Arab Gulf Journal of Scientific Research, 21 (4), pp 197- 203 (2003)

ORIGINAL PAPER

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The Effects of the Level of Fertiliser Use on Sunflower Production

Abstract: The aim of this study was to determine the level of farmers' fertiliser use, the factors affecting it, and the relationship between agricultural policies and environmental problems arising from excessive fertiliser use. Sunflower producers have used 20.92 kg N/da, 14.33 kg P_2O_5/da, and 2.22 kg K_2O/da although the extension unit has advised 10-15 kg N/da, and 8 kg P_2O_5/da in sunflower production to compensate for lowered plant nutrients in the soil. This means that there is an excessive fertiliser use problem in the research area. Only 21.7% of farmers have applied fertiliser according to the result of soil analysis. In the use of plant nutrients, it has been found that factors such as farm area, source of fertiliser, irrigation possibilities, finanial credit usage situation, and the quality of land were statistically significant but other factors such as land usage situation, educational level of farmers, and decision making on fertilisation were not statistically significant.

Keywords: Sunflower, fertiliser use, agriculture policies, environment, Turkey.

عوامل مستوي إستعمال السماد في إنتاج دوار الشمس

هاليل كزيلاسلان وحسن أكا

المستخلص: تستهدف الدراسة تحديد وفحص مستويات إستخدام السماد، أو التسميد بالحد الآقصى اللازم، لنمو وإنتاج محصول دوار الشمس (عباد الشمس). إضافةً إلى عوامل تأثير السماد في العلاقة بين السياسات الزراعية، والمسائل البيئية، الناجمة من التسميد، لأسباب إنخفاض مواد تغذية النبات في التربة. يوصى التسميد بمقادير 10 – 15 كجم أزوت (N) و 8 كجم فسفور (P_2O_5) لكل هكتار مزرعة دوار الشمس، إلا أن المزارعين (عينة الدراسة)، قد إستخدموا 20,92 كجم أزوت (N) و14.33 كجم فسفور (P_2O_5) و2,22 كجم (K_2O) مما يعنى إزدياداً للتسميد عن الحد المطلوب في منطقة الدراسة. حيث أن 21.7% من المزارعين فقط كان إستخدامهم للسماد، مع مراعاة نسبة الغذاء في التربة. إتضح من الدراسة أن مصدر إستجلاب السماد، إضافةً إلى عوامل الري، جودة ومساحة الحقل، من المؤثرات الإيجابية في التسميد. إلا أن وضع إستعمال الأرض، والمستوي العلمي للمزارع، وإتخاذ القرار في تسميد الأرض ليس له تأثير.

كلمات مدخلية: دوار الشمس، التسميد، السياسات الزراعية، قضايا البيئة، تركيا .

Introduction

Achieving efficiency in factor usage and getting the highest advantage from limited resources are the main aims and principles of economics. Therefore, in each production activity, determination of resource productivity and the situation of factor usage requires the use of present resources in a way which is suitable to economic conditions (Kizilaslan, 1996).

Sunflower is one of the few agricultural products in which Turkey's production is insufficient. Domestic production must rise to the same level as domestic consumption to achieve self-sufficiency in sunflower (Akca *et al.* 1998). This can be achieved in two ways: achieving higher yields per da or expansion of agricultural lands under cultivation. However, achieving production increase via the former is more feasible than the latter because, since the 1950s, there has been a decline in the availability of cultivable agricultural land. In addition, increasing yields is possible by means of the application of modern production techniques at the best time and in the right place (Kizilaslan and Gurler, 1997).

The use of fertiliser according to features of the products and needs of the soil has attracted important attention. However, the financial constraints facing farmers and agricultural policies followed by government, are the two most important elements affecting the behaviour of the farmers' fertiliser application. When the support of governments decreases and the price of fertiliser

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increases, farmers have reduced the use of fertilizer. On the contrary, when government support has increased and fertiliser costs have decreased, farmers have tended to increase fertiliser use (Dag, 1993). The tendency of farmers to increase their income and yield in agricultural production is parallel to the objectives of the policies of governments on the macro level. In the Seventh Five-Year Development Plan, covering the period of 1996-2000, there were some aims such as modernisation of agricultural methods, development of export facilities of agricultural products, and increased fertilization of land (Anonymous, 1995).

Material and Methods

Primary data has been used in this study. There are 587 farms growing sunflower intensively in Zile County of Tokat Province. Seven villages (20% of 36 villages) were selected as the research area. Data was collected by survey from 56 farms, determined at 95% significance level and 10% error.

At the stage of analysis of data, the following two methods were used:

First: *If variables affecting fertiliser use were investigated under two groups, the method of hypothesis test about the difference between two population means; matched pairs have been used to test the difference between two groups means.*

Second: *If variables affecting fertiliser use formed more than two groups, analysis of variance was used to determine whether the difference among groups' means was significant or not.*

As a result of variance analysis in the determination of emerging resource of difference, the control of Least Significance Difference (LSD) was performed (Caglayan, 1983; Yildiz and Bircan, 1992).

Results and Discussion

General Information about Fertiliser Use on Farms

The amount of fertiliser used in sunflower growing is shown in Table 1.

For sunflower growing in the region, the amount of fertiliser suggested by Karadenizbirlik (Oilseeds Agricultural Selling Cooperatives) is 10-15 kg N/da, and 8 kg P_2O_5/da (Anonymous, 1999). However, farmers usually use 20.92 kg N/da, 14.33 kg P_2O_5/da, and 2.22 kg K_2O/da (see, Table 2). It can be said that there was an excessive and unconscious use of fertiliser in the research area. The reason for this is that only 21.7% of farmers applied fertiliser as the result of soil analysis.

Table 1. The Amount and Type of Fertiliser Used in Farms

Farm Area Groups (da)	Fertilisers				
	DAP	Urea	Compound (20-20-0)	Compound (15-15-15)	A. Nitrate (33%)
1 - 10	7.53	12.37	24.21	8.68	5.79
11- 25	17.50	16.25	23.13	15.94	13.13
26 - +	18.10	20.71	35.95	19.29	7.62
General	14.34	16.61	28.13	14.73	8.57

Compound (20-20-0) and Urea are two types of fertiliser used higher in quantity than the compounds (15-15-15), DAP, and A. Nitrate (33%), respectively.

Table 2. The Level of Fertiliser Use in Farms (Plant Nutrients) (kg/da)

	Farm Areas (da)			
Plant Nutrients	1st Group (1 - 10)	2nd Group (11 - 25)	3rd Group (26 - +)	General
Nitrogen (N)	15.23	21.98	25.27	20.92
Phosphorus (P_2O_5)	9.27	15.08	18.35	14.33
Potassium (K_2O)	1.32	2.40	2.90	2.22
Total	25.82	39.46	46.52	37.48

The Level of Fertiliser Use According to Farm Area

Average sunflower production area was calculated as 21.91da. The sunflower production area accounted for 25.46% of total agricultural land of farms. Sunflower was grown in irrigated (88.41%) and dry (11.59%) lands. In addition, 78.40%, 14.34%, and 7.26% of total land was managed by landowners, tenants, and sharecroppers, respectively (see, Table 3). The amount of fertiliser used per da increased parallel to increase in farm size. As a result of variance analysis, it has been determined that this difference did not emerge by coincidence. LSD control showed that the difference emerged from 1st group farms who had less than 10da land, and 3rd group farms who had more than 26da of land (see, Table 4).

Table 3. Distribution of Land According to Land Ownership Situation

	Farm Area (da)			
	1 - 10	11 -25	26 - +	General
Number of farms	19	16	21	56
Average sunflower production area				
* Dry	0.47	1.56	5.14	2.54
* Irrigated	6.90	16.38	32.96	19.37
* Total	7.37	17.94	38.10	21.91
The share of sunflower production area in total farm land (%)	13.97	19.68	33.91	25.46
Land ownership				
* Land owner	83.57	80.49	76.75	78.40
* Tenant	5.00	3.48	9.00	7.26
* Sharecropper	11.43	16.03	14.25	14.34
* Total	100.00	100.00	100.00	100.00

Table 4. The Level of Fertiliser Usage According to Farm Area

	Farm Area Groups (da)			
	1 - 10	11 – 25	26 - +	General
Total plant nutri. (kg) (NPK)	490.50	631.20	977.00	2,098.70
Number of farms	19	16	21	56
Av. plant nutri. (kg/da) (NPK)	25.82	39.46	46.52	37.48
Table of Analysis of Variance				
Source of Variation	Sum of Squares	Degree of Freedom	Mean of Squares	F
* among groups	4,362.62	(k-1) 2	2,181.31	10.05
* within groups	11,500.43	(N-k) 53	216.99	
General	15,863.05	(N-1) 55		
$F_{calculated}$ (10.05) > F_{table} (3.15), Result: Difference between groups is significant at $P < 0.05$				
Table of LSD Control				
Groups compared (1)	Difference between two groups' mean (2)	Standard Deviation difference between groups' mean (3)	LSD (0.05) (4 = 3 * t)	Result (*)
1 - 10 with 11 - 25	-13.64	4.99	9.78	significant
1 - 10 with 26 - +	-20.70	4.66	9.13	significant
11 - 25 with 26 - +	-7.06	4.89	9.58	not significant

*If the LSD value is higher than the absolute difference, the difference is not significant; otherwise, it is significant (t = 1.96)

The Level of Fertiliser Use According to Situation of Land Use

Average plant nutrients used on farms according to the situation of land use has been given in Table 5. The least fertiliser was used by tenants. This amount (20.10 kg/da) is near to the level of fertiliser suggested by soil scientists. On the other hand, the others used more fertiliser than the level suggested. As a result of Analysis of Variance done to determine whether there is a difference among groups and the direction of effects of the land usage situation on plant nutrients used per area, it was found that the difference between groups is not statistically significant.

Table 5. The Level of Fertiliser Use With Respect to Situation of Land Use

	Land Use Situation						
	a	b	c	a & b	a & c	b & c	General
Total plant nutrients (kg)	1,517.10	20.10	99.90	106.30	291.80	63.50	2,098.70
Number of farms	40	1	3	3	7	2	56
Av. plant nutri. (kg/da)	37.93	20.10	33.30	35.43	41.69	31.75	37.48
Table of Analysis of Variance							
Source of Variation	Sum of Squares		Degree of Freedom		Mean of Squares		F
* among groups	562.48		5		112.50		0.38
* within groups	15,300.57		50		306.01		
General	15,863.05		55				

$F_{calculated}$ (0.38) < F_{table} (2.37), Result: Difference between groups is not significant at $P < 0.05$

(a): land owner (b): tenant (c): sharecropper

According to Table 6, the educational level of farmers was low because 66.07% of them graduated from primary school. As a result of Analysis of Variance, the difference between average plant nutrients usage is not significant according to educational level of farmers and this difference emerged by coincidence. In practice, the educational level of farmers does not appear to affect plant nutrients used per area.

Table 6. The Level of Fertiliser Use on Farms According to the Level of Education of Farmers

	The Level of Education					
	Illiterate	NE (+)	Primary	Secondary	High School	General
Total plant nutri. (kg)	240.50	191.50	1,438.40	192.40	35.90	2,098.70
Number of farms	5	7	37	6	1	56
Av. plant nutri. (kg/da)	48.10	27.36	38.88	32.07	35.90	37.48
	Table of Analysis of Variance					
Source of Variation	Sum of Squares		Degree of Freedom		Mean of Squares	F
* among Groups	1,532.28		4		383.07	1.36
* within Groups	14,330.77		51		280.99	
General	15,863.05		55			

$F_{calculated}$ (1.36) < F_{table} (2.53), Result: Difference between groups is not significant at $P < 0.05$

NE (+): Not having a primary school degree but attending a course

The Level of Fertiliser Use According to Fertiliser Source

Sunflower producers buy fertiliser from different sources. Those who bought fertiliser from Karadenizbirlik used 42.03 kg/da plant nutrients. Those who bought fertiliser from Karadenizbirlik and private sellers, private sellers, and agricultural credit cooperatives used 36.42 kg/da, 27.62 kg/da, and 26.58 kg/da plant nutrients, respectively. (see, Table 7)

Table 7: The Level of Fertiliser Use According to Fertiliser Source

	Fertiliser Source				
	a	b	c	d	General
Total plant nutri. (kg)	1,471.10	276.20	132.90	218.50	2,098.70
Number of farms	35	10	5	6	56
Av. plant nutri. (kg/da)	42.03	27.62	26.58	36.42	37.48

Table of Analysis of Variance				
Source of Variation	Sum of Squares	Degree of Freedom	Mean of Squares	F
* among groups	2,289.94	3	763.31	2.92
* within groups	13,573.11	52,261.02		
General	15,863.05	55		

$F_{calculated}$ (2.92) > F_{table} (2.76), Result: Difference between groups is significant at $P < 0.05$

	Table of Control of LSD			
Groups compared (1)	Difference from mean (2)	Standard Deviation of difference of groups mean (3)	LSD (0.05) (4 = 3*t)	Result
a with b	14.41	5.79	11.35	significant
a with c	15.45	7.72	15.13	significant
a with d	5.61	7.14	13.99	not significant
b with c	1.04	8.85	17.35	not significant
b with d	-8.80	8.34	16.35	not significant
c with d	-9.84	9.78	19.17	not significant

(a) Karadenizbirlik, (b) Private Sellers, (c) Agricultural Credit Cooperatives, (d) Karadenizbirlik & Private Sellers

Analysis of Variance was done to determine whether the difference among average plant nutrients used was significant or not according to the sources from which fertilisers were obtained. The difference was statistically significant. It can be said that difference among means was by the use of fertiliser obtained from Karadenizbirlik.

The Level of Fertiliser Use According to Irrigation Possibilities

Irrigation is an important factor affecting the amount of fertiliser used. It has been found that farmers use of fertiliser, parallels irrigation possibilities. In the research area, farmers who did not have any irrigation problems used more fertiliser than those having some irrigation problems. According to whether the farmers did or did not have irrigation problems, the difference among the amounts of plant nutrients used per area was statistically significant at $P<0.05$. However, it is a recommended that farmers should apply fertiliser at the optimum level suggested by extension agents and soil scientists, to obtain high yield levels in sunflower growing and as a consequence, lower the severe environmental effects. (see, Table 8)

Table 8: The Level of Fertiliser Use in Farms According to Irrigation Possibilities

Irrigation possibilities	Number of farms	Total plant nutrients (kg)	Av. plant nutrients per farm (kg/da)	Difference of means	t
* Having irrigation problems	15	474.20	31.61	8.01	5.04
* Not having irrigation problems	41	1,624.50	39.62		

$t_{calculated}$ (5.04) > t_{table} (1.96), Result: Difference between groups is significant at $P < 0.05$

The Level of Fertiliser Use According to Situation of Credit Usage

The amount of plant nutrients used by farmers either using or not using financial credit was calculated as 39.66 kg/da and 29.48 kg/da, respectively. That is, having credit helps farmers buy and use more fertiliser. In addition, the difference in the amount of average plant nutrients used by farmers with or without credit was found to be statistically significant. (see, Table 9)

Table 9: The Level of Fertiliser Use in Farms According to Credit Use

Credit usage situation	Number of farms	Total plant nutrients (kg)	Average plant nutrients per farm (kg/da)	Difference of means	t
* Using credits	44	1,745.00	39.66	10.18	5.51
* Not using credits	12	353.70	29.48		
$t_{calculated}$ (5.51) > t_{table} (1.96), Result: Difference between groups is significant at P < 0.05					

The Level of Fertiliser Use According to the Quality of Land

Fifty out of fifty-six farms grew sunflower on irrigated land and the rest on dry land. The amount of plant nutrients used in these conditions was 39.38 kg /da, and 21.62 kg /da, respectively. As a result of analysis, the difference between means was found to be statistically significant. That is, the quality of land is an important factor for fertilisation (see, Table 10).

Table 10: The Level of Fertiliser Use in Farms According to Quality of Land

Quality of land	Number of farms	Total plant nutrients (kg)	Average plant nutrients per farm (kg/da)	Difference of means	t
* Irrigated	50 1	968.98	39.38	17.76	5.46
* Dry	6,129.72	21.62			
$t_{calculated}$ (5.46) > t_{table} (1.96), Result: Difference between groups is significant at P < 0.05					

The Level of Fertiliser Use According to the Decision Making of Farmers

Farmers generally choose the type of fertiliser to be used in agricultural production according to their own experience, and use it in the amounts they wish. Some farmers apply fertiliser by asking their relatives, neighbours, and leading farmers in the region for advice. After gaining experience, they can decide themselves the type and amount of fertiliser to be applied in agricultural production (Caglayan, 1983). However, it is difficult to determine these farmers proportionally. Therefore, it is useful to accept that there can be some farmers who used fertiliser according to the advice of extension agents in the past, but now they use it according to their own experience. Table 11 indicates that 39.29% of farmers used plant nutrients (34.22 kg/da) according to their own experience. 37.50% applied (40.76 kg/da) by asking their neighbours, relatives and leading farmers. Only 23.21% of farmers used plant nutrients (37.68 kg/da) according to the advice of extension agents. The difference among fertiliser used according to decision of farmers is not statistically significant.

Table 11: The Level of Fertiliser Use According to Decision Making of Farmers to Fertilisation

	Type of Decision Making to Fertilisation			
	a	b	c	General
Total plant nutrients (kg)	752.80	856.00	489.90	2,098.70
Number of farms	22	21	13	56
Av. plant nutrients (kg/da)	34.22	40.76	37.68	37.48
	Table of Analysis of Variance			
Source of Variation	Sum of Squares	Degree of Freedom	Mean of Squares	F
* among groups	451.53	2	225.77	0.79
* within groups	15,411.52	54	285.40	
General	15,863.05	56		
$F_{calculated}$ (0.79) < F_{table} (3.15), Result: Difference between groups is not significant at P < 0.05				

(a): according to their own experience (b): by asking relatives, neighbours or leading farmers in the region
(c): by asking experts

Excess Fertiliser Use and Environmental Problems

If the objectives of agricultural policies applied in developed and less developed countries are investigated carefully, it can be said that in the past agricultural policies took little or no account of environmental side effects of agricultural activities (Barbier, 1989; Akca, 1996). Until recent years, agricultural economists and governments had thought intensive use of agro-chemicals was the quickest way to increase agricultural production, and consequently, to meet the peoples' needs for food. However, excess and unconscious use of fertilisers and other agro-chemicals has caused environmental problems such as soil and water pollution. Increased production costs of agricultural products in many countries has also contributed to these problems (Akca and Sayili, 1998). On the other hand, less fertiliser use could lead to loss of production, and consequently, loss of farmers' income and foreign exchange of the country (Esengun and Akay, 1998). To determine the impact of agrochemicals on wheat yield, seven years data of cereal management small plot trials were processed at the Agricultural Research Institute of the Hungarian Academy of Sciences. The impact of mineral fertiliser on wheat yield was 47.5% but non-appropriate fertiliser applications caused 23.2% yield declines (Jolankai and Ragasits, 1995).

Conclusion

It can be said that the problem in the research area was excessive and unconscious fertiliser use rather than too little use of fertiliser. Therefore, extension staff should advise farmers to use fertiliser according to the results of soil analysis. In addition, agricultural policies should be formed and implemented by governments, taking account of the severe effects of unconscious fertiliser use on the environment.

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Ref. 2128
Received 07/01/2001
In revised form 06/11/2003