0 46,0	47,5 44,8	50,7 47,0		10,9	12,7	12,5	
	0	Emergence Head	46,0	44,8	47,0	46,9	12,4	14,/	10,0	12,7
		formation	49,2	44,4	46,8		13,4	14,1	12,8	
		Planting	48,8	42,2	47,9		12,4	12,4	12,3	
		Emergence	46,0	48,5	47,6		13,9	11,1	11,8	
	3	Head				47,2				12,6
		formation	47,4	47,8	48,7		13,2	13,2	12,8	
		Planting	43,6	44,2	44,3		14,1	14,7	13,7	
2013		Emergence	44,6	46,2	45,5		14,6	11,2	13,2	
Ä	6	Head				45,9				13,6
		formation	47,7	46,4	50,4		14,6	12,9	13,7	
		Planting	44,0	44,7	45,1		13,5	14,2	14,9	
	0	Emergence	43,4	46,2	44,0	45.0	14,5	13,5	12,9	10.1
	9	Head		42.4		45,2				13,1
		formation	48,0	43,4	48,0		11,7	12,0	10,8	
	Variety aver	age	46,3	45,5	47,1	46,3	13,3	13,1	12,7	13,0
	App. time	Planting: 45,8	h Emer.: 4	45.8 h Head	1:47.4 a	App.	Planting	: 13,2 Eme:	2.9 Head	12.9
	Tipp: time	Planting Planting	37,0	39,8	40,1	time	10,5	10,5	9,7	,>
		Emergence	42,5	39,2	39,7		11,0	9,9	11,9	
	0	Head	42,3	39,2	39,1	40,2	11,0	9,9	11,9	10,4
		formation	43,4	39,8	40,3		9,8	10,1	10,5	
		Planting	39,2	39,8	40,8		12,4	12,4	12,3	
		Emergence	42,0	40,3	40,3		13,9	11,1	11,8	
	3	Head				40,5				12,6
		formation	42,0	40,4	39,2		13,2	13,2	12,8	
_		Planting	40,4	36,8	41,7		14,1	14,7	13,7	
2014	-	Emergence	38,8	38,8	40,5		14,6	11,2	13,2	
Ā	6	Head				39,4				13,6
		formation	37,6	40,7	39,3		14,6	12,9	13,7	
		Planting	42,1	35,7	39,3		13,5	14,2	14,9	
	9	Emergence	39,8	41,1	38,2	39,1	14,5	13,5	12,9	13,1
	9	Head	42,1	36,9	36,5	39,1	11,7	12,0	10,8	13,1
		formation	42,1	50,9	50,5		11,/	12,0	10,8	
	Variety aver	age	40,6	39,1	39,7	39,8	12,8a	12,1b	12,4 a	12,4
	App. time	Planting: 39,4	Emer.: 40),1 Head: 3	89,8	App.	_	:11,1a Eme	r:10,8 ab	Head:10
		Planting	41.5	127	15 1	time	b 10,7	11.6	11.0	
			41,5 44,2	43,7 42,0	45,4 43,4		10,7	11,6 12,3	11,0 11,2	
	0	Emergence Head	44,2	42,0	45,4	43,6	11,/	12,5	11,2	11,6 b
		formation	46,3	41,9	43,6		11,6	12,1	11,7	
		Planting	44,0	41,0	44,4		12,3	11,6	11,2	
		Emergence	44,0	44,4	43,9		12,5	11,0	10,9	
	3	Head	44,0	++,+	43,7	43,8		11,1	10,9	11,5 b
ge		formation	44,8	44,1	43,9		12,0	11,6	11,0	
ra		Planting	42,0	40,5	43,0		12,8	13,9	12,3	
avt		Emergence	41,7	42,5	43,0		12,0	10,5	11,3	
Years average	6	Head				42,6				12,3 a
Yea		formation	42,6	43,5	44,9		12,6	11,6	12,4	
		Planting	43,1	40,2	42,2		12,5	13,1	12,9	
		Emergence	41,6	43,7	41,1		13,2	12,7	11,9	
	9	Head				42,2				12,3 a
	,		1 15 0	40,2	42,3	1	11,9	11,6	10,6	1
·	,		45,0	10,2	7-					
		formation				42.7	12.2a	12,0 ba	11.5b	11.9
	Variety aver App. time	formation	43,4	42,3	43,4	42.7 App.	12,2a	12,0 ba :12,5 Emer	11,5b	11,9

Table 2. Mean oil and protein contents (%) of sunflower varieties depending on nitrogen doses applied during different development periods

Means were significant at 1% level marked with capital letters. means were significant at 5% level marked with small letters.

The difference was not statistically significant (Table 1 and 2), although there was a numerical difference between the nitrogen doses both in the trial years and in the average of the years due to the oil content. Average of sunflower species to which 0, 30, 60, and 90 kg of nitrogen was applied per hectar ha⁻¹ and application periods was 46,9, 47.2, 45.9 and 45.2% in the first trial year, 40.2, 40.5, 39.4 and 39.1% in the second trial period, and 43.6, 43.8, 42.6 and 42.1% (Table 2) as average of the years. In both years of the experiment and in the average of the years, there was a decrease in the oil content after 30 kg of nitrogen dose.

Several studies have reported that higher doses of nitrogen lower the rate of sunflower oil (Tripathi and Sawhney, 1992, Wagh et al., 1992, Herdem, 1999, Javier et al., 2002; Maltas et al., 2018).

The effect of fertilizer doses on the oil content of the sunflower for the growth periods was statistically significant at the level of 5% in the first trial year. Despite the numerical difference in the second year of the trial and the average of the years, there was no statistical difference (Table 1). In the first year of the experiment and in the average of the years, the doses of nitrogen increased the oil content as the application time lagged, while the second year of the experiment showed indecision (Table 2). Thus; In the first year of the experiment, in the oil contents were 45.8, 45.8 and 47.4%, respectively, in the first, second and third years, respectively, and 39.1, 40.1 and 39.8%, respectively, and 42.6, 43.0 and 43.6%).

There was no statistical difference among the varieties for oil percentage, in trial years, and in the average of years, even though there was a numerical difference (Tables 1 and 2). According to the average of the trial factors, the oil contents of Tarsan, L65400 and Imeria varieties were determined as 46.3, 45.5 and 47.1% respectively, 40.6, 39.1 and 47.18% in the second trial, 43.4, 42.3 and 43.4% in the average of the years. The presence of these differences among varieties can be attributed to both genetic characteristics and climate and cultural practices (Haris et al., 1978; Fick, 1978)

Protein content (%)

The percentage of grain protein was 13.0% in the first year and 12.4% in the second year (Table 2). Although there were numerical differences between years of trial, there was no statistical difference (Tables 1 and 2).

Non significant differences were found between the doses of nitrogen and the application times of these doses, both in the years of the trial and in the average of the years. Among the varieties of sunflower, 1% in the second trial

year and 5% in the year average were found to be significant. No difference was found in the first trial year (Table 1).

The averages of each two years of trial and the average of the years of the experiment were close to each other and it was observed that protein averages increased as the average doses of nitrogen were increased. The highest protein content was determined at 60 kg ha⁻¹ nitrogen dose (13.6%) in the first and second trial years and at least 30 kg / ha nitrogen dose (12.6%) in 2013 and controlapplication (10.4%) in 2014. At the average of the years, the highest protein content was determined in 60 and 90 kg ha⁻¹ nitrogen application (12.3%) and least in 30 kg per hectera nitrogen application (11.5%).

Based on the results obtained, it was determined that the nitrogen dosing applications had an effect on the protein content in both trial years. Previous studies (Tripathi and Sawhney, 1992; Wagh et al., 1992), similar to the results of the study, have reported that nitrogen doses increase the percentage of residual protein.

In the first year of the experiment, the protein content was 13.2% during the sowing, 12.9% during the emergence period, 12.9% during the head formation period, 11.1%, 10.8 and 10.5% during the second trial period and 12.5, 11.8 and 11.7% in the average of years respectively. During the head formation period, the protein content was lower than in other application periods (Table 2).

The lowest percentage of protein was found in the Tarsan variety (12.3, 12.8 and 12.2%) in the two years and the average of the years, and the lowest protein content was found in the LG5400 (12.1%) in the second trial, 12.7 and 11.5 %).

In the first year of the experiment, the content of protein to nitrogen dose and fertilizer application time did not show a statistical significance at the level of 5% of the nitrogen dose x application time interactions (Table 1 and Figure 1).

According to the average of years, the non-stability of protein content in terms of nitrogen doses and fertilizer application times resulted in a statistically significant 5% level of nitrogen doses x application times interactions (Table 1 and Figure 2).

In the second year of the experiment, the protein content of varieties was not stable due to nitrogen doses and fertilizer application times, resulting in a significant increase in the doses of nitrogen doses x application times x type interaction as a statistical 5% level (Tables 1 and Figure 3).

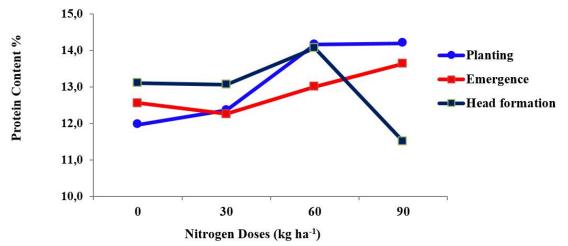


Figure 1. Nitrogen doses of protein contents x application times in the first year of the experiment.

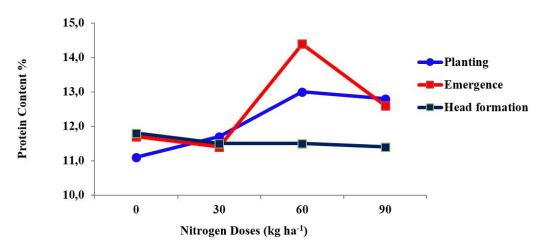
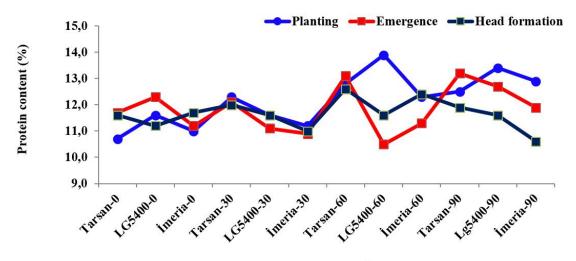


Figure 2. Nitrogen doses of protein contents according to averages of years x application times interactions



Variety x Nitrogen doses (kg ha-1)

Figure 3. Nitrogen doses of protein contents in the second year of the experiment x application times x variety interactions

Grain yield (kg ha⁻¹)

Grain yield in 2013 was (2968 kg ha⁻¹) 624.7 kg more than year 2014 (2343 kg ha⁻¹) and this difference between years is statistically significant at the 1% probability level (Tables 3 and 4). The yield of grain in the first trial is higher than that of the second trial in this year, because of the rainfall and temperature and the length of the growing period in this year. Nitrogen doses were statistically significant at 5% level in the first year of application and at the average of years, whereas in the second year it was insignificant (Table 3). In the first year of the experiment and in the average of the years, as the nitrogen dose increased, the grain yield per decare increased. In the second trial, the increase in the nitrogen doses showed instability.

Table 3. Results of variance analysis of grain and oil yields of sunflower varieties depending on nitrogen doses applied during different development periods

			Grain y					Oil y		
Variation Source	d.f		F valı	ies		d.f		F val		
variation Source	u.i	Yea	nrs	Y	llar Ort.	u.1	Ye	ars	Yı	llar Ort.
		2013	2014	d.f	F values		2013	2014	d.f	F values
Year (A)	-			1	43,97*	-			1	18,34*
Error ₁	-			2		-			2	
Nitrogen doses (B)	3	3,745*	1,859	3	4,570*	3	1,283	2,147	3	1,400
A x B	-			3	1,337	-			3	1,594
Error ₂	6			12		6			12	
Applicatio time (C)	2	3,191*	0,232	2	2,821*	2	1,263	0,140	2	1,210
AxC	-			2	1,268	-			2	0,764
BxC	6	4,004*	3,557*	6	2,793*	6	3,071*	3,495*	6	2,715*
AxBxC	-			6	4,869**	-			6	3,636**
Error ₃	16			32		16			32	
Variety (D)	2	8,905**	1,102	2	3,325*	2	3,487*	0,968	2	2,357
A x D	-			2	7,283**	-			2	2,832
B x D	6	0,440	0,526	6	0,685	6	0,432	0,147	6	0,498
A x B x D	-			6	0,275	-			6	0,165
CxD	4	0,423	0,728	4	0,400	4	0,604	0,533	4	0,585
AxCxD	-			4	0,727	-			4	0,585
BxCxD	12	0,557	0,246	12	0,537	12	0,712	0,520	12	0,924
AxBxCxD	-			12	0,289	-			12	0,363
Error ₄	48			96		48			96	

** Marked F values are 1%, * marked F values are significant in 5% level.

According to the applied nitrogen doses, the maximum yield of grain per decare per year in the experiment years and in the average of years was 3238, 2564 and 2901 kg ha⁻¹, respectively, at 90 kg nitrogen application while minimum yield was in first trial year and in average of years in control group as 2656 and 2468 kg and in second trial year as 2229 kg respectively at 60 kg nitrogen application per hectare. The results obtained from the experiment are in parallel with studies of Wagh et al. (1992), and Herdem (1999).

When the nitrogen doses were examined in terms of application times to sunflower, grain yield was found to be highest in the sowing period (3174 and 2379 kg ha⁻¹) and lowest in head formation period (2772, 2299 and 2545 kg ha⁻¹), respectively. In both years when the experiment was carried out and in the average of the years, the application of nitrogen applications together with sowing, resulted in the highest allowable yield.

This difference was statistically significant at the 1% level for the first year of experiment and at 5% level for the

average of the years (Table 3). In the first year of the experiment and in the average of the years, the yield of Tarsan variety was 3241 and 2777 kg / ha^{-1} , respectively, and in the second year of experiment, the yield of the variety of Imeria (2438 kg ha^{-1}) was more than the other varieties.

In the first year of the experiment, the nitrogen yields and the stability of the fertilizer application times caused the nitrogen doses x to be significant at the 5% statistical level of the application time interactions (Table 3 and Figure 4).

In the second year of the experiment, the nitrogen yields and the stability of the fertilizer application times caused the nitrogen doses x to be significant at the 5% level of the application time interactions (Table 3 and Figure 5).

Nitrogen doses during non-fertilization trials and nonstabilization by application times resulted in a statistically significant 1% level for year x nitrogen doses x application times (Table 3 and Figure 6).

Particity Output Tarsan Colsado Tarsan	tio			
9 Planting 2392 2337 2349 1083 1159 1199 8 Emergence 2907 2466 1957 2656 1620 1345 1092 916 1 3 Emergence 3200 3113 3080 2001bc 1600 1296 1324 1 1486 1514 1457 1 1486 1514 1457 1 1486 1514 1457 1 1486 1514 1457 1 1486 1514 1437 1 130 1197 1 1533 1344 1300 1197 1 1533 1344 1300 1197 1 1533 1344 1399 1 153 1344 1399 133 1300 1353 1344 1399 133 1300 1324 1439 1313 1324 1431 1310 1328 1411 1466 1546 1605 1546 1605 1546 1605 1546				
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Table 4. Average values of grain and oil yields (kg ha⁻¹) of sunflower variaties depending on nitrogen doses applied during different growth periods.

Means were significant at 1% level marked with capital letters. means were significant at 5% level marked with small letters.

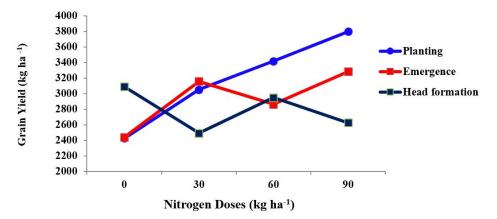


Figure 4. Nitrogen doses of grain yield x application times in the first year of the experiment.

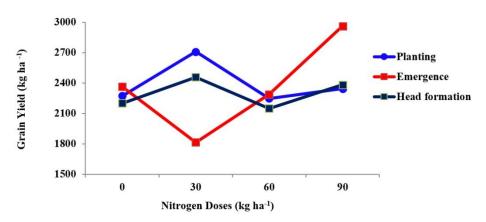


Figure 5. Nitrogen doses of grain yield x application times in the second year of the experiment.

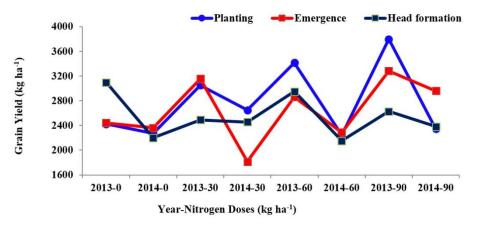


Figure 6. Year of grain yield x nitrogen dose x application time interactions

The fact that the grain yields of the varieties did not stabilize during the trial years led to the statistical significance of the year x variety of interactions at 5% level (Table 3 and Figure 7).

Oil yield (kg ha⁻¹)

The difference between the years of experiment was in terms of the content of oil per decare, and this difference was statistically significant at the 5% probability level (Table 3). In the first year of the experiment, the oil yield per hectare was 1348 kg and in the second year it was 935 kg. The oil yield was higher in the first trial year than in the second trial year and this can be due to the fact that grain (2968 kg ha⁻¹) and oil content (46.3%) in this year was higher than the second year (2343 kg ha⁻¹ and 39.8%). (Table 3 and 4)

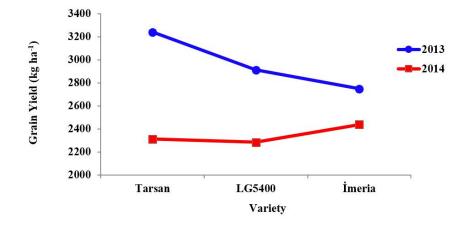


Figure 7. Variety of grain yield based to years x year interactions

There was no statistical difference between the doses of nitrogen in terms of oil yield, although there was a numerical difference between the two test years and the average of the years (Tables 4 and 3). The oil yields per decare obtained from the application of the 0, 30, 60 and 90 kg nitrogen doses were 1245, 1356, 1422 and 1369 kg ha⁻¹ respectively in the first trial year, 918, 933, 880 and 1011 kg ha⁻¹ in the second trial year, 1082, 1145, 1150 and 1188 kg ha⁻¹ in the average of the years respectively (Table 4). In average of the years, it was observed that oil yield increased due to increasing nitrogen doses. When the averages of oil yields are examined, the results are similar to the studies performed by Herdem (1999), Esendal et al. (2010) who stated that obtained result showed increasing effect of nitrogen to oil yield.

Despite the numerical differences between the application times of nitrogen doses and the oil yields per hectar, both in the trial years and the averages of the years, no statistical differences were found (Tables 4 and 3). In the first year of the experiment oil yield per hectare in the sowing time was 1419 kg, 1342 kg in the emergence period and 1283 kg in the head formation period, 939, 947 and 921

kg in the second trial period and 1179 kg, 1144 and 1102 kg respectively in the average of years. During the test years and the average of the years, the oil yield per decare was lower than in the other application periods (Table 4).

There was no statistically significant difference in the second year of the test and in the average of the years, and in the first year there was a statistical difference in the level of 5% probability (Table 3). Tarsan, L65400 and Imeria varieties were determined as 1443, 1313 and 1287 kg in the first year of the test of the oil yield per hectare, 936, 902 and 968 kg in the second trial period, and 1190, 1108 and 1127 kg in the average of the years. In the first trial year of the Tarsan variety, the average oil yield (1443 and 1190 kg ha⁻¹) was higher than the other varieties in the first trial period and in the average of the years.

The fact that oil yield demonstrating non-uniformity in the first and second years of the experiment and the average of the years in terms of nitrogen doses and fertilizer application time, caused "nitrogen doses x application times" interaction to be in a statistically significant at 5% level (Table 3 and Figures 8, 9 and 10).

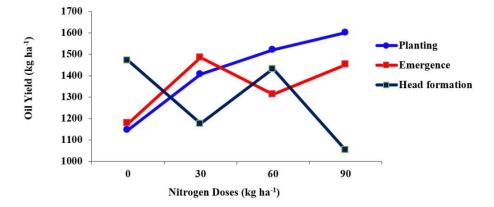


Figure 8. Nitrogen doses of oil yield x application times in the first year of the experiment

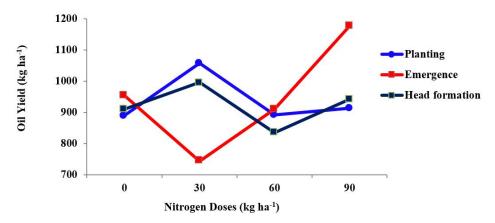


Figure 9. Nitrogen doses of oil yield x application times in the second year of the experiment

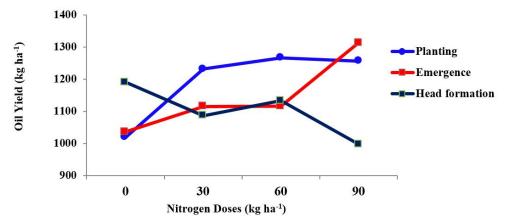


Figure 10. Nitrogen doses of oil yields based to years x application times interactions

Nitrogen doses during the trial years and the fact that the oil yields were not determined according to the application times caused "year x nitrogen doses x application times" interaction to be in a statistically significant 1% level (Table 3 and Figure 11).

This study was carried out in order to determine the effects on the quality and yield of nitrogenous fertilizer doses applied in different development periods of oil sunflower varieties with different development periods.

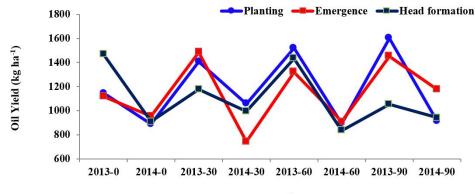
There was no effect on the oil and protein contents of the trial years, and it had an effect on grain and oil yield.

The effect of nitrogen doses on oil and protein content was not significant. The content of oil in 30 kg ha⁻¹ nitrogen application (47.2, 40.5 and 43.8%) and protein content in 60 kg ha⁻¹ nitrogen application (13.6, 13.6 and 12.3%) were the most. In the second trial, the maximum yield was 90 kg ha⁻¹ nitrogen (3237, 2564 and 2901 kg ha⁻¹), the oil yield was 60 kg nitrogen (1422 kg ha⁻¹) in the first trial year, and (1011 and 1180 kg ha⁻¹) in second trial year and average of the years, at a nitrogen dosage of 90 kg ha⁻¹ respectively.

The content of oil (45.8, 40.1 and 43.0%) and protein (13.2, 11.1 and 12.0%) were higher in the application of nitrogen doses at the time of emergence, and in the application at sowing period the grain and oil yield were (3174, 2379 and 2776 kg ha⁻¹) and (1419, 939 and 1179 kg ha⁻¹) respectively and these values were higher than in other application periods.

There were differences in the characters examined among the varieties. The grain yield was (3240, 2313 and 2777 kg ha⁻¹) and oil yield was (1444, 936 and 1190 kg ha⁻¹) for Tarsan variety, while the oil contents were (47.1, 39.7 and 43.4%) for Imeria variety and (46.3, 40.1 and 43.3%) for Tarsan variety. Besides, the protein content of Tarsan variety (13.3, 12.8 and 12.2%) was higher than the other varieties.

As a result, when considering the grain and oil yield in the study, 90 kg of nitrogen dose per hectare should be applied during emergence period to species with median development period (LG 5400), while 60 kg nitrogen dose should be applied to early and late sunflower varieties (İmeria and Tarsan), during sowing period.



Year-Nitrogen Doses (kg ha⁻¹)

Figure 11. Nitrogen doses of oil yields based to years x application times interactions

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