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ECONOMIC ANALYSIS OF SUNFLOWER PRODUCTION IN THE VIEW OF OROBANCHE RESISTANCE CONDITIONS

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The objective of this research is to determine the use of production factors in 3 different types of sunflower production with respect to orobanche resistance in the agricultural enterprises in Thrace Region which is located at European continent of Turkey. The data used in this research have been obtained through questionnaire technique from 571 agricultural enterprises which were determined by Stratified Random Sampling Method in 2009. It has been reached to the highest yield by 189.30 kg da^{-1} and the highest gross profit by 37.91 US$ da^{-1} in the production of sunflower, resistant to orobanche. In the research, it has been determined that the rate of soil testing among the sunflower producers is considerably low and almost the whole of the production has been made under rainfed conditions. As a result of the research, it has been concluded that orobanche resistant sunflower, which has higher water productivity than other cultivars by 367.13 g m^3, will have a higher proportion in the sunflower cultivation areas in future because of its higher contribution to producer welfare.
Keywords: Sunflower, orobanche (*Orobanche cernua* L.), input Use, gross profit, water productivity

INTRODUCTION

Turkey ranks among the top 10 countries in the world sunflower production by 580000 ha cultivation area and by its production amount which is more than 1050000 ton (FAO, 2010). The sunflower is one of the important sources of income for the producers in Thrace Region, which meets almost 60% of country production (TURKSTAT, 2010). The most important difficulty in sunflower production, which has 60-year history in Turkey, is orobanche (*Orobanche cernua*). The orobanche is one of the factors that affect the sunflower yield negatively in Thrace Region which is located at European continent of Turkey along with Spain and East European countries (Kaya *et al*., 2010). In the areas of Thrace where the orobanche is intensively infected, the cultivars which are genetically resistant to orobanche and Imidazolinone (IMI) are produced beside slightly non-orobanche-resistant cultivars (Demirci and Kaya, 2009; Semerci *et al*., 2010).

The improvement studies form the important part of the research works conducted about this issue. However there are studies in limited numbers about determining the resource use level (Pirinccioglu, 1973; Safak, 1981; Tuna, 1993; Aksoy and Gaytancioglu, 1996; Altintas and Oguz, 2002). On the other hand in the literature examines, it has been concluded that there has not been any socio-economic study on sunflower production so far which has been conducted by considering the condition of sunflower resistance to orobanche.

Turkey is one of the countries that fail to meet the supply in response to demand in oil seed production. When the agricultural import values of the country in 2008 are analyzed, it is understood that Turkey has imported oil seeds of the amount of 3.2 billion US$ (TEAE, 2009). Oil seed production in Turkey has been supported since 2000 in order to be able to meet the current supply deficit. The effective use of production factors has great importance in decreasing the production cost and contributing to the producer prosperity besides the granted subsidies in order to make increase in oil seed production.

The research which has been conducted is a first for both research area and Turkey in terms of analyzing the quantity of input use of 3 different sunflower cultivars which have different characters about resistance to orobanche. In the study the differences in input levels which have been used in sunflower cultivars in the extent of orobanche resistance have been analyzed, and water productivity values have been calculated and the interpretations about possible changes in coming periods based on the sunflower species in sunflower cultivation areas in Turkey, have been made by giving gross profits of cultivars.

MATERIALS AND METHODS

Thrace Region is one of the important agricultural basins which have high production potential with its 24378 km^2 area unit which forms 3% of Turkey (Semerci, 1998). The average precipitation in the region varies between 500-800 mm and average temperature value varies between 13.0 ^{0}C - 14.6 ^{0}C. The region has been selected as a research area for the fact that it meets more than half of the sunflower demand of the country and also the producers in the region have

become experts in a considerable extent. In the research the data acquired from the project named "The Determination of Efficiency of Subsidizing Policies, and Productivity in Sunflower Production (TAGEM - 08/AR- GE / 06)" which has been supported in the extent of R&D studies by Ministry of Food Agriculture and Livestock of Turkey have been used.

The data in this research have been obtained from agricultural enterprises in the provinces of the region such as Edirne, Kirklareli, Tekirdag, Istanbul and Canakkale by using "Stratified Random Sampling Method". The formula of "Neyman Method- Stratified Random Sampling Method" which has been used to determine the sample size is given below (Yamane, 1967):

$$n = \frac{\Sigma(Nh\,Sh)^2}{N^2D^2 + \Sigma Nh\,(Sh)^2}$$

In formula

n : sample volume,

N_h : the number of units in the layer (frequency),

S_h : standard deviation of layer h,

N : total unit number,

D : d/z

d : average of a certain percentage (1% - 5% - 10%, etc.) deviation,

z : degrees of freedom in t-distribution scale (N-1) and expresses "t value" belongs to a certain confidence limit (90% - 95% - 99% etc.).

A total of 571 surveys have been conducted with sunflower producers in the extent of the research; 175 of them have been obtained from the enterprises in Edirne province, 116 of them have been obtained from enterprises in Kirklareli province, 233 of them from the enterprises in Tekirdag province, 26 of them from enterprises in Istanbul province and lastly 21 of them from the enterprises in Canakkale province. The data used in the research belong to cross sectional data of the year 2009. Upon determining the sample residential area, 95% confidence interval and 4% deviation from mean have been considered. Also for determining the number of enterprises where the questionnaire technique applied, 95% confidence interval and 1% deviation from mean have been taken into account (Cicek and Erkan, 1996).

In this research it has been determined that there are 3 sunflower cultivars produced in the examined enterprises. These are (a) orobanche resistant sunflower cultivars, (b) IMI IMI resistant sunflower cultivars, (c) non-resistant sunflower cultivars. The one way ANOVA has been used to determine the differences statistically among the sunflower producers in terms of seed yield, income, hoeing cost, seed cost, fertilizer quantity, pesticide cost, precipitate and land rent value per da. Statistic program has been used for statistical analysis and "Tukey HSD Test" have been used to determine the differences among sunflower cultivar groups (Ural and Kilic, 2006; Green *et al*., 2000). Tukey's multiple comparison test is one of several tests that can be used to determine which means amongst a set of means differ from the rest. Tukey's multiple comparison test is also called Tukey's honestly significant difference test or Tukey's HSD. Tukey's test is developed in reaction to the LSD test and studies have shown the procedure accurately maintains alpha levels at their intended values as long as statistical model assumptions are met (i.e., normality, homogeneity, independence). Tukey's HSD is designed for a situation with equal sample sizes per group, but can be adapted to unequal sample sizes as well.

RESULTS AND DISCUSSION

***The sunflower production and input use level of the enterprises where the questionnaire has been conducted in the research area*:** In the enterprises, where the questionnaire has been conducted, 9295.82 ton sunflower has been produced in 52601.5 da (1 da=1000 m^2). In return for about 176.7 kg da^{-1} sunflower yield per unit area, 104.43 US$ da^{-1} income have been obtained. When the sunflower cultivation area has been considered on parcel basis, the sunflower production has been made in 666 parcels in the enterprises where the questionnaire has been conducted. As a result of the survey, it has been proved that in 49% of total parcel number (327 piece and 22199 da) the orobanche resistant cultivars have been used, in 41.14% (274 piece and 26529.5 da) IMI resistant cultivars have been used and in 9.76% of the rest parcel (65 piece and 3873 da) sunflower cultivars which are non-resistant-to-orobanche have been used.

***Seed use level in sunflower production*:** The seed use quantity in sunflower production in Turkey has been determined as respectively 1250-1291 gr da^{-1} by Pirinccioglu (1973) and Safak (1981). In parallel with the developments in the world, the hybrid seed use in sunflower production reached 90% in the beginning of the 2000's (Kaya, 2002). Upon starting to use hybrid seed in sunflower production and wide-ranging cultivation by pneumatics grain drill, there has been an important decline in seed quantity. On the previous studies the seed use quantity in sunflower was determined as 377 gr da^{-1} by Gungor and Semerci (1999) and as 407 gr da^{-1} by TEAE (2001). In this research conducted, the seed use level has been calculated as 368.70 gr da^{-1} in the orobanche resistant cultivars, 385.88 gr da^{-1} in the IMI resistant cultivars and 385.36 gr da^{-1} in the cultivars which are non-resistant-to orobanche. As a general 19.915 ton seed were used in the enterprises for sunflower production in 2009. The seed quantity per unit area has been determined as 378.06 da^{-1} and seed cost as 7.24 US$ $da^{-1.}$

***The nutrient requirement of sunflower and the fertilizer use level*:** In sunflower production, the nitrogenous fertilizer recommendation may vary according to the quantity of

nitrogen in the soil and yield potential of the species (along with the humid condition and precipitation quantity). In addition to this, it is recommended to use the nitrogenous fertilizer between 6-19 kg da $^{-1}$ for 120- 250 kg da^{-1} yield in Europe (Glas, 1988).

In research area it has been determined that 20.20.0 type compound fertilizer has been used generally in sunflower production. In Thrace the total chemical fertilizer quantity used for sunflower production in 2009 was 1025.46 ton in 571 agricultural enterprises where the questionnaire has been conducted. The chemical fertilizer quantity per unit area has been determined as 19.50 kg da^{-1} and the fertilizer cost as 11.05 US$ da$^{-1.}$

In the previous studies about sunflower production, it was reported by Safak (1981) that fertilizer use level per unit area was 24 kg da^{-1} and 15.59 kg da^{-1} by TEAE (2001). In this research, fertilizer use quantity has been calculated as 17.78 kg da^{-1} for the cultivars non-resistant-to orobanche, 19.35 kg da^{-1} for cultivars resistant to orobanche and 19.87 kg da^{-1} for the cultivars resistant to IMI group pesticides.

***Water use level*:** Many studies have shown that water use level varies between 200-900 mm for the sunflower (Unger, 1982). The sunflower in Thrace Region is generally produced in rainfed conditions and occasionally in semi-arid and subhumid areas when the precipitate is stored and precipitate in spring period is in limited quantity except for production period (Erdem *et al*., 2001).

In research area, precipitate quantity in 2009 sunflower production period varied between 476.6 mm – 760.4 mm (TSMS, 2009). Within the studies, it has been observed that in the enterprises analyzed, the sunflower production is rather low in the irrigated conditions. Because, in the enterprises analyzed, it has been observed that only 2.84% of sunflower cultivation area (in 1490 da) is irrigated. For this reason it is possible to say that sunflower production in Thrace Region is made densely under rainfed conditions when the enterprises are considered.

***Protection against the weeds and the parasitic plants*:** Weed control is one of the important methods applied for avoiding from poor growing and low yield and preventing the possible weed problem in the future. The producers may suffer a loss heavily by the weeds attacking to the sunflowers. Along with weeds, the parasitic plants (like orobanche) also benefit from the sunflowers' water and nutrition thus makes the sunflower weaker and lead to deficiency in yield (Stewart and Press, 1990).

In the study carried out in the area, it has been determined that the use of the sunflower cultivars which are resistant to orobanche and IMI group pesticide has reached to 93% and pesticide use level is 150 ml da^{-1} (Kaya *et al*., 2010). Within the other studies, it has been calculated that pesticide use level is 160.41 ml da^{-1} (Gungor and Semerci, 1999) and 87 ml da^{-1} (TEAE, 2001). As a result of this research, it has been concluded that total 7731.5 lt pesticides has been used for weed control and protection against parasitic plants in the analyzed enterprises. The pesticide use quantities basing on the sunflower seed group are: for the cultivars which area resistant to IMI group pesticide are 150.38 ml da^{-1}, for the cultivars resistant to orobanche are 143.20 ml da $^{-1}$ and for the cultivars non-resistant are 145.44 ml da $^{-1}$. These values are parallel with the previous research findings in the area.

***Discriminant analysis of the factors in the sunflower production according to the orobanche resistance*:** The inputs used in the sunflower production have been analyzed with the method "Tukey HSD Test" in order to determine whether they are different from the 3 different seed types which have showed differences according to the orobanche resistance or not and the obtained results are given at Table 1.

According to the analysis results, a variety at 5% significance level has been determined in terms of income per unit area, hoeing cost, fertilizer quantity, agrochemical cost and rainfall amount between the pesticide resistant IMI group cultivars and orobanche resistant cultivars. It has been understood that there is statistically 5% difference at significant level between the varieties that are resistant to IMI group pesticides and varieties that are non resistant to orobanche in the aspect of hoeing cost, fertilizer quantity and pesticide cost. It has also been concluded that there is statistically difference between the orobanche resistant to orobanche cultivars and cultivars that are non resistant to orobanche in the aspect of yield, income, hoeing cost, seed cost and precipitation factors.

According to the analysis results, it has been determined that there is statistically difference in variables related to yield and seed cost among the groups but it has been understood that there is not statistically difference in the aspect of land rent value factor among the groups.

***Yield, income and gross profit of the sunflower*:** Although the average sunflower yield value of 2009 (176.7 kg da^{-1}) in the enterprises that the inquiry was conducted is 2.42% lower than Turkey's average, it has been 31.75% higher than world sunflower yield value (FAO, 2010; TURKSTAT, 2010). In the research area enterprises, it has been determined that average yield of sunflower cultivars that are resistant to orobanche is 189.3 kg da^{-1}. This value is 12.28% higher than cultivars that are resistant to IMI group pesticides and 17.94% higher than cultivars that are non resistant to orobanche (Table 1).

When purchasing price and premium support are evaluated together, it has been seen that unit area income of sunflower cultivars that are resistant to orobanche is US$114.15 da^{-1} while the income of other cultivars is between US$97.00-97.50 da^{-1} (Table 2). Pesticide cost of varieties that are resistant to IMI group pesticides is 3.5- 4 times higher than other sunflower groups. The basic reason of this is that the unit selling price of the IMI group pesticides is more expensive than agricultural pesticides that are used in other

Table 1. The differences among the groups and average values of cost elements in the sunflower production according to the seed types

	Groups	Mean	Groups (*) - (J)	Mean Difference (I-J)	Stand. Err.	Sign.
Sunflower Income	IMI Res.	101.24	IMIR - R	-13.92	2.18	0.000 (**)
(US$ da^{-1} (***)	Res.	115.16	IMIR - NR	7.76	3.67	0.088
	Non-Res.	93.47	R - NR	21.69	3.62	0.000 (**)
Yield	IMI Res.	169.73	IMIR - R	-21.32	3.52	0.000 (**)
(kg da^{-1})	Res.	191.05	IMIR - NR	14.98	5.93	0.031(**)
	Non-Res.	154.75	R - NR	36.30	5.84	0.000 (**)
Hoeing cost	IMI Res.	5.37	IMIR - R	1.94	0.22	0.000 (**)
(US$ da^{-1})	Res.	7.31	IMIR - NR	1.82	0.36	0.000 (**)
	Non-Res.	7.19	R - NR	0.12	0.36	0.938
Seed cost	IMI Res.	6.51	IMIR - R	-1.47	0.08	0.000 (**)
(US$ da^{-1})	Res.	7.97	IMIR - NR	0.47	0.14	0.001(**)
	Non-Res.	6.03	R - NR	1.95	0.13	0.000 (**)
Fertilizer quantity	IMI Res.	19.90	IMIR - R	1.24	0.39	0.004 (**)
(kg da^{-1})	Res.	19.53	IMIR - NR	2.73	0.65	0.000 (**)
	Non-Res.	16.85	R - NR	1.48	0.64	0.053
Pesticide cost	IMI Res.	3.78	IMIR - R	2.53	0.13	0.000 (**)
(US$ da^{-1})	Res.	1.25	IMIR - NR	2.73	0.22	0.000 (**)
	Non-Res.	1.05	R - NR	0.20	0.21	0.604
Precipitate	IMI Res.	534.42	IMIR - R	9.98	3.85	0.027 (**)
(mm)	Res.	524.44	IMIR - NR	-11.73	6.49	0.168
	Non-Res.	546.15	R - NR	-21.71	6.39	0.002 (**)
Land rent value	IMI Res.	30.87	IMIR - R	-0.61	0.38	0.236
(US$ da^{-1})	Res.	31.48	IMIR - NR	0.49	0.64	0.722
	Non-Res.	30.38	R - NR	1.11	0.63	0.183

(*) IMIR: IMI Resistant sunflower cultivars, NR: Non-resistant sunflower cultivars, R: Resistant sunflower cultivars
(**) The mean difference is significant at $P < 0.05$, (***); 1 hectare = 10 decares (da).

Table 2. Yield, income and gross profit state according to sunflower cultivars in the research area

Criteria	Resistant Cultivars	IMI Resistant Cultivars	Non-Resistant Cultivars
Yield (kg da^{-1})	189.30	168.60	160.50
Gross Production Value (US$ da^{-1})	114.15	97.38	97.07
Seed + labour cost (US$ da^{-1})	7.97	6.80	6.11
Seed quantity (kg da^{-1})	368.70	385.88	385.36
Fertilizer + labour cost (US$ da^{-1})	10.52	11.66	9.90
Fertilizer quantity (kg ha^{-1})	19.35	19.87	17.78
Pesticide + labour cost (US$ da^{-1})	0.84	0.35	0.10
Pesticide quantity (kg da^{-1})	143.20	150.38	145.44
Soil preparation cost (US$ da^{-1})	19.02	17.41	18.00
Hoeing cost (US$ da^{-1})	7.32	4.75	7.11
Land rent value (US$ da^{-1})	30.98	31.10	29.96
Total cost (US$ da^{-1})	76.66	75.24	72.10
Gross profit (US$ da^{-1})	37.91	22.14	24.97

sunflower cultivars. The use of IMI group pesticides decreases hoeing cost of sunflower varieties approximately 35% in this group when compared to other varieties.

When the cost factors in sunflower production are taken into consideration, it has been understood that the product cost of orobanche resistant cultivars is higher than other varieties. However, it has been seen that the highest profit per unit area belongs to same seed cultivar as the yield, income and gross profit values are high. Among the sunflower varieties, productivity level of cultivars that are non resistant to orobanche per unit area has been found high as the cost factors are lower, though yield level of varieties that are resistant to IMI group pesticides is 8.1 kg da^{-1} higher than the varieties that are non resistant to orobanche.

Table 3. Discriminant analysis of water productivity among the sunflower cultivars

	Sunflower Cultivars Groups	Mean Difference (I-J)	Stand. Err.	Sign.
Water productivity ($g\ m^{-3}$)	IMI Resistant - Resistant	-44.63	7.42	0.000 (*)
	IMI Resistant-Non Resistant	37.63	12.50	0.008 (*)
	Resistant - Non Resistant	82.26	12.31	0.000 (*)

(*) The mean difference is significant at $P < 0.01$.

***Water productivity and income relation of the sunflower cultivation*:** It has been determined that there is statistically 1% difference at significance level about water productivity in the aspect of resistance to orobanche in the sunflower amount produced in the research area (Table 3).

In this research, water productivity has been calculated as 367.13 g m^{-3} in orobanche resistant cultivars, as 322.50 g m^{-3} in IMI group cultivars and as 284.87 g m^{-3} in cultivars that are non resistant to orobanche. These values show that the highest sunflower production is in the orobanche resistant varieties as a result of unit amount water usage.

It has been observed that there has been 1/3 decrease in seed quantity used in sunflower production in the research area enterprises during the last 30 years. It is understood that the producers have kept the advices given by some research institutions about plant density (5000 plant da^{-1}) or seed quantity (400 gr da^{-1}) in sunflower production. It can be said that the conducted agronomic studies coming into practice and widespread use of pneumatic sowing machines in cultivation are important factors for reaching the suggested seed quantity in the aspect of production technique. In agricultural production, the effect of water quantity and irrigation rate on yield is well known. It has been determined that sunflower production is made under rainfed conditions in only 2.79% of production areas in the enterprises analyzed in the research area. As the irrigation level is quite low in sunflower production areas, this prevents reaching demanded yield level. In Turkey, Ministry of Food, Agriculture and Livestock supports the use of irrigation systems and infrastructure works in order to increase the agricultural production in country wide.

In this study it has been determined that there is statistically difference in the aspect of unit area yield and seed cost factors among the seed varieties in point of resistance to orobanche. It has been also understood from this research that orobanche resistant varieties have the highest water productivity. The highest gross profit per unit area has been obtained from orobanche resistant varieties among the sunflower varieties. In this research, it has been concluded that there is similarity between obtained findings related to input use levels in sunflower production and other previous research findings that were conducted in the region. In the research area in order to make increase in sunflower production, rainfed production must be proliferated and irrigation infrastructure works need to be focused on.

***Conclusion*:** This research has proved that orobanche resistant cultivars have higher yield value and more gross profit when compared to other varieties in sunflower production. However, high level water productivity of orobanche resistant varieties in comparison with the other varieties is an important finding obtained from this research. It is possible to envisage that the rate of orobanche resistant cultivars in sunflower production areas that are more important than the other varieties in the aspect of yield, gross profit and water productivity per unit area will increase under the possible drought conditions that may be experienced in future in agricultural areas.

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