THE ROLE OF NUTRIENTS AND FERTILIZATION OF OLIVE AND POTATO CROPS IN THE REGION OF MESSINIA, GREECE

Panagiotis KOTTARIDIS, Isidora RADULOV
Banat University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" from Timișoara
Corresponding author: isidora_radulov@usab-tm.ro

Abstract. *Two of the main crops in Greece and the Greek archipelago are olive trees and potatoes. Due to the planting of new high-density farms, the area with olive groves in Greece has increased constantly during the last quarter of the century. The productivity of olive trees depends on the supply of N, K and Ca in particular, but also on the level of supply with P, Mg and trace elements. The potato falls into the group of plants with high requirements for nutrients, due to its high productivity and poorly developed high root system, compared to other crops, with a lower solubilizing power of soil chemicals. This study presents the role of the main nutrients in the nutrition of potatoes and olives, with reference to the varieties grown in the area of Messinia, Greece. From the point of view of the quantity and quality of the harvest, not only the quantity of nutrients is important, but also their ratio. Potatoes and olives were grown in the Messina region of Greece. Messinia borders on Elis to the north, Arcadia to the northeast, and Laconia to the southeast. The Ionian Sea lies to the west, and the Gulf of Messinia to the south.*

Key words: *olive, potato, fertilization, nutrients.*

INTRODUCTION

The olive tree is belonging to the Oleaceean family, native to Syria and the coastal areas of Turkey, widespread in mainland Greece and the Greek archipelago. Olives prefer warm and sunny weather, without shade, while temperatures below −10 ° C can even cause the death of a mature tree. They have a good tolerance to soil dryness, due to their extensive and resistant roots. The olive tree prefers medium mixture (35-50% of sand, 25-45% of silt, 20-25% of clay), frank-clay, frank-loamy and frank-silt-clay soils; with well drained cultivation layer and a pH between 6.8 and 7.5. (https://olive4climate.eu/wp-content/uploads/Olive4Climate-Handbook-_ENG_AUGUST.pdf). Due to the planting of new high-density farms, the area with olive groves in Greece has increased constantly during the last quarter of the century (BERG ET ALL, 2018). The productivity of olive trees depends on the supply of N, K and Ca in particular, but also on the level of supply with P, Mg and trace elements (MANOLIKAKI ET ALL., 2022). STATERAS AND MOUSTAKAS (2018) show that air temperature and humidity significantly influence the absorption and mobility of nutrients in olive trees. The most important factor in the availability of nutrients for olive trees is the soil moisture, the amount of water being low in the summer months (CHATZISTATHIS ET ALL., 2010). In Greece, fertilization with mineral fertilizers is done in winter or early spring, so as to benefit from the supply of rainwater to transport nutrients to the roots. The potato (*Solanum tuberosum*) is an annual herbaceous plant that grows up to 100 cm (40 inches) tall and produces tubers that are botanically thickened, stems that are so rich in starch that it ranks fourth. The most important food crop in the world, after corn, wheat and rice. The potato thrives in deep, fertile, medium to light soils with good drainage and good aeration. Sandy to silty-loamy soils with abundant organic matter are considered excellent for high yields and quality production. Poor sandy soils that do not retain sufficient moisture are ideal for early varieties but require increased fertilization and irrigation. In terms of acidity, the crop grows without particular problems in a pH range of 4.5 - 7.5 with an ideal range between 5.5-6. [Https://garden.org/learn/articles/view/564 / Potato-Rotations-and-pH /]. It is important to identify the optimal level of potato fertilization in order to obtain both a high and quality harvest, but at the same

time to ensure the minimization of costs (PETROPOULOS ET ALL., 2020). Potato fertilization aims to provide the necessary nutrients for the development of a strong and rich root system and to create satisfactory and early germination, which will promote tuberisation. It is crucial that the amounts of Phosphorus and Potassium provided in the basic fertilization cover at least 2/3 of the total requirements, as the crop, in order to give high yields, must have these elements available early on. On the other hand, the use of N in the basic fertilization should not exceed 30-40% of the total crop requirements. Taking into consideration the information referred above, the aim of this study is to present the role of the main nutrients in the nutrition of potatoes and olives, with reference to the varieties grown in the area of Messinia, Greece.

DISCUSSIONS

In order to prepare an efficient, sustainable fertilization program, without providing unnecessary nutrients to the olive grove, first macroscopic observation of the trees, leaflets, cognitive examination and soil sample analysis are needed. [Paul Vossen, Fertilizing olive trees – UCCE Sonoma Country]. In a study made in 2019, FERNÁNDEZ-ESCOBAR shows that nutrient deficiencies can occur when olive orchards are established on unfertile soils with low availability of a specific nutrient, or when a specific nutrient is blocked due to the physical or chemical characteristics of the soil. Although the olive tree has relatively modest mineral nutritional requirements, it will respond to fertilizers with healthy vegetative growth and abundant yield. Therefore, it is important to closely and continuously monitor the mineral condition of the olive, in order to avoid periods of malnutrition, which would jeopardize the efforts of the whole year. Moreover, as mentioned above, it is important to maintain a balanced mineral nutrition regime, with special attention to the correct amounts of nitrogen and potassium, in order to reduce the amplitude of the alternative fruit (GARGOURI ET ALL, 2002). The nutrient requirement of the olive grove can be estimated based on soil analysis, foliar diagnostics, and calculation of nutrient removal and/or visual examination of plants (CENTENO ET ALL, 2011). Visual examination of olive trees to identify symptoms of deficiencies or excesses on leaves, shoots and drupes is another useful method of assessing the nutritional status of plants and determining the need for fertilization. It should be noted that visual examination can sometimes cause misinterpretations, as similar symptoms may occur with deficiencies of different elements and also as a result of non-nutritional stress (RODRIGUES ET ALL., 2011).

Table 1

Role of nutritive elements in olive trees

Nutritive element	Role of nutritive element in olive trees	Deficiency	Excess
N	stimulates the growth of shoots, branches, trunk and roots essential for good cell division, growth and respiration.	causes a limited growth; leaves remain small, with a pale green; color on the whole tree; flower buds is limited; fruits fall or have small size	abundant vegetative growth; poor flowering; reduction of potassium uptake
P	stimulates the formation of the flowers, the ripening of the fruits, the growth of the shoots, development of the root system and the lignifications of the tissues	small leaves with dark green color tending to purple;	reduced absorption of potassium, calcium, iron an boron
K	stimulates the formation of flowers and oil synthesis; determine accumulation of reserves in the tree, the lignification of	appearance of necrotic spots in the terminal part and in the edges of leaves that	Reduce uptake of magnesium and boron

	tissues; resistance to frosts, droughts and parasites	progress towards the internerval areas	
Mg	stimulates photosynthesis, carbohydrate metabolism	leaf chlorosis that starts from the top or edges of the leaf and gradually spreads over the entire area of the leaves.	Reduce absorption of potassium
S	essential for protein formation, chlorophyll formation and ATP-sulfurylase activity	leaf chlorosis	
Ca	important for the development and functioning of the root, a component of the cell walls and is necessary for the flexibility of chromosomes and cell division	chlorosis from the tips of the leaves, as in the case of boron deficiency, but in this case the veins in the chlorotic zone of the older leaves turn white	Reduce absorption of iron, magnesium and boron
B	stimulates flower induction in flower buds and reduction of summer fruit fall	reduce flowering, setting, production and oil synthesis	-
Fe	stimulates photosynthetic activity	apical leaves are small, with apical chlorosis, deformations (crumple of the apex) and early abscission	-

The potato falls into the group of plants with high requirements for nutrients, due to its high productivity and poorly developed high root system, compared to other crops, with a lower solubilizing power of soil chemicals. Given these biological features of the plains, potato fertilization will be directed in such a way that climate and soil differentiations favor the absorption of nutrients in the rhythm and the need for nutrients in phases of vegetation for a continuous accumulation.

The consumption of nutrients for a ton of tubers plus the other organs of the plant is variable depending on the cultivated soil, the type of soil, climate, etc. The specific consumption per ton is between 5.6 - 5.9 kg N, 1.6 - 1.8 kg P2O5, 7.2 - 7.5 kg K2O, 3.1 - 3.2 CaO, 1.6 - 1.8 kg Mg.

The potato is a large consumer of nitrogen and potassium, these being considered by most agrochemists the main fertilizing elements with a decisive role in the formation and accumulation of production (GOFFART ET ALL., 2008). The rate of nutrient absorption takes place in parallel with the growth rate of plants, being maximum after flowering. Until flowering, one third of the necessary nitrogen and potassium and a little more phosphorus are absorbed, most of the fertilizers, being capitalized in the flowering-maturation phenophase (ANDRE ET ALL., 2019).

Early potatoes have a faster rate of absorption and soluble fertilizers, accessible to earlier plants, must be applied to this production destination. Semi-late and late varieties use harder soluble fertilizers, even manure.

From germination to the beginning of tuber formation the main goal is the formation of a rich and robust root system, which will provide the plant with nutrients and water and will meet the high nutritional requirements of the tubers in the later stages of cultivation (KOCH ET ALL. 2019). The aim is to develop as early as possible a rich area of leaves, to allow the production of abundant nutrients, which will migrate to stolons in order to form tubers.

From the beginning of tuber growth to their final size potatoes exhibit their highest requirements in nutrients and water than at any other stage (OLIVEIRA ET ALL., 2021)

Table 2

Role of nutritive elements in potato

Nutritive element	Role of nutritive element in olive trees	Deficiency	Excess
N	determines the development of foliage, tuber growth and total harvest contributes decisively to the formation of a large leaf area and a more active root system. Contributes to protein synthesis, stimulates the growth of meristematic tissues, favoring the branching of stems	reduced, discolored foliage, with erect, rigid leaves, determines the slowdown of growth and low yields.	-causes lush growth of vines to the detriment of production; -sensitizes plants to manna and prolongs the growing season, -negatively influences the percentage and size of starch grains, -when nitrogen overdoses are associated with lower temperatures in the tubers accumulates chlorogenic acid that gives the tubers an unpleasant taste, blackening the core when boiling and decreases the resistance to storage.
P	-stimulates the development of the root system and the number of tubers per nest; -influences the increase of the starch content and the size of the grains, -prints boiling resistance and promotes the formation of a thicker periderm, which gives the tubers a higher resistance to damage	-poor plant development, -wrinkling and darkening of foliage color	
K	-development of the foliar system; -increase the production and quality of tubers; -accelerates the accumulation of starch in tubers and has a significant contribution to protein synthesis; -increases resistance to mechanical damage and storage.	-dark green color of the leaflets with brownish-brown shades that in a more advanced stage become necrotic; -blackening of the core under the shell, with a blue-gray coloration	
Mg	- improve the photosynthetic capacity of the leaves; - increase the production of carbohydrates,	the mature leaves become necrotic and the edges remain green	
Ca	-formation of the tubers, protects them from natural problems, -promotes the healthy development of the skin.	wrinkling of the leaves and yellowing of the leaflets.	

STUDY CASE

Potatoes and olives were grown in the Messina region of Greece. Messinia borders on Elis to the north, Arcadia to the northeast, and Laconia to the southeast. The Ionian Sea lies to the west, and the Gulf of Messinia to the south. The most important mountain ranges are the Taygetus in the east, the Kyparissia mountains in the northwest and the Lykodimo in the southwest. The main rivers are the Neda in the north and the Pamisos in central Messinia. Off the south coast of the southwesternmost point of Messinia lie the Messinian Oinousses islands. The largest of these are Sapientza, Schiza and

Venetiko. The small island Sphacteria closes off the bay of Pylos. All these islands are virtually uninhabited.

The climate of Messinia is temperate, with mild winters and hot summers and annual temperature range between 13 ° C and 19 ° C. The lowlands and coastal regions in winter, due to hot and humid south winds, maintain temperatures between 17 ° C and 21 ° C, while areas not affected by the sea have temperatures below 16 ° C. The summer in coastal areas is cool due to the sea breeze, with the highest temperatures appearing in the upper Messinian plain. Snow is rare and confined only to the high peaks of Taygetos, with low winds and is usually north-northwest inland and south-southwest in coastal areas

Potato and olive variety

The variety of potatoes grown was *Spunta*. Early maincrop ware variety with good heat tolerance, good virus resistance and producing high yields. It is a traditional variety within the region with large tubers, uniform tuber size and high dry matter content.

The variety of olives grown was *Kalamon*. The Kalamon olive is one of the most cultivated olive varieties in Greece and other parts of the Mediterranean. In recent times it is also cultivated in other places, such as South America. It is excellent as an edible (table) but also for olive oil production. Olives of the Kalamon variety produced in the Prefecture of Messinia can be sold with the Protected Designation of Origin (PDO) "Kalamata". The olive oil produced in the same prefecture can bear the same name. Area occupied by the Kalamon table olive is only 3,400 acres with 165,000 olive trees and an average production of 3,000 to 3,500 tons. It is 3% of the total production.

Potatoes thrive in deep and fertile soils of medium and fine texture, with adequate drainage and ventilation. Sandy loam to slit loam soils with an abundance of organic matter are considered ideal for high yields and quality produce. Ideal range of pH being between 5.5 – 6

Fertilization of potato and olive trees

Potatoes: Every two years 150-200 kg manure per acres was applied because the soil type is sandy. The soil on which the potato was grown has a neutral pH. When preparing the land for growing potatoes was applied 20-30kg granular sulfur per acres. To reduce the pH value from neutral to weak acid, in the second month after cultivation were applied 10kg ammonium sulfat per acres. 20 to 30 days before harvest were applied 10 kg 20-20-20 complex fertilizer per acres.

Olives: In February 2 kg/tree 11-15-15 or 15-15-15 complex fertilizer was applied. In order to promotes the vegetation necessary for the formation of reproductive organs and the growth of fruit in May/June 500 gr N /tree was applied. In August 500 gr K /per tree was applied in order to increases the size and weight of the fruits and oil content of the fruit Improves the oil quality. Potassium also increases tree resistance to drought, frost and pest infestations and diseases.

CONCLUSIONS

The nutrient requirements of the potato differ depending on the stage of development of the crop. Potassium is the most widely used element in the potato. Nutrient staggering must be planned precisely to ensure the availability of nutrients during critical periods in terms of plant development. From the point of view of the quantity and quality of the harvest, not only the quantity of nutrients is important, but also their ratio. When applying, it is recommended to observe the ratio of 1/2 of N / K.

Olive tree's nutritional status, which were determined through soil and leaf analyzes. Nitrogen and potassium are the two most important elements for the olive tree nutrition and which can affect both its productivity and its quality.

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