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Effects of soil properties, water quality and management practices on pistachio yield in Rafsanjan region, southeast of Iran

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ABSTRACT

In recent decades, the quantity and quality of irrigation water have been reduced due to a significant increase in pistachio cultivation and uncontrolled exploitation of groundwater resources as well as reduction in rainfall precipitation. Therefore, agricultural producers, researchers and policy makers need to pay more attention to appropriate land management as an important strategy to achieve greater yield per unit area and to use soil and water resources in an optimal way. So, the present study was conducted to model the relationships between pistachio yield and soil, water and management variables in Rafsanjan region, the southeast of Iran. One hundred and ninety nine mature orchards were selected and sampled in such a way that an acceptable range of soil and water quality and management were included. The data set consisted of a dependent variable (pistachio yield) and 67 independent variables including soil, water and management characteristics. The results of hybrid genetic algorithm-artificial neural network (GA-ANN) showed that the lowest error was related to the case in which the 23 features were used in modeling. Then, stepwise multiple linear regression (MLR) and artificial neural network (ANN) techniques were applied to estimate pistachio yield. The results indicated that MLR could explain only 28% of the pistachio yield variation, whereas its accuracy increased when the data became more homogeneous via geographically dividing the study area into four parts with the highest densities of pistachio orchards. ANN-based model had a 90% accuracy to predict pistachio yield in the study area. Thus, an accurate estimation of pistachio yield could be achieved by reducing the data dimensionality using feature selection techniques and modeling with ANN. As the models were highly sensitive to irrigation water features, special attention should be paid to new irrigation methods and management practices as an effective strategy to minimize water losses and increase water use efficiency.

1. Introduction

Pistachio (*Pistacia vera* L.) is one of the most important exportable products in arid and semi-arid areas of Iran. Although pistachio trees are tolerant to drought and salinity, optimum pistachio yield is not necessarily achieved in drought conditions (Hasheminasab and Assad, 2015). In recent decades, due to considerable increase of the areas under pistachio cultivation and uncontrolled exploitation of groundwater resources as well as reduction in atmospheric precipitation, groundwater resources have been depleted, and reduction in the quantity and quality of water has become a major concern of farmers (Bagheri et al., 2012). Therefore, optimum management as an important strategy to achieve acceptable pistachio yield and the efficient use of soil and water resources have been of interest to researchers and orchard owners. To develop management plans (e.g., planting, harvesting, productivity, transportation, etc.), the mathematical modeling has been used as a process for crops yield prediction (Soares et al., 2013). Some researchers have used a simple linear correlation between the crop yield and soil characteristics. The results of such researches were different from farm to farm and from one year to another. In some studies, crop yield was predicted by multiple linear regression (MLR) techniques (e.g., Hosseinifard et al., 2008; Khakural et al., 1999; Kravchenko and Bullock, 2000; Satir and Berberoglu, 2016; Zhou et al., 2017). Non-linear statistical methods have also been used by some researchers (e.g., Adams et al., 1999; Blanc, 2017; Hansen and Indeje, 2004).

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