New Approaches to Evaluation in Soil and Plant Analysis as a Component of Sustainable Plant Nutrition Management

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Abstract— **Soils are the common value of all living things on our planet with their many functions in the ecosystem and are accepted as the most important tool in the plant production activities of societies. The environmental effects of fertilization practices that are not done appropriately in crop production in agriculture are quite common and adversely affect product quality and public health. Soil and plant analyzes for fertilization purposes in plant production are important evaluation tools as the basic components of plant nutrition management. Depending on the developments in plant cultures, biotechnology and fertilizer technologies, it was necessary to update the evaluations and recommendations of analysis laboratories according to conventional practices, and fertilization recommendations based on comprehensive analyzes and evaluations in well-equipped laboratories that are well adapted to the developments in this field have turned into special areas of expertise. The preservation of soil fertility and its sustainable use at a level that meets the basic needs of people and without polluting the environment requires optimum use of agricultural practices. In plant production practices, the control parameters of sustainable agriculture are evaluated in terms of maintaining soil quality, controlling nutrient input and output, and fulfilling the functions of the soil.**

***Keywords*— Soil quality, sustainability, fertilization**

I. Introduction

As a dynamic interface between the lithosphere, atmosphere, hydrosphere and biosphere, the soil is the region where minerals and organisms interact with air and water, and it is considered as a limited and non-renewable resource in nature, whose properties are determined by the functions of the ecosystem of which it is a part in its natural position and the management of that soil. Soil acts as a natural filter to remove unwanted solid and gaseous components from air and water, and recycles organic materials. The retention and release of water and nutrients, as well as the life processes of plants and soil organisms, occur in the soil and the biological activity of the soil increases with soil health [1].

Today, the soils of the world are under multi-faceted dangers. The form and extent of these hazards are expressed in various ways. Some of these dangers are the loss of ecological functions of the soil by unplanned settlement and faulty land use, erosion and pollution. Substances polluting air and water and agricultural activities (mineral fertilization, using toxic chemicals against pests, watering the soil with wastewater and producing agricultural industry waste materials, etc.) are significantly effective in soil pollution. Pollution of air and water, the formation of wastewater contaminated with harmful substances, the formation of huge urban solid waste piles, exhaust gases, mineral oils and nuclear leaks are complex ecological problems that deteriorate the properties of the soil, reduce soil fertility and harm soil living things.

Inorganic and organic harmful substances accumulating in the soil act as plant poisons or deteriorate the quality of nutrients, entering the food chain and other living things and causing serious problems. Because the biological decomposition of toxic substances is extremely rare and difficult compared to normal nutrients. For this reason, harmful toxic substances taken with the normal food chain are constantly accumulating in the body of living things. Substances such as chlorinated hydrocarbons, DDT and mercury and heavy metals are shown as typical examples of this accumulation. In addition, the introduction of unnatural matter into the soil affects soil fertility significantly and negatively. Cleaning and restoring a damaged and heavily polluted soil is both very difficult and very expensive.

Soil pollution is closely related to wide-ranging issues such as environmental pollution, population growth, technological and economic development, which change ecological balances all over the world. The protection and development of soil and water resources is included in a national policy of all countries. It is important to use agricultural practices and analysis and evaluation methods suitable for innovations in plant cultures, agricultural industry and biotechnological fields in order to protect and improve the fertility and quality of the soil and to use it sustainably to meet the basic living needs of the people.

II. Soil pollution by agricultural activity

Soil is a unique natural resource from which the basic nutrients of living things are produced. Today, agricultural pressures on the soil are increasing in order to get various and more products from the soil as much as possible due to reasons such as advancing technology, rising living standards and increasing population. For this reason, some deteriorations and changes may occur in the structure and properties of the soil. The main agricultural activities that cause soil pollution are given below.

- Organic and mineral fertilizers and various regulators applied to the soil
- Biocides used to destroy animal and plant pests

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- Agricultural irrigation with poor quality water sources,
- Pollution of the waste materials belonging to the agricultural industry.

Mineral fertilizers are given to the soil to supplement the nutrients taken with the crop and exploited from the soil. If the mineral fertilizers are given in accordance with the climatic conditions, the needs of the plant and the soil characteristics, there are no significant problems in the soil regarding mineral fertilizers. In determining the appropriate form and amount of mineral fertilizer and the optimum application time, plant species, soil characteristics, local ecological conditions, plant culture form, irrigation method and nutrition techniques etc. are taken as a criteria. If the soil is fertilized with incorrectly selected mineral fertilizers without taking these factors into account and in excessive doses, it can have harmful effects on the environment and crops.

In addition, some of the fertilizers are obtained from raw sources in nature. These resources may contain some mineral substances harmful to the soil and plant. In this way, if mineral fertilizers obtained from raw material sources are applied to the soil without separating the harmful metals in them, the soil and the plants growing on it will be damaged by these materials. Nitrogen, phosphorus and potassium fertilizers, which contain the nutrients that plants need most, are used to increase productivity in agricultural areas. In intensive agricultural regions, these fertilizers can be applied to the soil in excessive amounts in order to obtain as much product as possible and the source of the problems arising from the use of mineral fertilizers in the soil is the habit of using excessive fertilizers.

A. Effects of Excessive Fertilization on Economy, Environment and Public Health

Fertilization in agriculture is of vital importance for soil fertility and sustainability, agricultural production and economies of societies, as well as important effects on public health and environmental problems. In case of use of agricultural chemicals above the requirements, serious losses occur in the quantity and quality of the plant product, soils, surface and underground waters can be polluted at dangerous levels, and public health is seriously affected. In addition, it causes problems such as salinization in soils, heavy metal accumulation, nutrient imbalance, deterioration of microorganism activity, eutrophication and nitrate increase in water, depletion of the ozone layer and greenhouse effect. The increase in nitrate values, which is very important in some fresh vegetables due to excessive nitrogen fertilization, and exceeding the nitrate limit values in fresh vegetables can cause significant public health problems. All these necessitate the effective and analysis-based use of fertilizers.

B. The Importance of Effective Fertilizer Use and Analysis-Based Fertilization in Agriculture

Fertilizers are extremely necessary chemicals that contain nutrients needed by plants and increase productivity in plant production, and are an important agricultural practice. The decrease in arable land per capita in the world requires more production per unit area and more fertilizer supply for this production. However, the main problems encountered in fertilizer applications in the agricultural sector on a world scale; The reason is that the farmers do not have enough information about fertilization practices in the use and consumption of fertilizers, and most of the farmers still fertilize as usual instead of scientific agricultural practices.

Fertilization recommendations prepared in the appropriate form, amount, time and application options, taking into account the soil and ecological conditions and the yield potential of the plant to be grown, are known as the best fertilization practice to ensure optimum economic efficiency. Effective fertilization is based on providing the most appropriate fertilization practice in terms of amount, form and timing for optimum efficiency. “Ineffective fertilizer use” (low production and inefficiency due to inordinate fertilizer use, soil and water pollution caused by excessive fertilizer use, and environmental and public health problems related to these) that are not based on analysis are among the issues that await solutions in the agricultural sector. Despite the new technical developments in agricultural systems and materials, it is clear that fertilizations that are not based on analysis will cause increasing yield and quality problems and especially difficult to compensate public health and environmental problems. Environmental and public health problems can be minimized with efficient fertilization based on analysis, and it is predicted that productivity and quality in agricultural production will increase on a world scale.

The ecological conditions of the region to be cultivated, the culture form and product potential of the plant to be grown, the availability of soil and water resources and the necessary regulations constitute the main components of effective fertilization practice. Soil analysis to determine the level of soil properties and useful nutrients is an important criterion that reflects the fertility of the soil to be cultivated. For this purpose, it is necessary to conduct soil analyzes before the production season and to implement the recommended program according to the results of this analysis. Plant analysis is an important criterion that best reflects the nutritional health of the plant and is very helpful in solving the nutritional problems that it may encounter, especially during the vegetation period. Fertilization programs can be revised and nutritional problems in the growing period can be eliminated by determining the nutritional status with the leaf analyzes made in the defined appropriate period of each plant during the growing period.

Plants need sufficient water for their physiological needs. Irrigation water quality is an important factor that affects the fertility, chemical and physical properties of the soil to which it is applied, and the development of the plant. In nature, rain water comes into contact with geological environments and dissolves them and carries the dissolved substances within it; or may be affected by various emissions in nature. Plant toxicity, salinization of soils, accumulation of toxic ions, soil degradation and chronic infertility problems can be seen at the end of irrigations with waters that are not suitable for their properties. It should be ensured that the irrigation water is of the right quality, and it is extremely necessary to conduct periodic water analyzes of even water sources that are known to be of good quality due to time-dependent variability.

III. New Fertilization Strategies Based On Advances In Fertilizer Technologies And Crop Patterns

Depending on the developments in plant cultures and fertilizer technologies, there is a need to update the evaluation and recommendations of analysis laboratories according to conventional practices. Soil, plant and water analysis laboratories have important functions in making effective fertilization recommendations, profitable production and clean and healthy environment. Most of the producers who have soil analysis show a producer profile with an investigative personality, who have their soil, plant and water samples analyzed regularly. Laboratories should be equipped with materials, methods and competent personnel that can help these manufacturers' problems, which are sometimes difficult to solve. Today, agricultural analysis laboratories have turned into a special field of expertise due to the wide scope of their work. For success in fertilization, it is extremely important to expand public or private soil, plant and water analysis laboratories in agricultural regions, to modernize the existing ones with up-to-date infrastructure, equipment, equipment and valid analysis criteria, and to adapt to new developments.

Today, due to new crop plants, developed new varieties and hybrid seeds, classical, semi-dwarf and dwarf cultivars in fruit growing, species and varieties grown specifically for consumer demands, nutrient demands are quite high in terms of quantity and timing in fertilization programs and changing in a wide range plants are encountered. There is a need to arrange fertilization programs in accordance with the nutritional requirements of newly developed hybrid varieties. However, the limitation of studies on the nutritional requirement of new varieties is one of the most important problems in making accurate fertilization recommendations. Dialogue and experience sharing with the producer who has analyzed on this subject about the determination of the genetic potential of the plant can be a good guide in solving the problems.

On the other hand, agricultural chemicals and fertilizers have been developed in many different forms, compound combinations with varying ratios and new compositions in the agricultural sector. Their complexity necessitated the development of new analysis evaluation criteria with sophisticated, comprehensive and product-specific approaches instead of traditional fertilizer and fertilization recommendations made with classical approaches. At the same time, all these developments have transformed the agricultural analysis laboratories, which follow the changes and apply new analysis and evaluation methods specific to the conditions, into specialized areas of sophisticated service. It is important that laboratories are active in the recommendations on dosing and timing of these chemicals and fertilizers and that the fertilizer industry-laboratory relations are kept open. By following the developments in the fertilizer and other agrochemicals sector in agriculture, developing recommendations for the use of preparations with different action mechanisms and complex compositions in fertilization recommendations will allow more effective use and adoption of these new preparations.

In plant nutrition management, soil analyzes and plant analyzes are evaluated integratedly in a production season, and the fertilization program applied at the beginning of vegetation can be revised depending on the conditions during the growing period. In the effective management of the plant nutrition program, the recording of the findings related to soil and plant analysis and the applications made, and the sharing of the observations regarding the product with the laboratory consultant and constant communication facilitate the solution of soil and plant related problems. This approach also assigns an agricultural consultancy mission to laboratories that perform soil and plant analysis, helping to improve service quality from analysis to recommendation, and overall effective fertilization.

Another important point in providing all these is that soil, leaf and water analysis laboratories should expand their scope of work and update the methods used, follow the developments in the related science field and be in effective communication with the producer. All these developments and changes highlight the absolute necessity of analysis-based applications and the importance of laboratory service quality in fertilizer applications.

IV. New Approaches To Diagnose And Evaluate Problems In Soil Analysis

In classical soil fertility tests, which are expressed as routine soil analyzes and whose analysis parameters vary between 7-14, at least some basic properties of the soil and some useful nutrients are analyzed and fertilization recommendations are made for plants. Although a significant number of soil properties are determined with these parameters, some specific and dynamic soil properties that may cause infertility in the soil cannot be determined, and the productivity potential, weaknesses or strengths of the soil cannot be known. In the fertilization recommendations made with these parameters, the amount, form and application times of the fertilizers containing the nutrients that the plant will need are specified; Due to the lack of data on the strengths or weaknesses of the soil, it is not possible to evaluate its sustainable use. The phenomenon of soil quality has emerged due to such a need and may differ in terms of evaluation methods according to purposes and conditions. Although there are different approaches in its applications, it is generally accepted as a soil concept that plays a key role in classical and postmodern agricultural practices and has been put into practice in soil analysis laboratories around the world in recent years.

Soil quality refers to the suitability of the soil for plant growth without reducing plant growth in agricultural use and without harming the environment. Today, soil problems that arise due to soil degradation due to various natural or human reasons, especially climate change, have led to the focus on the concept of soil quality in determining the inefficiency of agricultural lands and the effects of land use on soil resources. In this context, soil quality is evaluated as “the ability of a soil to produce agricultural products continuously and safely in the long term and to improve human and animal health without degrading the natural resource base or adversely affecting the environment” with an environmental and sustainability-oriented approach [2]. It is based on an approach that aims sustainability by preserving and improving soil quality with alternative agricultural practices in agricultural practices.

Strategy	Linkage			Goal
Alternative Agriculture Skilled Management Crop Rotation Organic Recycling Reduced Chemical Input Crop/Livestock Systems Integrated Pest Management	⇨	**Soil Quality**	⇨	**Sustinable Agriculture** Productive / Profitable Energy Conserving Environment Sound Economically Viable Conserved Natural Resources Improved Health / Food Quality / Safety

Fig 1. A conceptual diagram showing how soil quality traits link the alternative farming strategy with the ultimate goal of sustainable agriculture [3].

Since the term soil is an issue that concerns all segments of society, it is anticipated that soil quality determination will provide important information on the following issues when we examine the subject at technical and social level.

- Determining the current state of soil quality and productivity,
- Determination of the problematic parameters that are dominant in the soil and related potential and acute problems
- Identifying potential inefficiency problems in the soil
- Determining sustainable use strategies for the protection and improvement of soil quality, and predicting the soil quality value to be achieved with appropriate regulations,
- Determination of effective fertilization and management strategies,
- Detection of the presence of contamination in the soil and determination of its environmental effects.
- Determining the need for soil arrangement / improvement in the near, medium and long term,
- Planning of soil resources,
- Providing guidance on land valuation to investors in the purchase and sale of land,
- The suitability of the soil for various product patterns and cultural and natural practices, etc. determination.

V. Conclusion

Agricultural practices with production patterns applied in an ecological region without considering environmental values appear as inefficiency, pollution and public health problems. In the future, the development of plant production in agricultural practices will be realized not only through biotechnological innovations, products with high genetic capacity and the use of improved chemicals, but also through the use of agro-ecological practices and sustainable agricultural practices that consider environmental values. However, it is thought that the success of these practices depends on the conservation and improvement of soil quality, which requires sustainable use of soil and water resources, and the conscious implementation of agricultural practices based on analysis. For this reason, in the plant production process, soil and plant analyzes should be carried out on time and with appropriate techniques, implementation of an effective fertilization program, development of laboratory services according to developing biotechnological materials and agricultural chemicals; It is of great importance in terms of efficiency, profitability, sustainability and environmental health.

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