

Review

Olive growing and importance of plant nutrition in olive cultivarsCansu Dölek Gencer^{1*}, Volkan Okatan², Nazan Korkmaz³¹ Cukurova University, Kozan Vocational High School, Kozan, Adana/Turkey² Usak University, Faculty of Agriculture and Natural Sciences, Department of Horticulture, Uşak, Turkey³ Mugla Sitki Kocman University, Ortaca Vocational School, Ortaca, Muğla-Turkey**ABSTRACT**

Olive has spread naturally in regions where have Mediterranean climate in both hemispheres. Olive, which has a great importance in the world and in our country, is a fruit species need to be studied. Olive, which is consumed as both fresh and olive oil, has a large importance in gastronomy and health sector. When quality and yield in olive are considered, the suitable conditions for the plant should be provided by paying attention to the breeding conditions. In this research, the general rules of olive growing are mentioned and importance of plant nutrition is emphasized, and the heights and temperature values that it can grow, soil cultivation, the improvement of the soil properties, the effects of nutrients on plant, nutrient uptake theories have been investigated. The aim of this study is to determine the functions of some plant nutrients and the nutrient intake of plants from soil. Since the olive is both immortal thanks to its tubers under the soil and is able to adapt to all conditions, it is a significant fruit species economically, but in order to increase yield and quality, plant nutrition should be given importance. This study will reveal the importance of plant nutrition and fertilization in olive and will lead the studies, which will be carried out concerning this issue in future.

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cansudolek.90@gmail.com

1. Introduction

In Turkey, olive can be grown at altitudes between 800-1000 meters, but in lower height especially below 400 meters is more yielding. However, in Spain it can be grown in regions where have altitudes 250-1200 meters. While some olive varieties in the Atlas Mountains in North Africa can live up to 1600-1700 meters, they can be found in 2000 meters in Argentina in the Southern Hemisphere (Ünsal, 2008). The places where is between 45 °C the north and 30 °C the south latitude, have 16-22 °C average annual temperature, is above -8 °C the lowest temperature in winter, is resistant hot wind and have clay or calcareous soils, are the most optimal regions for olive breeding. Olive is a fruit species that is resistant to high temperatures, even drought and low soil moisture. Olive trees do not like excess wind, especially during flowering, fruit ripening and full oiling. The high humidity leads to disease and fruit disorders (pilling) on the tree (Ünsal, 2008).

Olive likes water, but is also resistant to drought. The olive can be grown in the Marmara region with an average annual precipitation of 900 mm and in the Black Sea region, which has a higher rainfall rate as well as in the Şanlıurfa region, which has a very low rainfall average. When annual rainfall in olive falls below 750 mm, the irrigation is required, otherwise the economic value of the product decreases (Ünsal, 2008). The olive tree, which is long-living, is resistant and can be propagated easily, was called as vivax oliva (long- living) by the ancient Romans.



Figure 1. Regular and beaded growth in olive fruits (Cansu Dölek Gencer, unpublished thesis)

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In the olive, the major root, which form constantly new roots, nourishes the stem and branches. Even if the trunk of

ORCIDCansu Dölek Gencer: <https://orcid.org/0000-0001-7628-0676>Volkan Okatan: <https://orcid.org/0000-0001-5787-7573>Nazan Korkmaz: <https://orcid.org/0000-0001-7756-3512>

the tree dries, the trunk revives with shoots sprouting from its tubers and roots and emerges as a new tree. The olive that is evergreen and long-living and have hard wood is the most proper plant species against erosion (Ünsal, 2008). If the soil cultivation is done with an appropriate technique, the biological activities of the soil increase. As a result the raw nutrients in soil mature, the maintaining of rainwater in the soil get easier and development of roots is better because of the soil aeration. The soil cultivation in the olive groves, the firstly is applied at a depth of 15 cm at the times when the soil gets annealed immediately after the harvest while the secondly is applied a depth of 10-12 cm 10 days before the tree blossoms in spring (Bülbül, 2008).

The most significant of organic fertilizers is farm manure. It is called a mixture, which forms from the stools and residues of the stables animals. It contains many nutrients. It should be mixed with some super phosphate fertilizer when the farm manure is stocked. In January-February, 50-200 kg farm manure is given per tree (depending on tree size) and mixed to the soil with soil cultivation. It regulates the physical, chemical and biological properties of soil. When the manure is given to the soil, the water holding capacity of the soil increases and the permeability is positively affected (Bülbül, 2008). The capacity of the plant to produce flowers of sufficient quantity and quality is significant in obtaining the product (Cuevas and Polito, 2004). Macro and micro nutrients play a significant role in the fruiting process. In this context, the importance of potassium in the development of grass pipe in female flower is emphasized (Holdaway-Clarke and Hepler, 2003). Potassium is a significant element in flowering and fruit formation. Foliar application of KNO_3 has a positive effect on yield in olive. On the other hand boron is considered to be one of the significant micronutrients due to its effect on plant growth (Khayyat et al., 2007). In fact, the effects of boron application on the germination of farina and germination have been demonstrated. Leaf boron applications in olive cultivation are widely used because of its efficiency on phenology, yield, oil quality, shoot growth, crown volume, fruit attitude and hence efficiency (Larbi et al., 2011; El Khawaga, 2003). Product losses occur due to lack of nutrients in aquaculture in sandy soils. In the studies carried out in the leaves of olive trees, nitrogen, potassium, phosphorus and boron deficiency were determined (El Khawaga, 2007; Desoukaye et al., 2009; Acarsoy et al., 2011).

Plant nutrition in olive cultivars

In fruit trees and woody plants, there is a significant accumulation of nitrogen metabolism (uptake, transport, distribution and storage) (Titus and Kang, 1982; Kato, 1986; Roubelakis-Angelakis and Kliewer, 1992). In the preparation of fertilization programs, remobilization of nitrogen (re-transport) is a significant issue to be considered. In this context, in woody plants, nitrogen is remobilized and stored in roots and shoot shells at the end of the season (Titus and Kang, 1982; Irget et al., 2007). When the studies on the nutrition and fertilization of olives are examined in our country; a limited number of fertilization application studies have been seen such as the soil fertilization (Güner, 1969; Özelbaykal, 1995) foliar fertilization (Çetin and

Mendilcioğlu, 1992) and soil + foliar fertilization (Canözer and Çolakoğlu, 1985; Dikmelik et al., 1999). The studies on the subject are generally aimed at examining the relationship between; the determination of nutritional status of olives grown in different regions (Canözer, 1978; Zabunoğlu et al., 1977; Akilloğlu, 1995; Toplu, 2000, Soyergin et al., 2002), the seasonal changes of nutrients (Eryüce, 1980; Püskülcü, 1981; Soyergin, 1993; Sarıfakioğlu, 1995), the product and pruning, the amount of nutrients removed (Dikmelik, 1984), the nutrition status and yield (Fox et al., 1964) and quality (Seferoğlu, 1997; Irget et al., 2007).

The water content of the plant is between 80-95% and the rest is dry matter. The amount of this water varies depending on the species of plant, the amount of water in the growing environment, the temperature and the wind force. Analyzes related to the determination of dry matter content in the plant are carried out in samples obtained by grinding after the fresh plant samples are dried at 65-70 °C for 24-48 hours. The ratio of carbon and oxygen in the total dry matter is very high, and they are followed by hydrogen. The amount of the other elements is lower, and shows significant differences between themselves and from plant to plant (Çokuysal et al., 2016). Green plants uptake a large proportion of carbon and oxygen from the atmosphere with their over-ground organs, and uptake hydrogen and a certain proportion of oxygen from water taken by their roots. In order to all other elements can be taken by the plant, they must be present in the root environment and soluble structure. The uptake and use of nutrients by plants depends on various factors such as light intensity, temperature, the amount of the water (Çokuysal et al., 2016).

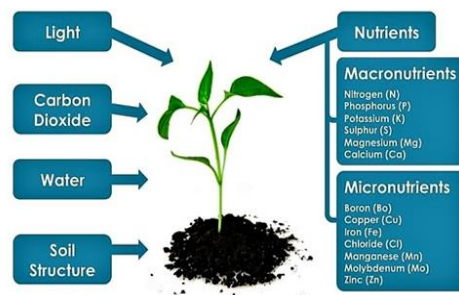


Figure 2. Plant nutrient requirements (Anonymous, 2019a)

Olive trees need more nutrients some periods such as the differentiation of the fruit buds (February-March), the beginning of the flowering (May), fruit set (June) and the hardening of the kernels (July-August). Nitrogen increases the quantity and quality of the crop and decreases the fruit fall. It ensures the formation of the new sprouts of the tree. The olive trees particularly need more nitrogen during flowering and fruit set. This requirement varies by depending on the size of the tree and the structure of the soil. Olive trees spend half of the nitrogen in these periods (flowering and fruit set). For this reason, the nitrogen fertilizer in irrigated fields should be applied three times: at 3 weeks before the flowering, the fruit set and the hardening of the kernels periods, but the in not irrigated fields, it is applied in late February and early March (Bülbül, 2008).

Phosphorus improves the soil by increasing the activity of soil microorganisms. It increases flowering, fruit set and the fat content and the quality of the fruit. It increases the resistance of the tree against cold and frost, and it gives olive's unique color, aroma, taste and smell. However, it increases the resistance of the tree against cold and frost. Increases fat content and quality. Potassium is significant for flower and fruit formation. It ensure the saving of water of olive tree. Phosphorus and potassium fertilizers do not get lost by washing like nitrogenous fertilizers. So they should be applied in February. Plants uptake all the nutrients that they need from the soil in different ways. However, due to some reasons such as excessive chlorosis in the soil, deterioration of microorganism activities they cannot uptake these nutrients from the soil. Zinc (Zn), manganese (Mn), boron (B), iron (Fe), copper (Cu), molybdenum (Mo), chlorine (Cl), Nickel (Ni) are micro nutrients. In the deficiencies of these micro nutrients, the flowering and fertilization problems in the trees, the disorders in the fruit and death backwards in the tree may appear (Bülbül, 2008). In this research, the general rules of olive growing are mentioned and importance of plant nutrition is emphasized, and the heights and temperature values that it can grow, soil cultivation, the improvement of the soil properties, the effects of nutrients on plant, nutrient uptake theories have been investigated.

2. Results

Carbonic acid theory: Carbonic acid (H_2CO_3) is formed by the reaction of CO_2 , which formed by roots and microbial activity, with water. H^+ ions, which are separated from carbonic acid and become free standing, release by replacing cations in colloids and mix to the solution. Cations that mix the soil solution are taken to the root surface by replacing with H^+ ions on the root surface (Figure 3). The cations absorbed from the colloid surfaces must firstly pass into the soil solution. The role of this theory in the transport of plant nutrients to the roots is very low (Kahraman, 2012; Çokuysal et al., 2016).

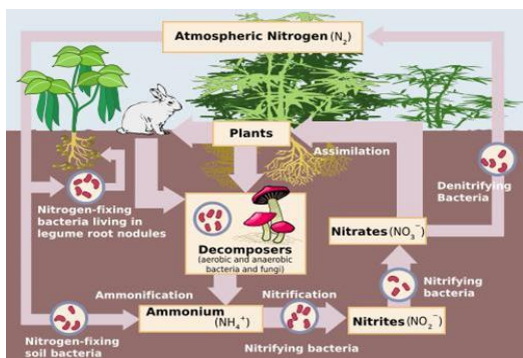


Figure 3. Cycle of nutrients in soil and movement in plants (Anonymous, 2019b)

Contact Exchange Theory: This theory suggests that absorbed nutrients are taken directly through the roots as a result of contact with the root surface of them (Figure 4). In this theory, there is no need for the presence of CO_2 and ions do not need to pass into soil solution. Plant nutrients are transported from soil solution to the root zone by mass flow

and diffusion. Mass flow: the nutrients, which is dissolved in soils, is to carry-over to roots by convective flow of water (Eryüce, 2013). As the water absorption of the roots increases, the mass flow increases. The fastest mass flow occurs immediately after precipitation and irrigation, while the slowest mass flow occurs at the time of evaporation (Barber, 1974).

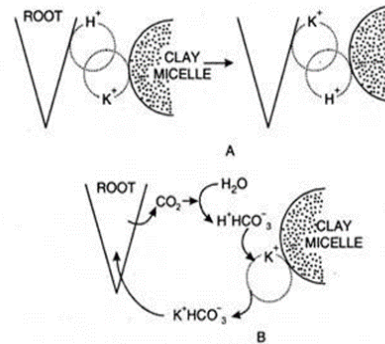


Figure 4. According to the theory of carbonic uptake of ions (Anonymous, 2019c)

Diffusion; When a nutrient is absorbed at high level in the root zone, the concentration of the nutrient in the around the root decreases and concentration difference occurs with to the external zone. As a result, the nutrient is transported from farther zone to the root zone by diffusion. It is stated that a large proportion of nutrients such as N, Ca, Mg and S, which have high solubility, are transported to the root zone by mass flow, while a small portion of P and K required by the plant is uptake with the mass flow (Barber, 1995; Çokuysal et al., 2016).

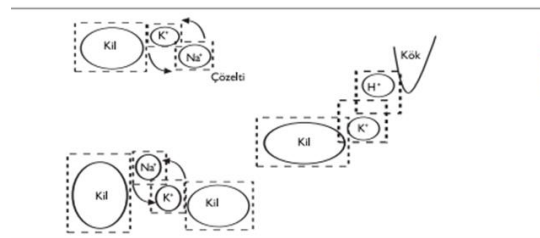


Figure 5. Displacement of ions according to the theory of interchange (Eryüce 2013)

High productivity in cultivation ranks first among production targets. Pollination is essential for fruit formation in stone fruit species. The capacity of the plant to produce sufficient quantity and quality of pollen is significant in obtaining the product. The quality of pollen is characterized by the vigor of the pollen and the germination power (Cuevas and Polito, 2004). As indicated by Wang et al. (2004), the physiology (especially germination and viability) of the pollen, is significant for plant breeding and adaptation (Khan and Perveen, 2006; Pinillos and Cuevas, 2008; Acarsoy et al., 2011). Due to the lack of the nutrient in sandy soils, the problem of the pollination in olive occur, and this results in product losses (Desoukaye et al., 2009; El Khawaga, 2007). In this context, 5, 50 and 100 ppm boric acid (33.5% B) applications in 12 years- old Arbequina, Bouteillan and

Koroneiki olives are stated to increase fruit set (Desoukaye et al., 2009; Acarsoy et al., 2011).

Özkaya (2004), has reported that in the leaves of olive trees determined the deficiency of the nitrogen, potassium, phosphorus and boron. However, applications to young leaves significantly increase the risk of damaging the tissue before flowering. A effective method for foliar fertilization of olives has not been found. With multi-mineral leaf fertilizers prepared with olives at concentrations specific to N, P, K and / or B [(10-33-21+1.8B) and (8-16-40)] containing a completely organic fertilizer called Fertivant, positive effects have been obtained to increase fruit quality and yield especially in table olives. As a result of this work; it was recommended that before flowering, especially potassium, phosphorus and boron are applied, in the small fruit period potassium is applied

Mordoğan et al. (2013), have examined the effect of 0, 75, 150 and 225 kg/tree doses of organic fertilizer (bovine fertilizer) on the nutrient content of olive soils. They have noticed that these applications have significantly affected the content of N, K, Ca, Mg, Cu, Na at 0-20 cm depth; P, K, Ca, Mn, Cu, Na at 20-40 cm depth. The applications have not affected the Fe and Zn content of soils. 225 kg / tree dose of organic fertilizer has significantly increased the K and Mg content of soils. With the application of organic fertilizers, only Fe and Na contents of the soil showed significant changes over the years. It has been shown that Magnesium and zinc are effective in reducing the periodicity. Fertility and fertilization are negatively affected by zinc deficiency in trees, and zinc deficiency decreases the yield and fruit quality.

Zinc sulphate application of 0.3%-0.5% of the leaves to remove zinc deficiency is recommended in the period when the flowers occur and the fruit get hazelnut size (Gezerel, 1998; Kalenderoğlu, 2010). Jasrotia et al. (1999), have studied the effect of N and K fertilization in olive trees. Frantoio variety was used in this research. Four different N applications (250, 500, 750 and 1000 g per tree) were done, K application was applied as 250, 500 and 750 g K₂O together with 500 g P₂O₅ per tree which is the basic dose of P₂O₅. Fruit set, yield and fat content at N level of 750 g applied per tree were high. The highest yield was recorded from 500 g K₂O per tree application. Researchers have also observed that increased N levels result in a significant increasing in growth and yield. Thus, in order to achieve higher fruit set, yield and fat content in olive trees, 750 g N and 500 g K₂O application per tree were found to be optimal (Kalenderoğlu, 2010).

4. Conclusion

Topography, climate and soil properties and plant nutrition are very significant when plant cultivation is planning. The plant cultivation can never be considered without fertilization. Plants get all the nutrients that they need from the soil in various ways. Fertilization is to improve the physical, chemical and biological properties of soils and is to reinforce the nutrients that the plant cannot take due to certain conditions. Soil cultivation and organic fertilization support synthetic fertilizers. At the same time, it provides more balanced growth, durability, high yield and quality in trees. The aim of this study is to determine the functions of

some plant nutrients and the nutrient intake of plants from soil. Since the olive is both immortal thanks to its tubers under the soil and is able to adapt to all conditions, it is a significant fruit species economically, but in order to increase yield and quality, plant nutrition should be given importance. This study will reveal the importance of plant nutrition and fertilization in olive and will lead the studies, which will be carried out concerning this issue in future.

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