Organic Field Crops Production Factors

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Abstract

Agriculture is one of the most important sectors in terms of human, animal and environmental health. The human-made contamination of our agricultural lands and water resources increasingly jeopardizes healthy and safe food production. Organic farming provides the opportunity to protect natural resources and sustainability in agriculture. Organic farming systems make sustainability depending on the recovery of natural resources destroyed by traditional agricultural practices. Field crops are grown on a large scale for consumption purposes. Knowing which production factor changes the productivity of crops under organic production conditions and which factors are very important can create an opportunity to prevent yield losses in organic production. In this way, in the production of organic field crops, labor, plant materials (organic seeds, tubers and seedlings), soil, fertilizers (farm manure, green manure, microbial fertilizers and commercial organic fertilizers), crop rotation, plant protection (disease, pest and weed control), irrigation, harvesting and storage are examined one by one and their relations with productivity are evaluated together. It is not impossible for us to turn the low yield, which is the biggest disadvantage in organic agriculture, into an advantage by paying attention to the production factors of field crops.

Key Words: *Organic agriculture, organic field crops, production factors*

Organik Tarla Bitkileri Üretim Faktörleri

Özet

Tarım insan, hayvan ve çevre sağlığı açısından en önemli sektörlerin başında gelir. Tarım topraklarımızın ve su kaynaklarımızın insan eliyle kirlenmesi, sağlıklı ve güvenli gıda üretimini giderek tehlikeye atmaktadır. Organik tarım, doğal kaynakların korunmasına ve tarımda sürdürülebilirliğe fırsat verir. Organik tarım sistemleri geleneksel tarım uygulamalarıyla tahrip olan doğal kaynakların yeniden kazanılmasına ve toprak verimliliğinin artırılmasına bağlı olarak tarımda sürdürülebilirliği kalıcı hale getirir. Tarla bitkileri ise insan beslenmesinin temelini oluşturan bitki gruplarını içerisine alan en geniş yelpazeye sahip bitki grubudur. Bu bitkilerin organik üretim şartlarında hangi üretim faktörüne bağlı olarak verimliliğinin değiştiği ve hangi faktörlerin çok önemli olduğunun bilinmesi organik üretimdeki kayıpların önüne geçmede fırsat yaratabilir. Bu sayede organik tarla bitkileri üretiminde işgücü, üretim materyali (organik tohum, yumru ve fide), toprak, gübreleme (çiftlik gübresi, yeşil gübre, mikrobial gübreler ve ticari organik gübreler), ekim nöbeti, bitki koruma (hastalık, zararlı ve yabancı ot mücadelesi), sulama, hasat ve depolama gibi üretim faktörleri tek tek irdelenerek verimlilikle ilişkileri birlikte değerlendirilmiş olur. Organik tarımda en büyük dezavantaj olarak karşımıza çıkan düşük verimi, tarla bitkileri üretim faktörlerine dikkat ederek avantaja çevirmemiz hiç te imkânsız değildir.

Anahtar Kelimeler: *Organik tarım, organik tarla bitkileri, üretim faktörleri*

Introduction

Field crops are grown on a large scale for consumption purposes. Knowing which production factor changes the productivity of crops under organic production conditions and which factors are very important can create an opportunity to prevent yield losses in organic production. In this way, in the production of organic field crops, labor, plant materials (organic seeds, tubers and seedlings), soil, fertilizers (farm manure, green manure, microbial fertilizers and commercial organic fertilizers), crop rotation, plant protection (disease, pest and weed control), irrigation, harvesting and storage are examined one by one and their relations with productivity are evaluated together.

Labor Force

Labor costs vary according to the enterprise, the type of production and labor. Organic production is a labor-intensive when compared to production systems containing extensive mechanization. Many techniques used in organic agriculture (mixed planting, cultural weed control, composting, etc.) require high labor. Organic production with a high labor requirement will create additional employment opportunities for the rural population

in regions where the labor is cheap (Scialabba and Hatam, 2002). In addition, the diversity in organic production can create additional job opportunities and ensure that the workforce is used in a balanced and profitable manner throughout the season (Anonymous, 2006; Anonymous, 2010 Turhan, 2005). Labor availability and cost in Turkey vary according to regions and seasons. In rural areas and regions where industry and service sectors are not concentrated, organic production emerges as an important opportunity in terms of making use of the workforce. With an alternation based on diversity, the workforce can be used in a balanced way in organic production. In the production of organic field crops, besides market research, labor costs should also be taken into account and relatively advantageous production can be prioritized. In cases where labor costs are high, the production of cereals, legumes and industrial plants, where mechanization is already used, can be seen as an advantageous production system in this respect (Akkaya, 2018; Bulut, 2011a).

Production Materials (Organic seeds, Tubers and Seedlings)

According to the relevant regulation, organic production materials are obtained from organic seeds, grown in organic production areas having suitable soil and climatic conditions in which no synthetic plant nutrition, growth agents, hormones and pesticides are used and only permitted soil improving materials are allowed during the growing seasons (Anonymous, 2010; Taşbaşlı et al., 2003; Yenice et al., 2004). The production materials used in organic agriculture must also be produced organically (Duman, 2015; Aydın Eryılmaz et al. 2019). Organic seed and production material production in Turkey is still in the development stage. Turkey has the capacity to meet the needs of domestic production and to become the organic seed production center of the EU and the region, with good planning and accurate decisions.

Soil

The ideal soil used in organic farming is the soil with an intact biological and mineralogical structure and texture, with a pH value between 5.5 and 7 (Taşbaşlı et al., 2003). In cases where the soil structure is improper, permitted soil improvers are used (Soyergin, 2003; Anonymous, 2010). Before starting organic crop production, it is decided whether production measures such as terracing, contour and strip-like planting, the use of soil moisture protective materials and mulching, shading with pruned branches or legumes, ditching and silt trapping methods are needed (Aksoy, 2006; Soyergin, 2003; Taşbaşlı et al., 2003). Pollution caused by fertilizers and pesticides applied in traditional agriculture can prevent the transition to organic agriculture. Contamination with cadmium and other heavy materials resulting from long-term fertilizer application, for example, can hinder organic production (Kirimhan, 2005). Soil analyzes should be done before starting organic agriculture in areas where long-term intensive agriculture has been applied in order to prevent wasted costs and efforts (Kirimhan, 2005). Tillage is carried out in a way that will ensure the protection and improvement of soil fertility, reduce erosion, prevent soil compaction, protect flora and fauna in the soil, and avoid over tillage (Kirişçi and Korucu, 2001; Aykas et al. 2005; Kırmızıhan, 2005; Yılmaz and Dengiz, 2021). Soil tillage tools such as harrows, cultivators, and disc harrows, which do not cultivate the soil deeply, are used (Aykas et al. 2005).

Fertilizing

In the production of organic field crops, soil and plant analyzes should be done with appropriate methods, and the productivity characteristics of the production area should be determined and a fertilization program should be prepared for the crops. The nutrient demand of the crop and the amount of nutrients in the available form in the soil should be evaluated together, and the amount of nutrients to be determined should be given to the soil by an appropriate method, taking into account the plant development period. With the "Regulation on the Principles and Implementation of Organic Agriculture" published in the Official Gazette No. 25841, "Manure and soil improvers" allowed to be used in the cultivation of organic crops are: farm manure, dried farm and dewatered poultry manure, liquid feces of animals, worm and insect compost, guano, products of animal origin and by-products (blood meal, nail meal, horn meal, bone meal, fish meal, meat meal, feather and hair meal, wool, fur, hair and dairy products), vegetable origin products and by-products (green manure, straw, leaves and other vegetable residues, oilseed meal, cocoa pods, discarded malt, etc.), composted or fermented household waste, composted or fermented vegetable material mix, cultivated mushroom production residues, seaweed and seaweed materials, sawdust and wood chips, composted bark, tree ash, peat, clays (perlite, vermiculite, etc.), soft rock a phosphate, aluminum calcium phosphate, basic slag, raw potassium salts (kainite, silvinite, etc.), magnesium, potassium sulfate which may contain salt, stillage and stillage extract, calcium carbonate of natural origin (chalk, marl, ground limestone, phosphate chalk), magnesium and calcium carbonate of natural origin (magnesium chalk, magnesium limestone), magnesium sulfate, calcium chloride solution, calcium sulfate (gypsum), industrial lime from sugar production, elemental sulfur, sodium chloride, ground rock, trace elements and microbial fertilizers (Rhizobium, Azotobacter, Azosprillum, Clostridium etc.) bacteria, blue-green algae, mycorrhizae, which provide nitrogen by living in common with plants or living freely in the soil (Anonymous, 2010).

In the cultivation of organic field crops, nitrogen is mainly supplied by legumes and green fertilization, which are included in the crop rotation. Other elements can be replaced by the decomposition of soil minerals and by

precipitation. However, since all of the lost nutrients cannot be supplied with these inputs, the use of appropriate fertilizers and soil improvers is needed (Soyergin, 2003; Anonymous, 2010). While this need is supplied in a short time with inorganic fertilizers containing nutrients in high proportions and easily soluble in traditional agriculture, in organic agriculture, more nutrients can be supplied with organic fertilizers at lower rates, the effects of which are slower but longer lasting.

Farm Manure

Farm manure consists of solid and liquid feces of cattle and sheeps and bedding laid under the animals in barns. Farm manure contains nitrogen, phosphorus, potassium, calcium, sulfur and many other nutrients, but these elements in the structure of organic compounds become available to plants after the organic matter is broken down by microorganisms and enzymes. Therefore, the effect of farmyard manure on plant growth is slower but longer lasting than mineral fertilizers. In a related study, it was determined that 19360 kg/ha of cattle manure applied to rapeseed increased the grain yield of wheat planted after rapeseed by 61% compared to the control treatement without fertilizer (Wen et al., 2003). In another study conducted in Erzurum, higher results were obtained from organic fertilizer sources, including farm manure, in terms of both yield and quality (Ozturk et al. 2012; Bulut et al. 2013). Since the fertilizers of animal originating from extensive livestock, organically grown or not grown for commercial purposes can be used in organic agriculture, it is necessary to plan plant and animal production together in enterprises and to support organic livestock production.

The nutrient content of the farm manure is affected by the type and age of the animal, the nutritional value of the feed, the amount and quality of the bedding, the solid feces/urine ratio and the storage technique of the manure. According to the animal species, the nutrient contents of farm manures are in decreasing order; poultry > sheep > horse > cattle manure. As the bedding ratio in the manure increases, the amount of nutrients decreases, while the ratio of solid feces and phosphorus, urine ratio and the amount of nitrogen and potassium increase. When manure is left in small, loose heaps in the open field, it is washed away and its nutritional value is significantly reduced. Fresh application of farm manure to the soil; it causes temporary nitrogen deficiency in the soil, unidirectional reproduction of microorganisms, transfer of weed seeds and disease factors to the soil. In order to obtain the expected benefit from farm manure, it must be kept in the manure as a compacted heap for 2-3 months and mineralized (decay) as a result of the activities of microorganisms. Manure piles should not deteriorate, contain enough moisture and be affected by external conditions as little as possible (Ceylan, 1994; Kalkanci 2014).

Application time, form and amount of farm manure varies according to soil characteristics, plant species and environmental conditions. In order to minimize losses by washing, the application should be done in autumn and winter in heavy (clay) soils, and with planting in light (sandy) soils. The fertilizer should be distributed homogeneously on the field surface and mixed into the soil by applying immediately. The amount of fertilizer to be given should be at least 10 ton/ha. Generally, it is appropriate to repeat 20-40 tons/ha of farm manure every 2-3 years. More farm manure is given to soils poor in organic matter, heavy rainy areas and hoe crops. On the other hand, although the demand for farm manure is not high, it is known that it increases the plant parameters such as hectoliter (Bulut et al. 2013).

Green Manure

It is known that green manures make important contributions to soil quality and plant health, especially in the crop rotation system. Green manure should not be applied in arid and semi-arid regions, since the expected benefit from green manure can be obtained under conditions of sufficient moisture and decay.

Plants to be used for this purpose: It should be compatible with local conditions and primarily leguminous, it should have a fast growth and short growing period, it should produce abundant vegetative parts and it should be able to grow in poor soils. Legumes such as bean, vetch, peas, soybeans and one-year clover and clover as green manure plants; oats, barley and rye or mixtures of legumes + wheat grains (vetch + oats) can be used. The green manure plant should be applied to the soil at the beginning of flowering and 2-4 weeks before planting of the main plant (Karakurt, 2009; Aslan et al. 2013; Torun et al. 2019). The C:N ratio of the plant is important, and as this ratio increases, the time required for the plant to rot in the soil becomes longer. When the mixing process is done in the very early period, the amount of organic matter supplied to the soil decreases, and when it is done in the very late period, the amount of nitrogen supplied to the soil decreases.

Microbial Fertilizers

Microorganisms, which take an active role in chemical changes in the soil, are important elements of productivity. Those that fix atmospheric nitrogen, decompose organic residues, suppress soil pathogens, increase nutrient availability, destroy the effect of toxic compounds, and produce organic molecules such as hormones that promote plant growth are called beneficial microorganisms (Tecimen and Sevgi, 2009). With organic farming practices, the use of these microorganisms, which increase soil fertility and contribute to plant development.

Nitrogen-fixing microorganisms convert gaseous nitrogen (N_2) in soil air into nitrogenous compounds (NH4 and NO3) that plant roots can use. This event, called biological nitrogen fixation. It is carried out by two groups of

microorganisms that fix nitrogen by living freely in the soil (non-symbiotic) and by living in symbiosis with a plant (symbiotic). Non-symbiotic nitrogen fixers are Azotobacter, Anabaena-Azolla, Azosprillum, Bacillus, Chromatium, Clostridium, Desulfovibrio, Pseudomanas, Rhodospirillum etc. bacteria and blue-green algae, and they can multiply in the soil without the need for another living thing (Azizoglu et al. 2012). Azotobacters, which are very effective in N2 fixation by making the best use of carbon, can provide 300-350 kg/ha N per year, and blue-green algae, which are important for paddy fields, can provide 100-300 kg/ha N (Soyergin, 2003). In field studies, it was determined that inoculation with Bacillus increased the root yield of sugar beet by 13% (Çakmakçı et al., 2001), and inoculation with Azospirillum increased the grain yield in wheat and barley by 15-18% (Ozturk et al., 2003).

Symbiotic nitrogen fixation takes place with Rhizobium bacteria, which co-live in the roots of leguminous plants. The amount of nitrogen fixed by Rhizobium bacteria depends on host plant, soil moisture, organic matter and nitrogen content, pH, P and K availability. For legumes to fix nitrogen, bacteria of that species must be present in the soil, otherwise the bacteria must be inoculated into the seed or field. Kantar et al. (2003) found that inoculation with Rhizobium increased the grain yield of chickpea by 17-23%. In addition, it has been determined that double and triple mixtures of phosphorus solvent and nitrogen fixing bacteria in wheat and barley increase both grain yield and quality and efficiency parameters, especially nitrogen uptake and use (Bulut, 2013a; Bulut, 2013b).

In organic farming, ground crude phosphate is the main form of phosphorus fertilizer. Its low solubility and low rate of release limit the plants' ability to meet their needs from this source. However, mycorrhiza and phosphorus-dissolving bacteria increase the use of phosphorus from crude phosphate. During the active plant development period, fungal species that live in symbiosis with the plant in the cortex tissue of the roots and are called mycorrhiza provide the plant to be better fed with nutrients such as nitrogen, potassium, iron, especially phosphorus, zinc and copper, while the plant also meets the carbon requirement of the fungus (Soyergin, 2003).

Crop Rotation

The main purpose of the crop rotation is to protect the crops from diseases, pests and weeds and to ensure the continuity of soil fertility. With a well-planned crop rotation in the production of organic field crops, control of diseases, pests and weeds becomes easier, the organic matter and nitrogen content of the soil increases, erosion decreases, the utilization of nutrients in the soil becomes more balanced, the risks that may arise in the crop production are reduced and the workforce is better utilized. In a crop rotation system for these purposes; a legume forage crop provides nitrogen to the soil and a grass cover crop increases the humus content of the soil, and a row crop eases the weed control (Aslan et al. 2013). Although the application of crop rotation may not solve all of the problems in organic agriculture, it plays an important role in maintaining soil fertility. While creating crop rotation systems in organic farming, the following points should be considered (Algan and Duman, 1998):

• Plants with high nitrogen consumption (sugar beet, potato, cotton, corn, rapeseed) and plants with nitrogen storage properties (clover, vetch, broad bean, pea),
• Deep rooted plants (clover, sugar beet, cotton) and shallow rooted plants (barley, onion),
• Plants with high water consumption (clover, corn, rice, cotton, sugar beet) and plants with less water consumption (barley, wheat, onions, peas),
• Plants with slow growth (cotton, onion, tomato) and plants with fast growth (corn, soybean, sorghum, vetch),
• Plants with high residues (forage legumes, cereals) and plants with low residues (potatoes, sugar beets, onions) should be grown one after the other.
• Deep rooted and more robust varieties should be preferred, and deep root formation should be stimulated with early planting.
• In the period between the two main crops, short season crop cultivation should be done and attention should be given for green manure plants.

Plant Protection

Since chemical pesticides are prohibited in organic farming, biological control, biotechnical methods and integrated control techniques that deal with all these control methods as a whole are recommended. Integrated control can be defined as "a pest management system that uses all appropriate control methods and techniques in harmony, taking into account the population dynamics and environmental relations of the pest species, and keeps the populations of pests below the economic damage level". It is reported that a good crop rotation combined with an appropriate fertilization management in organic field crop cultivation is successful in controlling diseases and pests (Özçelik, 2003). In the control of diseases and pests, attention is given to the following (Anonymous, 2006; Taşbaşlı et al., 2003);

• Selection of disease-resistant species and cultivars,
• Cultural practices and rotation program,
• Appropriate tillage methods,
• Cultural, biological and biotechnical control methods,
• Weed control by hand or hoeing method,

• Integrated methods of pests and disease

In organic field crops farming, weeds can be controlled by cultural measures, mechanical control, use of resistant varieties, allelopathy, biological control methods, use of cover crops and mixed cultivation techniques. Success depends on the appropriate method to be determined according to the production area and the field crop to be grown, or the integration of more than one method (Aksoy, 2003).

Cultural measures are to use clean seeds, to ensure that the agricultural tools and machinaries to be used are clean, to use mature farm manure, to prevent weed seeds from being carried to the field with irrigation water, to grow varieties with high competitiveness, to include row crops in rotation, to prepare a good seed bed and to plant at the appropriate planting time. It can be destroyed by tools, pulled by hand, frequently cut and left under water. The use of sunflower, chickpea and broad bean varieties resistant to parasitic broomrape had higher yields (Aksoy, 2003). Some plant species can produce chemicals with a phytotoxic effect that inhibit the growth of other species (allelopathy). It has been determined that cherry radish, which is planted before cotton and then mixed into the soil, prevents the emergence of Johnson grass, an important weed of cotton. By using some insects, parasitic plants, bacteria and fungi, undesirable plants can be biologically controled in culture areas (Aksoy, 2003).

Irrigation, Harvest and Storage

According to the current regulation, industrial and city wastewater and drainage water obtained from the drainage system cannot be used in organic production. The irrigation water used should not cause environmental pollution and irrigation should not cause deterioration and erosion in the soil structure. A water plan is prepared according to the amount of water that the plant will consume during the vegetation period. A water level measuring device is placed on the land, and irrigation water is measured and used according to the plan. A drainage system should be established in soils with poor drainage, low permeability, heavy clay and loamy soils. Irrigation cannot be done with the drainage water obtained from the drainage system. If there is a suspicion of pollution in the water resources to be used in organic agriculture, necessary tests and analyzes should be carried out. The irrigation method recommended in organic agriculture is generally pressurized irrigation (drip or mini sprinklers). It is recommended to use mulches to control weeds. Water pads are a combination of drip irrigation and mulching technique, and it is an irrigation method that can be used successfully for irrigation of all row crops in organic farming. The method is an easy-to-apply method with high irrigation efficiency, weed and erosion control, no surface flow and deep infiltration losses (Real, 2009).

It is essential that the techniques and tools used in the harvesting of organic products must not create any ecological problem and pollution. In the manual harvests, necessary hygiene measures must be taken by pickers and collected materials. In machine harvesting, the harvester is cleaned of all residues, and the parts that will come into contact with the product are washed if possible. Organic containers are used in the harvest of organic crops (Anonymous, 2010; Taşbaşlı et al., 2003). In addition, it is recommended that the harvest moisture of the grain should be 13-14% to prevent cracking and shrinking the seed.

Moldy and shriveled grains must be removed before the field crops are put into storage. Grains should be placed in clean containers in clean storage to ensure uniform grain temperature (Anonymous, 2010; Bulut, 2011b).

Conclusion and Future Trends

Today, environmental factors and unhealthy food consumption are factors for cancer increase and the emergence of problems that adversely affect human health, especially for infant development. In order to develop organic agriculture in Turkey, implementation of support policies, research-development and extension studies for the initiation and dissemination of organic farming in the places where ecologically more suitable for organic farming, the transition period may be shorter and easier. It is great important that organic crop farming can contribute to rural development socially and economically. Turkey has suitable organic faming conditions since it has suitable climate, soil, water resources, product diversity and high work force and population in agriculture. In terms of organic farming, it is predicted that employment will increase with organic agriculture and contribute to rural development. Due to the prohibition of synthetic pesticides in the pest control method in organic farming, almost all of the biological and mechanical applications are cultural. The widespread use and necessity of cultural measures, biological control and mechanical control practices in organic agriculture is an important indicator of the contribution to sustainable agriculture. Within the framework of Turkey's EU membership perspective, the main objectives are to improve income distribution, fight poverty, activate regional development dynamics and increase the contribution of agriculture.

In this respect, care must be taken to suspende organic crop production materials, increase the investment potential to be made, and create opportunities that provide information flow for the organic producers. Despite the increasing export of organic farm products of Turkey, its share in the world organic production and food market is very low. The organic products and produced foods, especially in North American and European countries, cannot meet the increased demand. Therefore, these markets potential offer a good opportunity for developing countries such as Turkey whose ecology and infrastructures are suitable for organic farming and organic product export. Increasing and diversifying organic production is one of the issues that should be emphasized. For accepting the organic

farming in Turkey, issues such as market guarantee, purchase support, input subsidy, income support, credit facilities and premium price application should be given. Supporting domestic market companies, increase consumer education and awareness, lowering the prices of organic products and establishing new organic markets will contribute to the expension of the organic markets.

As a result, organic agriculture is a great opportunity for Turkey to become an organic farming base in the future. Informing consumers on every issue and creating consumer awareness are of great importance for development of organic farming. Currently all legislation and legal regulations for organic farming in Turkey are in line with the European Union. By using this legal support, Turkey's goal in the short term should be the development and expansion of the domestic organic market. For the adoption and dissemination of organic agriculture, organic agriculture should be encouraged through pilot projects in the areas whose ecology is suitable for organic farming, through relevant public and private institutions.

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