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EXAMINING OF CHEMICAL FERTILIZER USE LEVELS IN TERMS OF AGRICULTURE ENVIRONMENT RELATIONS AND ECONOMIC LOSSES IN THE AGRICULTURAL FARMS: THE CASE OF ISPARTA, TURKEY

H. YILMAZ, V. DEMIRCAN and M. GUL
Suleyman Demirel University, Department of Agricultural Economics, Faculty of Agriculture, 32260 Isparta, Turkey

Abstract

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The aim of the study was to investigate the chemical fertilizer use levels of grown crops in Isparta province, Turkey and economic loses because of excessive fertilizer used by comparing of fertilizer amount recommended by Agricultural Research Institute and farmer's fertilizer application. In addition, in this study was examined the levels of awareness on the fertilizing of farmers and discussed about negative effects of excessive fertilizer use on environment. Data were obtained by conducting a questionnaire with 100 farms selected by stratified random sampling method. The result indicates that there was no effective and balanced fertilizing in the examined area. Fertilizing without taking into account the results of soil analysis was common in research area. This situation shows that farmers haven't sufficient knowledge on the fertilizing. The level of farmers' environmental awareness was low. It was determined that farmers were used more fertilizer than recommended by Agricultural Research Institute. Economic losses due to excessive fertilizer usage in apple, barley, wheat, cherry, chick pea, sour cherry, peach, apricot, rose, sugar beet, poppy seed, tomato, green lentil were between 1.00-137.24 TL ha^{-1}. Economic losses due to extra fertilizer use was 57.90 TL ha^{-1} and total economic losses were 27 751.17 TL (1 USD=1.34). Economic loss ratios for every crop type were 64.51% for apple, 16.02% for barley, 11.01% for wheat, 4.10% for sugar beet 1.52 % for cherry and 2.84% for other crops.

As a result, it can be said that soil analysis should be compulsory for all farmers. The extension staff should make more emphasis on education the farming community about the recommended doses, time and method of application to every grown crop. Fertilizer recommendations should be made taking into consideration possible environmental effects.

Key words: chemical fertilizer use level, economics losses, agriculture-environment relations

Introduction

It is now a requirement to increase the production per unit area since the world's agricultural fields have come to their limits, rural population continuously decreases, world population increases and parallel to this increase famine and malnutrition problems arise in underdeveloped and developing countries. More-

e-mail: hyilmaz@ziraat.sdu.edu.tr ; hsn_ylmz@yahoo.com

over application of fertilizers have been gained great importance as well as the elements such as irrigation, mechanization, high quality seeds, insecticide applications and training of the farmers in all countries where agriculture is practiced.

Agriculture is a vital sector for Turkish economy. It is still Turkey's largest employment provider and a significant contributing sector to GDP, imports and exports. The share of agriculture in year 2008 in GDP at current prices was 11.5%. The contribution of agricultural commodities in total export was 10.7% and import was 4.3%, 37.3% of the population lives in rural areas and 29.5% of total employment is based on agricultural sector (SPO, 2008)

More and more food will be needed to meet the demand of an increasing population in Turkey and worldwide. Substantial evidence has demonstrated that chemical fertilizer have played an important role in sustaining food production (Borlaug and Dowswell, 1994; Stewart et al., 2005). Chemical fertilizer will continue to play an important role in food security in Turkey due to the limited arable land resources and increase in future population. Therefore, the only way to improve food security is to increase crop yields through the scientific use of fertilizers with an emphasis on protecting the environment.

Chemical fertilizer use is the most important elements in determining productivity and the level of agricultural production. Chemical fertilizer has a significant impact on agricultural production, as a profitable economic activity. It is not possible to reach the desired quantity and quality of agricultural production without fertilizer use (Welte, 1973).

The most important of the conditions of the sustainability in agricultural production is rationalization of input use. This rationalization should be considered in the environmental and economic dimensions. Environmental dimension is providing the healthy and livable environment for the future generations and protecting natural heritage. Economical dimension is contributing to farmers and the country's economy by rationally using fertilizer to reduce the costs.

Fertilizer has the significant important effect on yield increase and its share in total production cost is lower. The share of the cost of fertilizer in total production costs varies depending on crops type. This rate is generally varied from 8 to 15%. This rate is from 4 to 8 % in developed countries. It was reported that the causes of the differences between these rates are; farm's size, the level of technological development, fertilizer use depending on soil and leaf analyses and the level of farmers' education and awareness (SPO, 1996). One-third agricultural production in Turkey has been produced as a result of fertilizer use (Ulgen and Yurtsever, 1995).

Fertilizer consumption in Turkey, has increased, because of application subsidy and promote, but it still hasn't achieved the desired level, even its consumption rate has slowed in recent years. Fertilizer consumption in Turkey is lower than many developed and developing countries. It was reported that use of NPK fertilizer in Turkey in 2007 was 100.4 kg ha^{-1}. This figures in Netherlands, Egypt, Japan, China, United Kingdom, Germany, France, Pakistan, USA, Italy, India, Greece and Indonesia, respectively were 665.5, 624.8, 373.2, 301.5, 287.5, 205.4, 180.1, 168.6, 160.8, 126.4, 121.4, 115.4, and 106.9 kg ha^{-1}. Average fertilizer consumption of EU was 141.6 kg ha^{-1} while the world average was 107.9 kg ha^{-1}. The rates of N, P and K were 57.5%, 24.4% and 18.1 % respectively, in the fertilizer which has consumed in the World. These rates of N, P, and K are 66.2%, 29.3% and 4.5% respectively in Turkey (FAO, 2009).

Even though fertilizer use is not at adequate levels in Turkey, the tendency of overmuch fertilizer use is a fairly widespread in irrigated and sufficient rainfall areas. An important part of the farmers are fairly sensitive about increasing yield by using fertilizer. In addition, they have insufficient information about which fertilizer is used for which crops, application time and method, amount of fertilizer, their fertilizer applies is traditional. This situation is one of the most important deficiencies. Farms in Turkey have become smaller by dividing. This case has been prevented from economical fertilizer use (SPO, 1996).

Isparta province is located in the inner part of West Mediterranean Region. It is a part of the lakes region.

Isparta province is hilly and 1050 m above the sea level. Isparta has Mediterranean and Central Anatolian climate. Thus, there are two types of climates in the province. Isparta has a semi-cold continental type climate. Areas close to Antalya has Mediterranean when you move to Northeast climate changes to continental. Isparta is located on the Taurus Mountain; a passage point north to south direction with average temperature of the province is 12.1^{0}C. Annual average rainfall is 600 mm. Surface area of province 893.307 ha, 251 282 of surface area is agricultural area (Anonymous, 2004)

Structure of agricultural production in Isparta Province has been transformed from field crop farming to fruit and vegetable farming. Isparta has a suitable climate for growing many vegetables and fruits. Fruit production has a very important share in agricultural production of province. The amount of fruit productions for apple, grape, cherry and sour cherry were 484 717, 47 287, 17 419 and 10 331 tons, respectively. Apricot, peach, plums, pears and walnut follows these fruits respectively. Isparta province has an important place in Turkey's cherry production and exports (Anonymous, 2004).

Isparta province has major potential in terms of agricultural production. It is now a requirement to increase yield per unit area since agricultural areas have come to their limits in Isparta Province. For this reason, fertilizer use is indispensable.

The objectives of this study were: (1) to examine the chemical fertilizer level used for growing crops in Isparta province, Turkey; (2) to determine economic loses because of excessive fertilizer used by comparing fertilizer amount recommended by Agricultural Research Institute with farmer's application and (3) to determine the fertilizing tendency and awareness levels of the farmers about fertilizing effect on the environment.

Materials and Methods

In this study, survey was conducted on farms in 14 villages of Aksu, Keciborlu, Senirkent, Sarkikaraagac, Egirdir, Gelendost and Sutculer counties of Isparta province to represent the research area (Anonymous, 2004). Data were collected from the farmers by using a face to face survey in the 2005 production year. The questionnaire was implemented with 100 randomly selected farmers. For sampling, the stratified random sampling method was used. The sample size was calculated using the Neyman method (Yamane, 2001). Sampling size was determined by using equation 1. The permissible error in the sample size was defined to be 10% for 90% reliability. In addition to the survey results, previous research studies and secondary sources were also used in the study.

$$n = \frac{\left(\sum N_h S_h\right)^2}{N^2 * D^2 + \sum N_h {S_h}^2} \qquad (1)$$

Nomenclature:
n: required sample size
N: number of holdings in target population
$N_{h:}$ number of population in the h stratification
S_h^2: variance of the h stratification
D: precision where (x - X)
z: reliability coefficient (1.65 which represents the 90% reliability)
D^2: $d^2=z^2$

The amount of fertilizer which was used for the examined crops (wheat, chick pea, sour cherry, peach, apricot, rose, walnut, cow wetche, sugar beet, maize, poppy seed, tomato, green lentil) was compared with the amount of fertilizer recommended by Research Institute of Soil and Fertilizer of General Directorate of Agricultural Research of Turkish Ministry of Agriculture (MARA, 2006). Besides, the amount of fertilizer used for cherry and apple which have high economic value in the research area was compared with the amount of fertilizer recommended by Aydemir et al. (2004). The amounts of inadequate and extra fertilizer use and economic losses because of excessive fertilizer use were determined for all crops examined.

Results and Discussion

Socio-economic characteristics of the farms

Characteristics of the farms in the research area

Table 1

General characteristics of the investigated farms

General characteristics	Mean	Cropping System				
		Crops	Area, ha	%	Number of farm	%
Farmers age (year)	49000±12089 [a]	Apple	142.60	29.75	70.00	70.00
Education level (year)	6.78±3.06	Barley	128.70	26.85	45.00	45.00
Farmers' experience in agriculture (year)	25.82±12.91	Wheat	81.30	16.96	24.00	24.00
Agricultural Cooperative membership (%)	74	Cherry	51.00	10.64	29.00	29.00
Numbers of sheep and goats	6.94±76.45	Chick pea	14.90	3.11	7.00	7.00
Numbers of cattle	0.71±1.39	Sour cherry	10.90	2.27	7.00	7.00
Gross product value (YTL)	45.040.77±81178.80	Peach	6.80	1.42	11.00	11.00
Farm area size (ha)		Apricot	5.70	1.19	6.00	6.00
Total farm area	5.42±4.17	Rose	6.20	1.29	6.00	6.00
Cultivated area	4.79±3.93 (88.50 [b])	Walnut	5.00	1.04	5.00	5.00
Fallow land area	0.62±1.20 (11.50)	Cow wetche	5.50	1.15	9.00	9.00
Irrigated area	2.42±2.78 (44.66)	Sugar beet	8.30	1.73	3.00	3.00
Non- irrigated area	3.00±3.26 (55.34)	Maize	3.50	0.73	6.00	6.00
Fertilizer use (kg ha^{-1})		Poppy seed	1.50	0.31	5.00	5.00
N	298.79±161.90 (67.46)	Tomato	5.40	1.13	10.00	10.00
P	88.29±66.40 (19.93)	Green lentil	2.00	0.42	1.00	1.00
K	55.81±79.30 (12.60)	Total	479.30	100.00	-	-
Average *NPK* fertilizer use	442.89±244.10 (100.00)					
Organic fertilizer use	104.00±244.70					
Leaf fertilizer use	124.20±83.50					
Farmyard manure use	7 650.00±7958.70					

[a] Standard deviation

[b] Percent

were given in Table 1. The share of crop planting patterns in investigated farms were 29.75%, 26.85%, 16.96%, 10.64% and 15.79% for apple, barley, wheat, cherry and other crops, respectively.

The average age of the farmers was 49 years and they have an average of 26 years of farming experience. The average education level of the farmers was 7 years. The rate of agricultural cooperative member was 74%. The average size of area in farms and cultivated area were 5.42 ha and 4.79 ha, respectively. It was found that farms were irrigated land 44.66 % of farm areas and fallow land 11.50%. It was determined that use of *NPK* fertilizer in the research area was 442.89 kg ha^{-1}. The rates of *N*, *P* and *K* in this fertilizer use were 67.46%, 19.93% and 12.60%, respectively. On the other hand, it was reported that use of *NPK* fertilizer in Turkey was 100.4 kg ha^{-1}. The rates of *N*, *P*, *K* in this fertilizer use were 66.2%, 29.3% and 4.5% respectively (FAO, 2009). According to these results, it can be said that fertilizer was used more than the average of the World, Turkey and EU in the research area.

The Attitudes towards Fertilizing and Environmental Awareness Levels of the Farmers

The chemical fertilizer application information level

Table 2

Farmers' fertilizing practices and environmental sensitivity levels

Have you ever made soil analyzed so far?	Percentage
Yes	53.00
No	47.00
The frequency of the soil analysis made by farmers	
Regularly (in a one –two year)	50.94
Spaced (in a three – four year)	28.30
Rarely (few times so far)	20.75
Have you ever attended any farmers training programs about fertilizer and fertilizing?	
Yes	23.00
No	77.00
If yes, how many times have you attended these programs?	
Once	56.52
Twice- Three times	43.48
What kind of sources do you get information to determine fertilizer amount?	
Own information and experience	35.00
Neighbor's and relatives' recommendation	15.00
Fertilizer dealers' recommendation	15.00
The staff of agricultural province/ district directorate' s recommendation	17.00
The staff of agricultural cooperative's recommendation	5.00
The result of the soil analyses	13.00
Do you exactly apply the fertilizer amount recommended by extension staff?	
Recommended	38.00
Below recommended	36.00
Over recommended	26.00
If you have economical power, do you use more fertilizer?	
Yes	71.00
No	29.00
you agree with the idea that it is necessary to use more fertilizer to increase the agricultural productio	
Yes	57.00
No	43.00
Do you believe that chemical fertilizer damages to the environment?	
Yes	67.00
No	20.00
I don't know	13.00
If yes, how does it damage?	
Decrease crops yield	14.93
The soil become barren, salinization	44.78
Damage to human, animals, plants	16.42
Groundwater contamination	11.94
Fruits and vegetables lose taste	4.48
Natural balance is distorted	7.46

of the farmers and sensitivity about environment is very important in terms of effective fertilizing and preventing of environmental problems which affecting agriculture. Farmers' fertilizing practices and environmental sensitivity levels were given in Table 2.

The soil analyses have never made the by 47% of the farmers, only 53% of them have made the soil analyses at least once so far. It was determined that 50.94% of the farmers have made regularly the soil analyses. In other studies conducted, rates of regularly the soil analyses were 17.50% (Karaman et al., 2008), 33% (Karamursel et al., 2004) and 25% (AERI, 2005).

While 77% of the farmers have never attended extension programs, fertilizer amounts applied by 35% of them were based on their knowledge and experiences. In other similar studies, fertilizer application ratios through knowledge and experiences were 61% (Oguz and Tetik, 2004), 67% (Karaman et al., 2008), 64% (Olhan, 2000), 59% (Karamursel et al., 2004). The rates of farmers who have used fertilizer based on soil analysis were 13%.

Fertilizing without taking into account the results of soil analysis was very common in research area. This situation reveals that farmers' awareness about the fertilizing didn't improve. In determining of fertilizer amount, the rate of farmers who exactly applied the amount which was recommended by agricultural trainer and extension staff were 38%. In another study, this rate was found 36% (Oguz and Tetik, 2004). It was determined that 71 % of the farmers expressed that if they had more economic power, they would use more fertilizer. The rate of farmers who believes that it is necessary to use more fertilizer to increase agricultural production was 57%. Because of the farmers' lack of knowledge, they expect that if they use more fertilizer, yield will increase. There are many papers written on optimum application rate and time of fertilizers in Turkey. These papers are explained that farmers don't have sufficient knowledge about fertilizing (Haktanir et al., 1990). Therefore, farmers should be trained on fertilizing in order to eliminate their wrong opinions and increase their level of consciousness.

Whether the farmers know the effects on environment of chemical fertilizer or not has been investigated. All 67% of the farmers believe that chemical fertilizer is causes environmental damage. In another study, this rate was found as 41.18% (AERI, 2005). The rate of farmers who didn't know whether chemical fertilizer damages the environment or not was 13%.

The farmers believes that misuse of chemical fertilizer is caused the negative environmental effects, barren soil, damaged for human, animal and crops, decrease of crop yield and underground water pollution, these ratios were 44.78%, 16.42%, 14.93% and 11.94%, respectively. In another study conducted by AERI (2005) was reported, farmers believes that soil become can be polluted and the human health can be damaged by mixing with surface and groundwater of chemical fertilizer, these ratios were 57.14% and 35.71%, respectively. It is known that a significant part of nitrogen and phosphorus is flowed into water through surface flow from soil and drainage water as a result of misuse and excessive application. Misuse or excessive use of nitrogen causes nitrate and nitrite accumulation in both soil reservoir and plant tissues (SPO, 1996).

The farmers reported that granule chemical fertilizer have been eaten by birds and for this reason, the population of partridge have been decreased in the examined region. Agricultural production has been done around the Lake Egirdir and Kovada in the region. Chemical fertilizers have been intensively used in fruit and vegetables grown in the agricultural area. It was reported that Egirdir and Kovada Lakes have polluted due to unconscious and faulty application of chemical fertilizers (Kesici and Kesici, 2006). This situation is threatening flora and fauna around Lake Egirdir and Kovada. Compound and phosphate fertilizers should be applied into plant root area in order to be useful for plants and not to damage to the environment in soil whose clay and lime contents are high in Turkey. It was determined that fertilizing on top of the soil and mixing of fertilizer with the soil were common applications of fertilizing in the research area. It was reported that as a result of this application forms, eutrophication has accelerated in water resources,

surface water pollution has come into problem and roughly half of the fertilizer used has lost (SPO, 1996).

Cleaning of contaminated soil is very difficult, expensive and even in some cases impossible. It will not be only enough to decrease the amount of fertilizer in order to decrease the negative impact of the nitrogenous and phosphorous fertilizer on the environment. In addition, some fertilizer application methods which increase nitrogen uptake of plant should be improved. (Nielsen and Jensen, 1990; Shepherd et al., 1993; Davis, 1994).

Before fertilizing, it is necessary to make soil analysis in order to fertilizing sufficiently and effectively. Although the soil analysis has been suggested for a long time, the farmers in Turkey have not considered it (Gok at al., 1998). Fertilizing should always be realized depending on soil and plant analyses to prevent soil pollution and ensure the sustainable agricultural production. Fertilizing without soil or plant analysis are prevented economic use of fertilizer, increased the cost of products, caused a decrease in the quality and quantity of the crop production and harm to soil and environment (Guo et al., 2006)

Type of fertilizers used and its amounts in investigated farms

It was determined that the rate of the farmers which use Ammonium nitrate (*N* 33) was 78%. It was calculated that the rates of fertilizers used by farmers were Diammonium phosphate/DAP (*N*18, *P46*): 64%, compound (*NPK*15.15.15): 52%, calcium ammonium nitrate/CAN (*N*26): 36%, ammonium sulfate (*N*21): 32% and urea (*N*46): 25% (Table 3). This results show that Ammonium Nitrate (*N*33) and Diammonium phosphate/DAP (*N*18, *P*46) were used more than other fertilizers in the research area.

In view of Table 4, amount of *NPK* fertilizer use was the highest (347.92 kg ha^{-1}) for sugar beet and the lowest (44.07 kg ha^{-1}) for cow wetche. It was determined that organic fertilizer was only used for apple and cherry. Leaf fertilizer was used for apple, cherry and tomato. The survey revealed that most farmers used farmyard manure for all crops, except for barley, chick pea, cow wetche, maize, poppy seed and green lentil (Table 4). Farmers surveyed believed that added farmyard manure improved their soil productivity and increased crop yields.

The doses of *NPK* used for similar crops were calculated in different studies conducted in other regions of Turkey. According to results of these studies were found for sugar beet; in Ankara, Konya and Tokat provinces were 349.8, 482.2 and 540.5 kg ha^{-1}, respectively. For apple in the Karaman, Amasya, Tokat, Icel and Isparta provinces were 387.0, 244.6,

Table 3
Types of chemical fertilizer used in investigated farms and its application amounts

Chemical Fertilizer Type	Number	Percentage of farms in use, %	Fertilizer application amounts, kg ha -¹	%
Ammonium Sulfate (*N* 21)	32	32.00	101.70	7.97
Calcium Ammonium Nitrate/CAN(*N* 26)	36	36.00	127.70	10.00
Ammonium Nitrate (N 33)	78	78.00	307.00	24.04
Urea (N 46)	215	25.00	70.00	5.48
Triple Super Phosphate/ TSP(*P* 44)	3	3.00	6.50	0.51
Di Ammonium Phosphate/DAP (*N* 18, *P* 46)	64	64.00	301.00	23.57
Compound (*NPK* 20.20.0)	15	15.00	85.50	6.70
Compound (*NPK* 15.15.15)	52	52.00	202.40	15.85
Potassium Sulfate (K 50)	12	12.00	20.10	1.57
Potassium Nitrate (*N* 13, *K* 46)	22	22.00	54.90	4.30

Table 4

The amounts of fertilizer used for crops, kg ha^{-1}

Crops	Fertilizer use, kg ha^{-1}								
	Crop Nutrients Elements					Organic fertilizer	Leaf fertilizer	Farmyard manure	
	N	P	K	Total (NPK)	%			kg	%
Apple	171.53	44.36	2.57	218.45	9.73	117.14	19.6	5 100.00	12.03
Barley	104.36	36.91	0.01	141.27	6.29	-	-	-	-
Wheat	115.08	39.30	0.06	154.44	6.88	-	-	1 583.33	3.74
Cherry	128.24	22.74	1.09	152.07	6.77	62.07	70.34	3 758.62	8.87
Chick pea	40.14	34.29	0.00	74.43	3.31	-	-	-	-
Sour cherry	94.23	24.20	1.02	119.44	5.32	-	-	428.57	1.01
Peach	89.32	13.82	5.01	108.15	4.82	-	-	1 181.82	2.79
Apricot	81.00	19.35	1.83	102.18	4.55	-	-	1 833.33	4.33
Rose	102.00	62.73	0.79	165.53	7.37	-	-	4 166.67	9.83
Walnut	52.80	22.00	0.00	74.80	3.33	-	-	2 200.00	5.19
Cow wetche	33.67	10.41	0.00	44.07	1.96	-	-	-	-
Sugar beet	280.50	66.53	0.89	347.92	15.49	-	-	3 333.33	7.86
Maize	104.00	29.08	0.00	133.08	5.93	-	-	-	-
Poppy seed	29.60	51.00	0.00	80.60	3.59	-	-	-	-
Tomato	140.05	54.37	11.55	205.97	9.17	-	27	18 800.00	44.35
Green lentil	93.00	30.00	0.00	123.00	5.48	-	-	-	-

259.0 and 223.5 kgha^{-1} (AERI, 2001) and 331.5 kgha^{-1}, respectively (Demircan and Yilmaz, 2005). For tomato in Manisa and Canakkale provinces were 309.1 kgha^{-1} (AERI, 2001) and 430.0 kgha^{-1}, respectively (Muftuoglu et al., 2008). For rose in Isparta province was 339.2 kgha^{-1} (Demircan, 2005). For wheat in Ankara, Konya, Adana and Tekirdag provinces were 164.5, 282.5, 287.6 and 231.0 kgha^{-1} respectively (AERI, 2001). For cherry in Isparta province was 222.1 kgha^{-1} (Demircan et al., 2006). For barley in Ankara, Konya, Tekirdag and Canakkale provinces were 171.0, 244.3, 222.0 kgha^{-1} (AERI, 2001) and 501.0 kgha^{-1}, respectively (Muftuoglu et al., 2008). For Maize in Trabzon and Samsun provinces were 150.8 and 305.5 kgha^{-1} respectively (AERI, 2001). For cow wetche in Canakkale province was 240.0 kgha^{-1} (Muftuoglu et al., 2008). Consequently, the quantities of fertilizer used are varied according to soil and agro-climatic conditions and crops' nutrient need. Excessive and unbalanced fertilizer use in the same or different crops by farmers varies depending on farm size, technological information use, fertilizer use based on leaf and soil analysis, education and awareness levels of their.

The economic losses caused by excessive use of fertilizers in investigated farms

Several factors are affect use of fertilizer by farmers. Nutrient needs of crop, climate, irrigation facilities, crop price, fertilizer price and farmers' income are factors influencing on the fertilizer use by farmers. The farmers use more fertilizer for crops which ensure maximum profit (Naseem and Kelly, 1999).

The availability of the beneficial plant nutrients in the soil is associated with several factors, such as soil pH, presence of lime and organic matter, salt content,

Table 5
NPK amounts recommend and used for crops and economic losses

Crops	Crop nutirent elements	Used amount, kg ha^{-1}	Recommended amount, kg ha^{-1}	Difference, kg ha^{-1}	Economic loss, TL ha^{-1}*	Sampling area, ha	Total economic loss, TL	Economic loss, %
1	2	3	4	5	6	7	8	9
Apple	N	171.53	90.00	81.53	81.83	142.60	17 902,00	64.51
	P	44.36	0.00	44.36	41.83			
	K	2.57	0.00	2.57	1.88			
	NPK	218.45	90.00	128.45	125.54			
Barley	N	104.36	80.00	24.36	24.45	128.70	4446.59	16.02
	P	36.91	26.20	10.71	10.10			
	K	0.00	0.00	0.00	0.00			
	NPK	141.27	106.20	35.07	34.55			
Wheat	N	115.08	90.00	25.08	25.18	81.30	3054.44	11.01
	P	39.30	26.20	13.10	12.35			
	K	0.06	0.00	0.06	0.04			
	NPK	154.44	116.20	38.24	37.57			
Cherry	N	128.24	120.00	8.24	8.27	51.00	421.77	1.52
	P	22.74	39.30	-16.56	-			
	K	1.09	82.64	-81.56	-			
	NPK	152.07	241.95	-89.88	8.27			
Chick pea	N	40.14	40.00	0.14	0.14	14.90	54.39	0.20
	P	34.29	30.57	3.72	3.51			
	K	0.00	0.00	0.00	-			
	NPK	74.43	70.57	3.86	3.65			
Sour cherry	N	94.23	80.00	14.23	14.28	10.90	155.65	0.56
	P	24.20	34.93	-10.73	-			
	K	1.02	41.32	-40.31	-			
	NPK	119.44	156.26	-36.81	14.28			
Peach	N	89.32	80.00	9.32	9.35	6.80	63.58	0.23
	P	13.82	34.93	-21.12	-			
	K	5.01	41.32	-36.31	-			
	NPK	108.15	156.26	-48.11	9.35			
Apricot	N	81.00	80.00	1.00	1.00	5.70	5.70	0.02
	P	19.35	34.93	-15.58	-			
	K	1.83	41.32	-39.49	-			
	NPK	102.18	156.26	-54.07	1.00			

*1 kg N Price : 1.004 TL ; 1 kg P Price : 0.943 TL; 1 kg K Price: 0.733 TL, (1 USD= 1.34 YTL)

(continued)

Table 5 *(continued)*

1	2	3	4	5	6	7	8	9
Rose	N	102.00	140.00	-38.00	-	6.20	239.13	0.86
	P	62.73	21.83	40.90	38.57			
	K	0.79	57.85	-57.06	-			
	NPK	165.53	219.69	-54.16	38.57			
Walnut	N	52.80	80.00	-27.20	-	5.00	-	-
	P	22.00	34.93	-12.93				
	K	0.00	41.32	-41.32				
	NPK	74.80	156.26	-81.46				
Cow wetche	N	33.67	40.00	-6.33	-	5.50	-	-
	P	10.41	30.60	-20.19				
	K	0.00	0.00	0.00				
	NPK	44.07	70.60	-26.53				
Sugar beet	N	280.50	170.00	110.50	110.91	8.30	1 139,09	4.10
	P	66.53	39.30	27.23	25.68			
	K	0.89	0.00	0.89	0.65			
	NPK	347.92	209.30	138.62	137.24			
Maize	N	104.00	170.00	-66.00	-	3.50	-	-
	P	29.08	34.93	-5.85				
	K	0.00	0.00	0.00				
	NPK	133.08	204.93	-71.85				
Poppy seed	N	29.60	70.00	-40.40	-	1.50	41.25	0.15
	P	51.00	21.83	29.17	27.50			
	K	0.00	0.00	0.00	-			
	NPK	80.60	91.83	-11.23	27.50			
Tomato	N	140.05	150.00	-9.95	-	5.40	121.18	0.44
	P	54.37	30.57	23.80	22.44			
	K	11.55	57.85	-46.30	-			
	NPK	205.97	238.42	-32.45	22.44			
Green lentil	N	93.00	40.00	53.00	53.20	2.00	106.40	0.38
	P	30.00	34.93	-4.93	-			
	K	0.00	0.00	0.00	-			
	NPK	123.00	74.93	48.07	53.20			
Total Economic loss for Research Area (TL)					-	-	27751.17	100.00
Economic loss (TL ha^{-1})					57.90	-	-	-

*1 kg N Price : 1.004 TL ; 1 kg P Price : 0.943 TL; 1 kg K Price: 0.733 TL, (1 USD= 1.34 YTL)

soil structure and cation exchange capacity, as well as by various soil types and environmental factors affecting the soil conditions. For this reason, it is very important to know soil properties in terms of ensuring balanced and adequate amounts of nutrients (Erdal et al., 2004). If these factors are taken into consideration for fertilizing, desired quality and yield can be achieved. In addition, chemical fertilizer use is impor-

tant in terms of sustainable use of soil and water resources and also control of pollution caused by agricultural activities (WB, 2008).

The amounts of chemical fertilizers used by farmers with the amount of fertilizer recommended by Agricultural Research Institute and economic lose which caused by excessive use of fertilizer was given in Table 5.

It was determined that the farmers used more than recommended *NPK* amount for apple, sugar beet, green lentil, wheat, barley and chick pea. Extra *NPK* amounts for these crops were 128.45, 138.62, 48.07, 38.24, 35.07 and 3.86 kgha^{-1}, respectively. *NPK* were used less than recommended for cherry, walnut, maize, rose, apricot, peach, sour cherry, tomato, cow wetche and poppy seed. Deficient usage amounts of *NPK* for these crops were 89.88, 81.46, 71.85, 54.16, 54.07, 48.11, 36.81, 32.45, 26.53 and 11.23 kgha^{-1}, respectively.

N fertilizer was used more than recommended for apple, barley, wheat, cherry, chick pea, sour cherry, peach, apricot, sugar beet, green lentil. Extra *N* usage amounts for these crops were varied between 0.14- 110.50 kgha^{-1}. The crops which in *N* was used less than recommended in rose, walnut, cow wetche, maize, poppy seed and tomato. Deficient usage amounts of *N* for these crops were between 6.33-66.00 kgha^{-1}. Among plant nutrients, nitrogen has negative environmental impacts due to washing and greenhouse gas formation. However, inadequate levels of nitrogen used by the farmers are insufficient for optimum crop yield (Mengel et al., 2006).

P was used more than recommended in apple, barley, wheat, chick pea, rose, sugar beet, poppy seed and tomato. Extra *P* usage quantities for these crops were between 3.72- 44.36 kgha^{-1}. *P* was used less than recommended for cherry, sour cherry, peach, apricot, walnut, cow wetche, maize and green lentil. Deficient usage amounts of *P* for these crops were between 4.93- 21.12 kgha^{-1}. Because of moving the excessive phosphorus to underground waters, the amount of phosphate has been increasing in drinking waters and streams. Because the phosphate was kept and its resolution is partly low, it can not be washed down the soil away from the process and phosphate accumulation in the soil causes high salt concentrations and barren promote (Guzel et al., 2002).

Even though *K* was recommended to optimum crop yield, it was determined that *K* was used deficiently for cherry, sour cherry, peach, apricot rose,

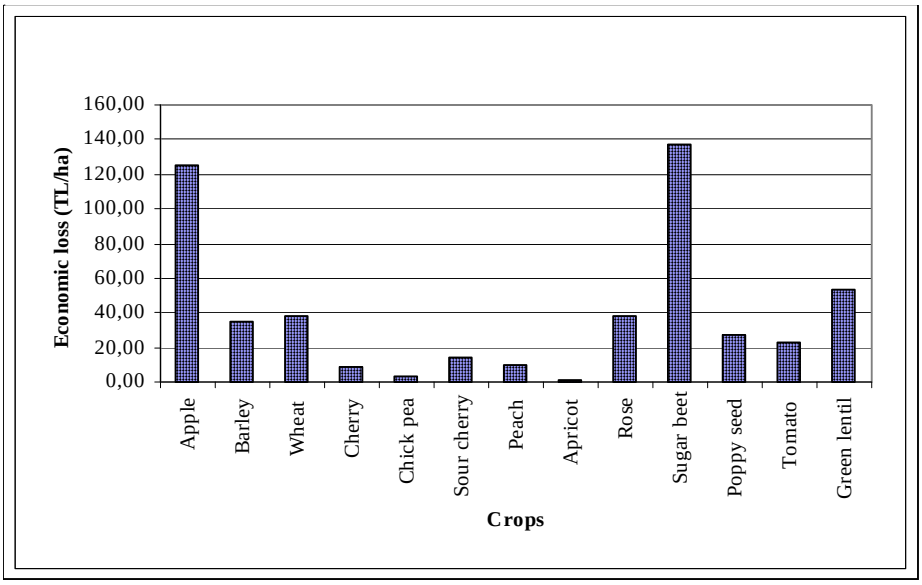

Fig. 1. Economic losses due to excessive fertilizer use in the investigated farms, TL ha^{-1}

tomato, walnut. Deficient usage amounts of *K* for these crops were between 36.31- 81.56 kgha^{-1}. Even though *K* wasn't recommended for apple, wheat, sugar beet, it was used very little amount for this crops. Quality of vegetables and fruit in exports is becoming important. Therefore, this situation makes sense to use fertilizer with potassium.

N and *P* were used more than recommended for crops examined in the research area but, *K* was used less than recommended. In other studies conducted in Turkey (Muftuoglu et al., 2008) found similar results for tomato, sun flower, barley, wheat, triticale, oats and cow wetche. Usage of *N* and *P* more than necessary causes transformed into useless plant nutrients. This situation prevents to get qualified yield (Kacar, 2004).

According to these results there was no effective and balanced fertilizing in study area. Insufficient or unbalanced fertilizer use causes decrease in yield and quality, food insecurity, the economic and technical problems (Eyupoglu, 2002). On the other hand, balanced fertilizing has resulted in more stable or improved crop yields, greater nutrients uptake and less damage to environment. This effect was found for maize production in studies conducted in West Kansas, USA (Stewart, 2001). It was found that 50 % of fertilizers used in crop production can be useful for crops; rest of the fertilizer has been removed by washing, the surface flow and evaporation (Engelstad, 1984).

Economic losses due to excessive fertilizer use in the research area were calculated (Table 5; Figure 1). Because there was no usage excessive fertilizer in maize, walnut and cow wetche, the economic loss was not found. Economic losses due to excessive fertilizer usage in apple, barley, wheat, cherry, chick pea, sour cherry, peach, apricot, rose, sugar beet, poppy seed, tomato, green lentil were between 1.00-137.24 TL ha^{-1}. Average and total economic losses due to excessive fertilizer use in the research area was 57.90 TL ha^{-1} and 27 751.17 TL (1 USD=1.34), respectively. The ratios of this economic loss for crop types were 64.51% on apple, 16.02% on barley, 11.01% on wheat, 4.10% on sugar beet, 1.52 % on cherry and 2.84% on other crops. In the previous studies conducted in Turkey found that there was economic loss due to excessive chemical fertilizer use. In similar study conducted in Izmir, Turkey was determined that 81% of cotton producers was used excessive chemical fertilizer and amount of extra fertilizer usage was 89.50 kgha^{-1} (Ozkaya and Ozdemir, 1992). In a study conducted in Tokat, Turkey, economic loss was determined as average 26 100 TL (Esengun et al., 1994). In a study conducted in Adana, Turkey, economic loss was found average 157 000 TL (Yilmaz, 1996). In studies done in Isparta, Turkey, economic loss for apple production was found average 208.10 TL ha^{-1} (Demircan and Yilmaz, 2005).

Conclusions

According to result of this study, the existence of ineffective and imbalanced fertilizer use in research area was determined. The level of farmers' environmental awareness was low. There were significant lack of extension and training about chemical fertilizers use. Therefore, many studies which determining accurately the fertilizer needs of crops and about environmental effects of chemical fertilizers should be conducted. The majority of the farmers were unaware of recommended dose, time and application method of the fertilizers. The extension staff should make more emphasis on education of farming community about the recommended dosages, timings and method of fertilizer applications on every grown crop. The effective training and extension activities which provide farmers research results related to fertilizing should be performed. The employees of organizations and companies that deliver technology, innovations and information into rural area households, should be made responsible for dissemination of information regarding the right practices of fertilizer applications by the farmers.

Soil analysis should be compulsory for all farmers. If the farmer doesn't have soil analysis report, fertilizer should not be sold to farmer. Fertilizer recommendations should be made taking into consideration economic optimum amount of fertilizer, possible environmental effects. Therefore, the optimum amount of fertilizer to achieve maximum yield should be deter-

mined for each crop.

In recent years, concerns about the agricultural production all over the world are increasing due to environmental degradation and resource conservation. Since fertilizer production requires non-renewable energy sources and fertilizer prices are increasing parallel to energy prices, sustainability of fertilizer and agricultural production might be at risk in the future. Hence, conscious use of chemical fertilizers would become more important for Turkey have limited resources. Turkey should move towards more suitable agricultural production systems to protect the environment.

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