DETERMINATION OF LEVEL OF FERTILIZER USAGE IN GREENHOUSES IN MUGLA REGION

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Abstract. The objective of this study was to determine the level of fertilizer use and its effect on the environment. In order to determine the number of greenhouses in which the questionnaire would be conducted, the simple random sampling method was used. The number of greenhouses was found to be 138 with the confidence interval of 90 % and 10 % error. When the relations between the variables determined in this study were analyzed, it was found that the producers with a higher education level gave more importance to the soil analysis, these enterprise owners made production in larger greenhouses using more organic fertilizers, and there was a strong relation between the use of organic fertilizers and the yield. When the relations between the variables and the yield were examined, it was determined that the yield was associated mostly with the chemical fertilizers used, and performing analysis followed it. Based on these data, it was found that 28 % of the enterprise owners who were elementary school graduates had the soil analysis made, and these enterprise owners applied fertilizers at an average of 900 kg·ha^{-1}. These rates decrease among the enterprise owners who are high school graduates. It was found that 40 % of these enterprise owners had the soil analysis made and applied fertilizers at an average of 750 kg·ha^{-1}. It was found that all of the enterprise owners who were university graduates had the soil analysis made and applied fertilizers at an average of 650 kg·ha^{-1}. Furthermore, soil samples were taken from 10 greenhouses to determine the amount of the material present in the soil. It was found that the salinity content rate in the soil was 0.17 % on average before the beginning of the production in plastic and glass greenhouses, and it reached 0.26 % in plastic greenhouses and 0.31 % in glass greenhouses at the end of the production. The results showed that the excessive use of chemical fertilizers would pose a potential pollution risk for soil and water resources. It was observed that the unconscious fertilizer use in greenhouses in Mugla region was not on the agenda, and it was also observed that the necessary measures were not taken regarding this issue. Therefore, public and private organizations must carry out more studies in order to raise the awareness of the producers, and the issue of increasing the incentives for carrying out the soil analysis before fertilization should be implemented as soon as possible.

Keywords: fertilizer, greenhouse, Mugla, salinity.

Introduction

Fertilizers are indicated to be among the most important inputs in agricultural production. If they are not applied in the sufficient amount, they cause loss of the yield and significant quality losses, whereas, if they are applied in the excessive amount, they cause pollution of the ground and surface water particularly due to washing of nitrogen and phosphorus fertilizers, and air pollution due to the nitrogen oxide emissions [1]. Moreover, if nitrogen fertilizers are over-used, the amount of nitrate in leaves, particularly in vegetables the leaves of which are consumed, reaches the level that threatens human health [2].

In a study carried out by Atilgan et al. [3] in Antalya region, it was stated that the beliefs such as "the more amount of fertilizers is used, the more yield will be obtained" or "the amount of the fertilizers used by neighboring enterprises may be correct" led to the over-use of fertilizers. The use of a larger amount of fertilizers than needed causes salinity of the soil. Well water is supplied to both animal and human use particularly in the regions where greenhouse enterprises are intensive, and there are no drinking water transmission lines. It was found that salificated well water lost its potableness and healthy properties due to the washing of various ions, particularly nitrate.

In order to ensure the optimum benefit from the fertilizer applied, the data, such as the time of the administration of fertilizers, administration method, plant species, soil characteristics, climate and the amount of plant nutrients in the soil, must be known. Fertilization methods and amounts vary according to the soil, plant and environmental factors. Therefore, it is not practically possible for the fertilizer manufacturers to indicate the information about the method of use and the amount to be used on the packaging. However, manufacturing companies may carry out studies on informing farmers about the use of fertilizers [3].

In a study carried out by Kaplan et al. [4] it was stated that chemical fertilizers were used very intensively particularly in winter months in greenhouses, therefore, water resources and particularly

well water could be dangerously contaminated, and the amount of crop production and the quality of the product could be negatively affected.

Korkmaz [5] stated that even under ideal conditions, only 50 % of the nitrogen fertilizers applied to the soil were used by plants, 2-20 % of the fertilizers were lost through evaporation, 15-25 % of the fertilizers combined with organic compounds in the clay soil, and the remaining amount of 2-10 % joined the surface and underground waters. The objective of this study was to determine the levels of chemical fertilizers used in greenhouse production in Mugla Province and its districts and to determine the potential negative effects of these fertilizers used on the environment.

Materials and methods

The research material consists of the primary data gathered through surveys from the intensive production of greenhouse enterprises within Mugla region. This study was conducted in the village of Fethiye district and county. The greenhouses in the study area constitute 83 % of all greenhouses in Mugla region [6]. The survey data cover 2014-2015 production periods. The simple random sampling method was applied in the selection of the representative farms as follows [7; 8].

$$n = \frac{N \cdot \sigma^2}{(N-1) \cdot D^2 \cdot \sigma^2}, \quad (1)$$

where n – sample size;
N – number of farms in the population;
s^2 – population variance.

$D^2 = (d/t)^2$, d expresses deviation at a particular rate (10 %) from average, t expresses t-table value which is equivalent to 90 % confidential limit. The number of farms to be surveyed was determined to be 138 with the confidence interval of 90 % and 10 % error.

Soil samples were taken from 10 greenhouses (5 plastic greenhouses, 5 glass greenhouses) to determine the amount of the material present in the soil. A total of 30 soil samples were taken from these greenhouses; 10 samples at the beginning of the production, 10 samples during the production and 10 samples at the end of the production. The mechanical structure of the soil is determined by the hydrometer method according to Bouyoucos [9]. To determine the amount of the material present in the soil, soil samples were taken before production (before fertilization), during production and postharvest. The parameters obtained in this study are expressed with numbers, such as a numerical value assigned to each stage of the education level and the relations between the values analyzed statistically in SAS packet program by using CORR expression [10].

Results and discussion

Enterprises dealing with tomatoe cultivation in the region accounted for 90 % of all enterprises. It was found that the producers gave priority to the cultivation of tomatoes since their economic return was higher and marketing was easier compared to other products. It was determined that except tomatoes, the production of other products was less due to the price volatility and the lack of marketing opportunities. In the surveys it was determined that no soil analysis was performed before applying the fertilizers in 40 % of the enterprises, 50 % of the enterprises had the soil analysis made only once, and the remaining 10 % had the soil analysis made more than once (Fig. 1). According to the study performed, before applying the fertilizers, the producers got help not from the official institutions or organizations but from fertilizer dealers which operated as commercial enterprises. Since fertilizer dealers are commercial enterprises, in order to make more profit, they sell more fertilizers than needed to the producers and recommend applying them. Atilgan et al. [3] determined similar findings in their study.

When the education levels of the enterprise owners were analyzed in the survey, it was determined that 70 % were elementary school, 20 % were high school, and 10 % were university graduates. Based on these data, it was found that 28 % of the enterprise owners who were elementary school graduates had the soil analysis made, and these enterprise owners applied fertilizers at an average of 900 kg·ha^{-1}. These figures decrease among the enterprise owners who are high school graduates. It was found that 40 % of these enterprise owners had the soil analysis made and applied

fertilizers at an average of 750 kg·ha^{-1}. It was found that all of the enterprise owners who were university graduates had the soil analysis made and applied fertilizers at an average of 650 kg·ha^{-1}. According to these data, it was concluded that the education level of the cultivators changed in direct proportion to the soil analysis and in inverse proportion to the amount of chemical fertilizers used (Fig. 2).

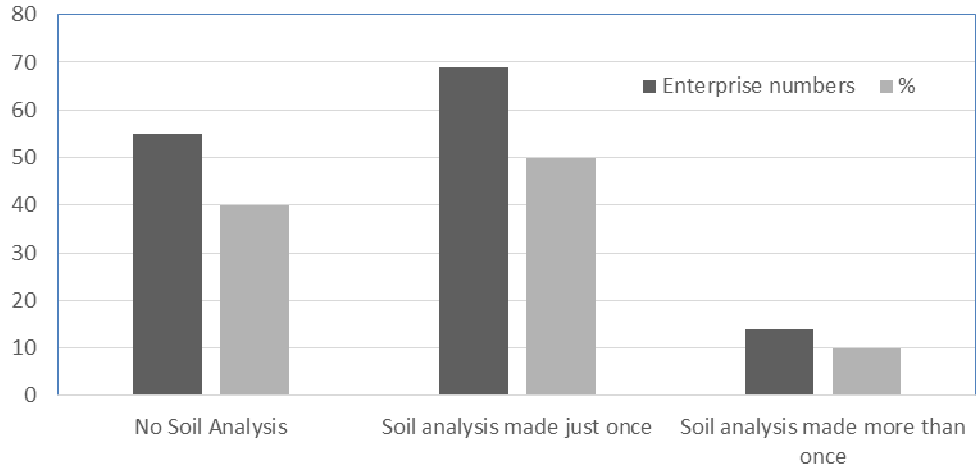

Fig. 1. **Distribution of the producers who have their soil analyzed**

Within this study, soil samples were taken from 10 greenhouses of different greenhouse types and located in different regions. A total of 30 soil samples were taken from these 10 greenhouses; 10 samples at the beginning of the production, 10 samples during the production and 10 samples at the end of the production. The soil analyses of these samples were performed. When the soil samples taken were analyzed, it was found that the salinity content rate in the soil was 0.17 % on average before the beginning of the production in plastic and glass greenhouses, and it reached 0.26 % in plastic greenhouses and 0.31 % in glass greenhouses at the end of the production (Fig. 3-4). Considering that the following production period will begin with the salinity content rates of 0.26 % and 0.31 %, the salinity content rate of the soil will gradually increase in every production period. The salinity of the soil will adversely affect the plant growth, and it will make the soil unusable with each passing day. Elimination of the excessive salt by washing will be difficult, for there are no drainage channels in greenhouses.

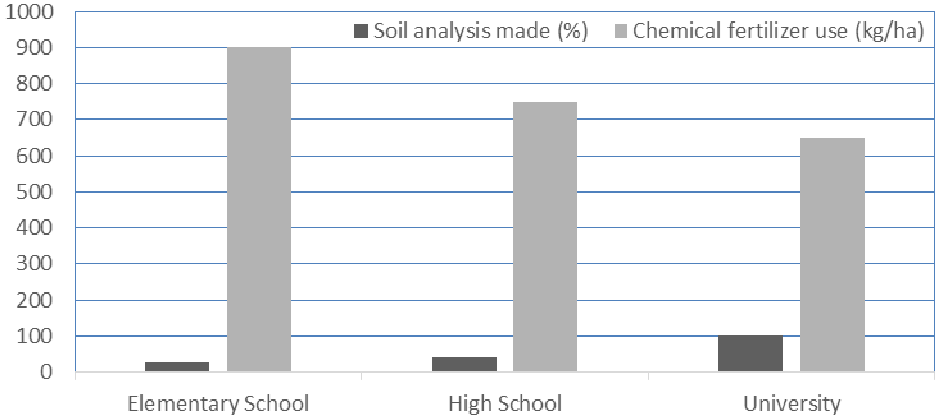

Fig. 2. **Distribution of the level of education and fertilizer use for enterprise owners**

In this study, the increase in the salt content observed in the soil analyses was considered to be associated with unconscious fertilizer applications. Akay and Kaplan [11] reached similar findings in their study.

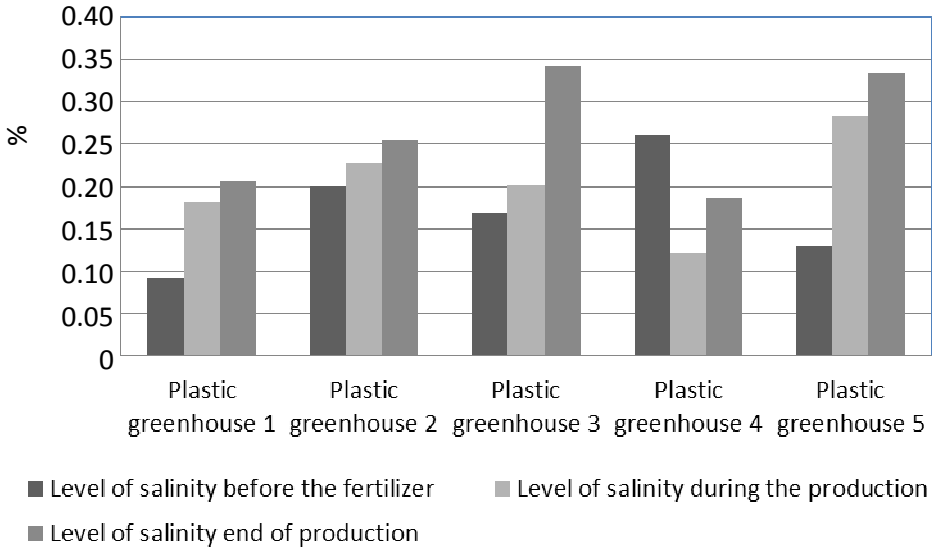

Fig. 3. **Distribution of soil analysis results in plastic greenhouses**

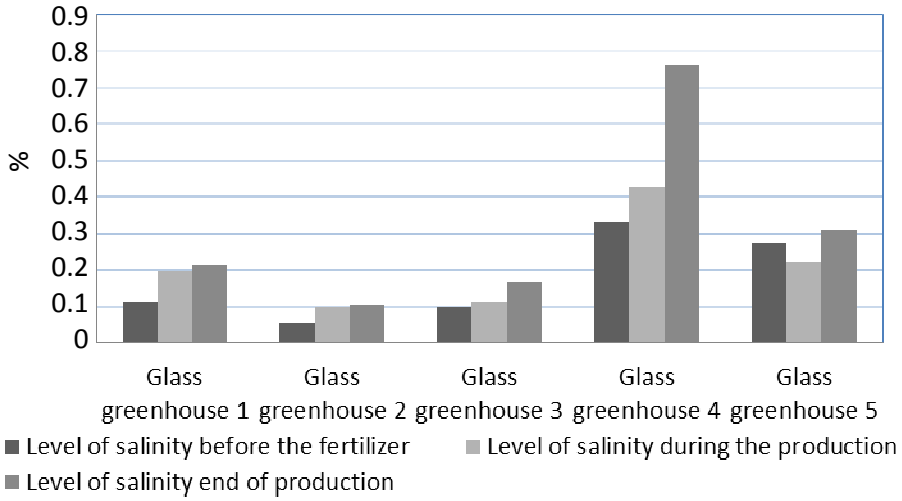

Fig. 4. **Distribution of soil analysis results in glass greenhouses**

The relationship between the variables

The relationship between the variables obtained in this study was examined with the correlation analysis. When the relations between the variables determined in this study were analyzed, it was found that the producers with a higher education level gave more importance to the soil analysis, these enterprise owners made production in larger greenhouses using more organic fertilizers, and there was a strong relation between the use of organic fertilizers and the yield. When the relations between the variables and the yield were examined, it was determined that the yield was associated mostly with the chemical fertilizers used, and performing analysis followed it.

It is known that significant levels of nitrogen and phosphorus interfere with water through the surface runoff and drainage waters from the soil as a result of wrong and excessive use of fertilizers [12].

It has two main environmental impacts. These are the increase in the nitrate concentration in the drinking water reserves and in the fresh vegetables the leaves of which are consumed [13; 14]. It is considered to be harmful when nitrate in the food exceeds 250 $mg \cdot kg^{-1}$ and when nitrite in the food exceeds 5 $mg \cdot kg^{-1}$ [15]. Accordingly, in order to prevent incorrect fertilization, some restrictions should be applied to the producers for the use of drip irrigation fertilizers used in the irrigation water and the use of other chemical fertilizers. Studies on providing information for the producers should be carried out by universities and associated organizations for a conscious production.

Table 1

The relationship between the variables in this study

	GA	EL	OFI	AOFU	IY	ACF
EL	0.1919 *	-	-	-	-	-
OFI	-0.1579	0.1178	-	-	-	-
AOFU	0.1902 *	0.2806**	-0.0196	-	-	-
IY	0.0138	0.1343	0.0086	0.3902***	-	-
ACF	0.0918	0.1080	-0.1113	0.5642***	0.6196***	-
AM	0.0640	0.0819	0.0954	0.2375**	0.2112 **	0.3945***

*: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$, ED: Education Level; OFI: Organic Fertilizers Information; AOFU: The Amount of Organic Fertilizer Usage; IY: Increased Yıeld; ACF: The Amount of Chemical Fertilizers; AM: Analysis Made; GA: Greenhouse Area

The best of the measures to be taken to prevent soil pollution and to ensure sustainable production is application of fertilizers based on the soil and plant analyses in intensive agricultural areas such as irrigated farming and greenhouse cultivation [16]. The prevention of the losses, which are caused by the application of fertilizers with inappropriate methods, at inappropriate amounts and at an inappropriate time, is of great importance. The obtained results suggest that a fertilizing program to be prepared by taking these matters into consideration will ensure the conscious use and saving of fertilizers [3].

Conclusions

It was found that the producers got help concerning the use of fertilizers not from official institutions or organizations but from fertilizer dealers which operated as commercial enterprises. It should not be forgotten that since fertilizer dealers are commercial enterprises, and they want to make more profit, they sell more fertilizers than needed to the producers and encourage them to use more fertilizers than needed. It was found that the vast majority of the producers did not have the soil analysis made before applying fertilizers. Therefore, fertilizers are used at an inappropriate time and in excessive amounts. In addition to the increase in the production costs, this affects the product quality and causes soil and environmental pollution.

In this study, it was concluded that establishment of laboratories performing plant and soil analyses at reasonable prices that can easily be reached by the producers is necessary for proper nutrition of plants and application of fertilizers in the correct amount and at the right time in greenhouse cultivation; the agricultural engineers are required to be raised that may help the producers with the greenhouse plant nutrition programs to be prepared according to the results of the analysis; furthermore, the producers are seriously in need of the training to be given by public or private organizations on the application of fertilizers.

It was observed that the unconscious fertilizer use in greenhouses in Mugla region was not on the agenda, and it was also observed that the necessary measures were not taken regarding this issue. Therefore, public and private organizations must carry out more studies in order to raise the awareness of the producers, and the issue of increasing the incentives for carrying out the soil analysis before fertilization should be implemented as soon as possible.

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References

1. Guler S. Developments in the fertilizer consumption in the world and Turkey. In: Karaman MR., Brohi A R (eds) Türkiye 3. National Fertilizers Symposium, Agriculture Industry-Environment, 2004, Tokat, pp. 47-54. (In Turkish)
2. Roorda van Eysinga NL. Nitrate and Glasshouse Vegetables. Fertilizer Research 5, 1984, pp. 149-156.

3. Atilgan A., Coskan A., Saltuk B., Erkan M. The Level of Chemical and Organic Fertilizer Usage and Potential Environmental Impacts in Greenhouses in Antalya Region. Ekoloji, 15(62), 2007, pp. 37-47. (In Turkish)
4. Kaplan M., Sonmez S., Tokmak S. The Nitrate Content of Well Waters in the Kumluca Region–Antalya. Turkish Journal of Agriculture and Forestry 23, 1999, pp. 309-313. (In Turkish)
5. Korkmaz K. Nitrogen and Nitrogen Pollution in Agriculture Input System, 2007. [online] [07.04.2015] Available at. http://www.ziraat.ktu.edu.tr/tarim_girdi.htm (In Turkish)
6. Ministry of Food, Agriculture and Livestock, Distribution of greenhouse areas according to the county in Mugla Region, 2014, Mugla. (In Turkish)
7. Gunes T., Arikan R. Agricultural Economics Statistics. Ankara University, Publications of Agriculture Faculty: 1049, Book: 305, Ankara 1998. (In Turkish)
8. Cicek A., Erkan O. Research and Sampling Methods in Agricultural Economics. Gaziosmanpasa University, Publications of Agriculture Faculty No: 12, Lecture notes series No: 6, Tokat, 1996. (In Turkish)
9. Bouyouces G. J. A recalibration of the hydrometer for making mechanical analysis of Soil. Agr. Jour., 43, 1951, pp. 435-438.
10. The General Linear Model Procedure. In User's Guide: Statistics, Version 8, 1999.
11. Akay S., Kaplan M. Salinity of Irrigation Water of Greenhouses and Its Effects on The soil Salinity in Kumluca and Finike Regions. IXth International Symposium of Scientific Centre of Fertilizers, TÜRKIYE, 25-30 Eylül 1995, pp. 379-384
12. Gutman BS. Biology. McGraw-Hill, Iowa, 1999.
13. Karaman M.R., Brohi A.R., Gunes A., Inal A., Alpaslan M. Effect of Regional Different N-Fertilizer Applications on Nitrate Accumulation in Winter Vegetables Grown on Tokat Region, Turkish Journal of Agriculture Forestry, 24, 2000, pp. 1-9. (In Turkish)
14. Oruc H.H., Ceylan S. Nitrate and Nitrite in Some Vegetables Consumed in Bursa, Uludag University, Journal of the Faculty of Veterinary Medicine, 20, 2001, pp. 17-21. (In Turkish)
15. Gur K., Zengin M., Uyanoz R. Nitrate Pollution Caused by Nitrogen Fertilizer in the Wheat Grown in Konya and the surrounding agricultural land. In: Agriculture-Environmental relations Symposium, Sustainable Use of Natural Resources, Mersin, 1996, pp. 103-110. (In Turkish)
16. Guo H., Li G., Zhang D., Zhang X., Lu C. Effects of water table and fertilization management on nitrogen loading to groundwater. Agricultural Water Management 82, 2006, pp. 86-98.