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Different forms of soil potassium as affected by the age of pistachio (*Pistacia vera* L.) trees in Rafsanjan, Iran

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ABSTRACT

Pistachio is a major crop that accounts for a considerable portion of Iranian agricultural exports. Despite the importance of potassium in pistachio production, no information is currently available on the changes of different forms of K in soil with pistachio tree age. The objective of the present study is to evaluate the status of different forms of soil K in pistachio orchards with trees of different ages. Pistachio orchards of three different ages of 10, 20, and 40 years old were selected in three different regions in Rafsanjan area, Iran. A piece of virgin land adjacent to each pistachio orchard was also selected as control. Three soil profiles were excavated in each orchard as well as three from the control virgin plots to sample their genetic horizons. Water soluble, exchangeable, nonexchangeable, and structural K were extracted and determined. Results showed that the amounts of soluble K in the virgin land were higher than those in the pistachio orchards with different tree ages. In soils initially rich in exchangeable K, growth of pistachio trees over 10, 20, or 40 years significantly reduced exchangeable K by 8.4, 46.3 and 43.6%, respectively. For the other two regions where soil exchangeable K was primarily lower, average reduction in exchangeable K was 2 to 20%. The nonexchangeable K fraction was significantly lower in the 10, 20, and 40-year-old pistachio orchards as compared to that in the uncultivated control soil, especially in regions where soil exchangeable K was primarily low. The highest reduction in nonexchangeable K was 50% for the 40-year-old pistachio orchards in the region where exchangeable K was lowest in the soil. Moreover, the reduction in nonexchangeable K was highest in the root zone as compared to the other soil layers. These findings suggest that uptake of potassium by plants, pistachio tree age, and primary status of exchangeable K are important factors affecting K depletion from K bearing minerals in soils under pistachio orchards. This indicates the possible need to apply K fertilizers to old pistachio orchards where exchangeable K might be lower than 200 mg kg^{-1}.

1. Introduction

Pistachio is a major crop in Rafsanjan area and forms one of its main agricultural exports. Rafsanjan area in Kerman Province has been recognized as one of the largest pistachio production sites, not only in Iran but also worldwide. Although N and P fertilizers are commonly used in pistachio growing areas of Iran, K fertilizers have been ignored. It is believed that the soils in Iran contain sufficient K-bearing minerals capable of releasing enough K to meet crop requirements (Jalali and Zarabi, 2006). Limited use of K has been attributed to i) lack of knowledge regarding plant K requirements and lack of documented effects of K on the nut yield and quality in pistachio; and ii) the out-of-date view that soils are not K-deficient but capable of supplying adequate quantities of K for pistachio production (Zeng et al., 1999b).

Pistachio trees have a high K demand and the annual K removal by fruits and leaves approximates nitrogen removal (Rosecrance et al., 1996). Potassium accumulation in annual organs during the nut fill period is five times greater in ON- than in OFF-years (Picchioni et al., 1997). Potassium uptake during the nut fill period is six-fold greater in ON- than in OFF-year trees and over 90% of the total annual K uptake occurs during the same period, with the majority of K accumulating in the fruit (Rosecrance et al., 1996). It has been reported that 70 mg kg^{-1} NH_4OAc-extractable K is probably sufficient for optimum seedling growth of pistachio (Tajabadi Pour et al., 2005). However, the critical level of soil available potassium for mature pistachio trees has been reported to be nearly 250 mg kg^{-1} (Ashworth et al., 1985; Malakouti and Tabatabaei, 2000).

Nonexchangeable K is probably associated mainly with the layer of silicate minerals which is slowly released to replenish the exchangeable form of K and feed the plant during the growing season (Tisdale et al., 1993). Tabatabai and Hanway (1968) stated that plant uptake of nonexchangeable K was a linear function of time of cropping and that was highly correlated with minimal levels of exchangeable K. They reported that on average about 24 times as much K was removed by

Abbreviations: So-K, Water Soluble Potassium; Ex-K, Exchangeable Potassium; Nex-K, Nonexchangeable Potassium; St-K, Structural Potassium.

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