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Effects of Different Leaf Fertilizers on Yield and Quality in Sunflower (*Helianthus annuus* L.)

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Abstract: In this study carried out at the Research Farm of Çanakkale Onsekiz Mart University between 1998-1999, the effects of Superalg, NZN, Crop-tec and Polyfeed fertilizers on yield and quality related characters of sunflower cultivar AS-503 were investigated. Although the effects of four different leaf fertilizers on 1000 seed weight, head and stem diameter were not significant. They had significant effects on seed yield, seed height, seed/husk ratio, oil content, plant height, seed dry matter and stem yield ($P<0.01$). In this study, the best results were obtained from Crop-tec and Polyfeed fertilizers. However, according to economic analysis, the finding suggest that NZN application has the highest gross margin per hector.

Key words: Sunflower, leaf fertilizer, crop-tec, polyfeed, superalg, NZN

INTRODUCTION

Food or nutrition demand of the world increases with increasing population of the world. Oil is one of the five basic nutrients for human being. Therefore, vegetable oil production is important[1] as animal fat is limited and expensive.

Food and nutrition demand of the world has increased with rising population of the world. Oil is one of the five basic nutrients for human being. Therefore, vegetable oil production is important as animal fat is limited and expensive. So during the last two decades, sunflower has emerged as one of the major edible oil seed crops in the world, ranking second in importance after soybean[2]. On the other hand sunflower seed meal is a good feedstuff for animals. It is also an important industrial crop as its oil is used in soap making, cosmetic products, plastic paints and its straw is used in paper industry. Therefore, the oil has found widespread acceptance as a high quality, edible oil throughout much of the world. Meanwhile 86% of world's and 80% of Turkey's oil production is vegetable oil. Sunflower meets 14% of world's and 57% of Turkey's oil production[1]. Sunflower production of the world is 22.74 million ton in 2002. Major producing countries are Argentina, Russian Federation, Ukraine, Chine, France, USA and India. These seven countries produce about 68.8% of the world's production. Sunflower was cultivated in 650.000 ha and produced at 820.000 ton in 2002 in Turkey[3].

When sunflower produces 8.7-8.8 t ha^{-1} dry-matter it uptakes 65 kg N ha^{-1}, 41 kg P_2O_5 ha^{-1}, 365 kg K_2O ha^{-1} and 133 kg CaO ha^{-1} from soil[18]. Because it uses a substantial amounts of nutrients of soil, leaf fertilizing is important in increasing yield and quality. Therefore this study was undertaken to investigate the effects of four commercial leaf fertilizers on yield and quality features of sunflower.

MATERIALS AND METHODS

This study was carried out at the Research Farm of Çanakkale Onsekiz Mart University between 1998-1999. The chemical composition values of the soil were pH 7.70, 21.18% $CaCO_3$, 0.98% organic matter, 0.15% total nitrogen, 131 kg ha^{-1} available P_2O_5, 2.50 me 100 g^{-1} K, 8 ppm Fe, 0.6 ppm Cu, 0.03 ppm Zn, 0.4 ppm Mn. The texture of the soil was SCL. Total rain during 1998-1999 was 546.9-595.3 mm, and the average temperature was 11.1°C in 1998 and 16.5°C in 1999.

AS-503 sunflower variety and four commercial leaf fertilizers (Table 1) were used in this study. The layout of the experiment was completely randomised block design with 3 replicates. Each plot was 20.8 m^2 (5.8x 3.5 m). 50 kg N ha^{-1} (ammonium sulphate 21%) in prior to sowing, 140 kg K_2O ha^{-1} (potassium sulphate 50%) and 50 kg P_2O_5 ha^{-1} (triple super phosphate 42-44%) were given to seedbed[17]. Sunflower seeds were sown with 70x20 cm plant density on April 16, 1998 and April 11, 1999.

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After the seeds emergence hoeing was performed twice. During the growth period, no irrigation was applied. The leaf fertilizers were applied as described in Table 2. First two plants at the end of each row (2x2x4=16 plants) and one row (58 plants) from each plot were eliminated as a side effect. Thus, 100 plants plot were harvested for taking measurements. Harvesting was carried out by hand on August 7, 1998 and August 11, 1999. The results of the study were analysed by MSTAT-C computer program and the means separations were carried out by LSD test.

RESULTS AND DISCUSSION

The results of sunflower fertilized with different leaf fertilizers were given in Table 3. In addition, the relationships between two parameters were presented in Table 4. Evaluation of the results was based on average values obtained from two years.

Seed yield: The results for two years showed that seed yield varied between 883.1-1248.9 kg ha^{-1} with application of different leaf fertiliser ($P<0.01$). According to LSD test, Crop-tec gave the highest seed yield, followed by Polyfeed, Superalg, NZN and control plot.

In this study, fertilizers that have high N-P-K and trace elements provided the best results. However, seed yield is dependent very much on variety, season, soil characteristics and agricultural applications. Average seed yield was found to be lower than that in Turkey's average yield, 1.26 t ha^{-1} [3] and this could be due to shortage of rainfall during the experimental period. However, parallel results were obtained in similar studies[4,5]. The reason for higher yield values from Crop-tec could be associated with high mineral content of fertilizer and the participation of minerals in metabolic processes.

1000 seed weight: The effects of applications on 1000 seed weight were not statistically significant ($P>0.05$). One thousand seed weight of control group was calculated as 39.8 g, on the other hand, same value for other treatments ranged from 41.0-45.7 g in other fertilizer groups. Fertilizers stimulate growth of plants by providing additional nutrients to seeds. Several studies in the literature reported different 1000 seed weight values, such as 43.8-70.2 g[6] and 97 g[7]. AS-503 in this study produced similar values, which is similar to those previously published.

Oil content: The effects of fertilizers on oil content were found to be significant and oil content varied between 35.2 and 41.6%. Highest oil content was obtained from Crop-tec, followed by Polyfeed, Superalg, NZN (Table 3).

The increase in yield by fertilizers was largely due to conversion of carbohydrates to oils in oil storing plants, like sunflower, resulting in increase in oil content. The results of several studies[8] using N fertilizing are consistent with this statement.

Dry matter in seed: The fertiliser applications had significant effects on dry matter which ranged between 88.7-94.7%. According to LSD test, Polyfeed and Crop-tec gave the highest dry matter values, followed by Superalg, NZN (Table 3). These results are similar to those reported by Gider[6]. Polyfeed and Crop-tec are rich in minerals among all fertilizers tested and were thought to result in an increased dry matter yield because it is believed that homogeneous distribution of inorganic elements results in increased metabolic products and especially elements like potassium[9] is known to increase cell sap density[10].

Seed/husk contents: Seed/husk contents of sunflower were increased to significant extents by the fertilizers. Seed/husk content of plants in control group was found as 55%, on the other hand, in the fertilizing plants this value ranged between 61.0-65.0%. The highest seed/husk content was obtained with Crop-tec, followed by Polyfeed, NZN, Superalg and control group. The results of the present study are consistent with those of many published studies[1,11].

Seed height: Depending upon the leaf fertilizer, seed height ranged between 1.19-1.62 cm and the effect of application was significant ($P<0.01$). Polyfeed resulted in the highest plants, 1.62 cm, followed by Crop-tec, Superalg and NZN as compared to control group. Fertilizing led to better growth of plants, thus there was an increase in seed height. In other studies[12] seed height was reported to range from 1.55 and 2.96 cm and to differ according to variety.

Head diameter: The head diameter of sunflower varied between 12.1-14.8 cm, but no effect of the fertilizers was found. The largest heads were obtained from Crop-tec and Polyfeed, followed by Superalg, NZN and control plot. Several researchers have reported that head diameter varies between 18-29 cm depending upon variety and growing techniques, the values could be between 6-45 cm[1].

The provision of elements that are provided through the use of fertilizers for optimum plant growth is probably the cause of fast and better growth of plants, thus the production of bigger-size seeds. The increase in size of sunflower heads due to fertilizing, especially N-fertilizers has been well established by many researchers[13,14].

Table 1: Chemical composition of fertilizers employed in this study

		Mineral elements(%)									
Fertilizer	Produces	N	P	K	Fe	Cu	Zn	Mo	B	Mn	Mg
NZN	NZN	19.7	-	-	-	-	6.5	-	-	-	-
Crop-tec	Cience	20.0	20.0	20.0	0.01	0.05	0.05	0.00	0.02	0.05	0.02
Polyfeed	Haifache	19.9	19.3	19.3	0.10	0.011	0.15	0.017	0.02	0.05	-
Superalg	Alginic acid, amino acids, sugar, protein, N, P, K, carbohydrate, vitamin. Prepared from Ascophyllum nodosum, Haminaria, digitata-hyperborea and chondrus cripus sea mosses										

Table 2: Application methods of leaf fertilizers

Leaf fertilizer	Application doses	Number of application	Application time
NZN	2000 ml ha^{-1}	1	At the fast growing period of the plants
Polyfeed	1750 g ha^{-1}	3	At 10 days intervals when plants heights are 40-50
Crop-tec	3500 g ha^{-1}	4	When the plants reach 5-6 leaves
Superalg	750 ml ha^{-1}	3	At the 5-6 leaf and bud stages of sunflower Twenty days after first application 6 weeks before the harvest

Table 3: Effect of different leaf fertilizers on yield and quality criteria

Fertilizer	Seed yield (kg ha^{-1})	1000 seed weight (g)	Oil cont.(%)	Dry matter (%)	Seed/usk ratio (%)	Seed height (cm)	Head diam. (cm)	Plant height (cm)	Stem yield (t ha^{-1})	Stem diam. (mm)
1998										
Control	851.2e	36.8e	34.3d	87.3d	54.9e	1.16e	11.9d	91.6e	14.257e	9.2
NZN	1084.0d	42.4a	35.8cd	88.3c	63.0c	1.25d	12.5c	138.1a	31.036b	16.4a
Polyfeed	1136.1b	41.3b	39.3ab	93.7a	64.4b	1.58a	13.7a	129.9c	27.767d	14.8c
Crop-tec	1187.0a	39.2d	40.6a	90.3b	65.1a	1.37b	13.9a	134.1b	36.433a	15.9b
Superalg	1107.7c	40.1c	37.3bc	88.7c	60.1d	1.29c	14.4b	108.1d	28.572c	13.9d
Mean	1073.2	39.9	37.5	89.7	61.5	1.33	13.3	120.4	27.613	14.0
Significant	**	**	**	**	**	**	**	**	**	**
1999										
Control	915.0d	42.8 d	36.1e	90.1d	47.0d	1.22e	12.3d	113.6d	14.309e	13.3e
NZN	1153.0c	49.0 a	40.0d	90.3d	62.9b	1.31d	13.1c	151.9a	31.098b	16.4b
Polyfeed	1201.1b	47.7 b	41.7b	95.7a	64.3a	1.66a	15.9a	139.8b	30.033c	16.8a
Crop-tec	1310.8a	42.8 c	42.6a	92.3b	64.9a	1.55b	15.7a	139.6b	38.433a	15.9c
Superalg	1173.7c	44.1 c	40.9c	90.8c	60.8c	1.33c	15.2b	129.8c	28.562d	14.1d
Mean	1150.7	45.3	40.3	91.8	59.9	1.41	14.4	134.9	28.487	15.3
Significant	**	**	**	**	**	**	**	**	**	**
Mean										
control	883.1c	39.8	35.2d	88.7b	55.0b	1.19d	12.1	102.6c	14.283d	10.6
NZN	1118.5b	45.7	37.9c	89.3b	63.7a	1.28c	12.8	145.0a	31.067b	16.4
Polyfeed	1168.6b	44.5	40.5ab	94.7a	64.7a	1.62a	14.8	134.8ab	28.900c	15.8
Crop-tec	1248.9a	41.0	41.6a	91.3ab	65.0a	1.46b	14.8	136.8a	37.433a	15.9
Superalg	1140.7b	42.1	39.1bc	89.7b	61.0a	1.31c	14.8	119.0bc	28.567c	14.0
Mean	1112.0	42.6	38.9	90.7	61.9	1.37	13.8	127.6	28.050	14.5
Significant	**	NS	**	**	**	**	NS	**	**	NS

*; p<0.01, NS; Non significant

Table 4: Correlations between different characteristics

Characters	1000 seed weight	Oil content	Dry matter	Seed/husk content	Seed height	Head diameter	Plants height	Stem yield	Stem diameter
Seed yield	0.36NS	0.76**	0.51*	0.91**	0.60*	0.80**	0.76**	0.95**	0.85**
1000 seed weight		0.11NS	0.24NS	0.59*	0.36NS	0.21NS	0.75**	0.39NS	0.70**
Oil content			0.67**	0.66**	0.66**	0.70**	0.47NS	0.68**	0.51NS
Dry matter				0.56*	0.84**	0.63*	0.36NS	0.33NS	0.39NS
Seed/husk content					0.67**	0.74**	0.87**	0.89**	0.91**
Seed height						0.76**	0.48NS	0.48NS	0.53*
Head diameter							0.46NS	0.69**	0.54*
Plants height								0.84**	0.95**
Stem yield									0.89**

**: P<0.01, *:P<0.05,

Table 5: Gross margin account in sunflower production and the application costs of leaf fertilizer (1000 TL ha^{-1})

Leaf fertilizer	Sunflower yields (kg ha^{-1})	Receipts (ha^{-1})	Variable input: the costs of leaf fertilizer(*)	Gross margins
NZN	1118.5	514510	27000	487510
Polly feed	1168.6	537560	58130	479430
Super alg	1148.6	524720	54000	470720
Crop Tec	1248.9	574490	144000	430490

(*) It includes the costs of application doses of leaf fertilizers and the spraying labour per hectare

Plant height: In the study, plant height varied between 102.6-145.0 cm and fertilizers had significant effects on plant height ($P<0.01$). Tallest plant were found with NZN, Crop-tec and Polyfeed, whereas shorter ones with Superalg and control group.

The results are, in general, similar to the results of some investigations[1,5,14,15]. It is well known that fertilizing promotes growth and development of plants. In fact, among all fertilizers, nitrogen promotes cell division and growth, thus stimulates plant growth, which together increased vegetative development and plant heights[16]. Therefore, the highest values in plant height were found in NZN applied plants. The reason for relatively shorter plants was probably owing to shortage of water.

Stem yield: Depending on perpetrates used in the present study, between 14.283-37.433 t ha^{-1} of stem was obtained. The difference between treatments in terms of stem yield was statistically significant ($P<0.01$). The greatest stem yield was obtained with Crop-tec, followed by NZN, Polyfeed, Superalg and control (Table 3). Higher stem yields were obtained from the plots in which had a greater stem diameter and plant height.

Stem diameter: Stem diameter varied from 10.6 to 16.4 cm. NZN gave the biggest head diameter in the present study, followed by Crop-tec, Polyfeed, Super and control groups (Table 3). Fertilizing had a positive effect on plant growth, which resulted in plants with larger stalks.

Economic Analysis

Considering the average sunflower yields for two years in the Table 2, it was determined that the highest gross margin per hectare (487 510 000 TL ha^{-1}) was occurred in the NZN application. Although the Crop Tec application had the maximum yield per hectare (1248.9 kg ha^{-1}) in controlled conditions, due to the higher costs of leaf fertilizer per hectare, our calculations show that it had a gross margin of 430 490 000 TL ha^{-1} (Table 5).

Relationship between seed yield and other characteristics: The correlation between seed yield and other criteria was given in Table 4. The relationship between seed yield, and oil content, seed/husk ratio, head diameter, plant height, stem yield and stem diameter was found to be highly significant ($P<0.01$). In addition, the relationship between seed yield, and dry matter and seed height was significant ($P<0.05$). There was no significant correlation between seed height and 1000 seed weight, which suggests that seeds are thin and long. Thus there would be more seeds in each head, which would therefore resulted in more seeds produced.

The increase in head diameter leads to increases in number of seeds per head. This is why there was no significant correlation between seed yield and head diameter. Better development of plants is probably the reason for greater plant height and stem yield. These plants spare nutrients to the seed during nutrient filling in sunflower seeds. Therefore, more seeds become mature, which in turn leads to increased seed yield.

When yield and quality criteria are considered, especially seed yield, head diameter, seed content without husk and oil content are the important parameters for oil producing varieties. On the other hand, stem yield is considered in terms of animal feed. Seed yield, which is very important in terms of oil industry and producers, was increased by 41.1% with Crop-tec, by 32.3% with Polyfeed, by 29.2% with Superalg and by 26.7% with NZN as compared with control group. This increase could be due to 20% N, P and K and trace elements contents of Crop-tec and Polyfeed. In order to increase yield and quality of sunflower, Crop-tec and Polyfeed as leaf fertilizers tested here are recommended. However, according to the economic analysis, the findings suggest that NZN application has the highest gross margin per hectare.

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