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Soil suitability analysis and evaluation of pistachio orchard farming, using canonical multivariate analysis

Mohsen Bagheri Bodaghabadi[a,*], Abbas Amini Faskhodi[b], Mohammad Hassan Salehi[c], Seyed Javad Hosseinifard[d], Mojdeh Heydari[d]

[a] Soil and Water Research Istitute, Agricultural Research, Education and Extension Organization (AREEO), Karaj, Iran
[b] University of Isfahan, Dept. of Geographical Sciences and Planning, Iran
[c] Soil Science Department, College of Agriculture, Shahrekord University, Shahrekord, Iran
[d] Pistachio Research Center, Horticultural Sciences Research Institute, Agriculture Research Education and Extension Organization (AREEO), Rafsanjan, Iran

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ABSTRACT

Soil properties and crop yields are strongly interrelated. Identifying the relation can leads to better management of cultivation and land suitability evaluation. Some difficulties related to statistically analyzing the soil properties, especially in relation with the crops and water, arises from the fact of their high variability and inter-correlation, which causes the multicollinearity problems. Adequate choice and use of multivariate statistical methods is appropriate to approach these areas of investigation. This study deals with the relations and inter-dependencies of soil physio-chemical attributes and pistachio *(Pistacia vera* L.*)* yield, as the most important commercial nut crop of Iran and one of the most worldwide. The study area is the pistachio orchard farms of Anar region in Rafsanjan County, Kerman, Iran; and the employed canonical multivariate methods are redundancy analysis (RDA) and discriminant analysis (DA). Six orchards were chosen with the same managerial procedures, pistachio cultivars (*Owhadi*) and tree ages. But, due to the aim of distinguishing influential soil properties, the vegetative growth and pistachio yields were different. Each orchard then was divided to two suitable and unsuitable parts, based on the actually measured yields. In each part, three replicates of soil sampling (in to depths of 0–50 and 50–100 cm) and three trees for eachever were considered in order to determining the pistachio yields. To explore the interrelationships between soil properties, orchard suitable/unsuitable parts and yields and distinguishing misclassified orchards based on the yield parameter and vegetative growth, the canonical multivariate RDA was employed. Results showed a relatively strong correspondence between yield and soil properties. Clay, EC, K and B were negatively related and sand and CaCO3 significantly positive correlated and altogether explained 100% of yield total variation. The multivariate DA then adopted to reclassify the orchard samples into two performance groups based on the variations of soil attributes. Results indicated two influential variables of clay and EC in distinguishing land suitability for pistachio farming, were able to classify 80.5% of orchards correctly (73.7% to suitable orchards and 88.2% to unsuitable ones). Overall, results showed a significant difference between soil properties in suitable and unsuitable areas, as well as a significant relationship between some soil properties and the yield of pistachio. Findings, applicably recommend that site suitability for optimal pistachio cultivation can satisfactorily be evaluated using only few and easy-determining soil properties, throughout canonical discriminant functions of appropriate multivariate analysis.

1. Introduction

The degree to which variation in plant community is predictable from environmental variation has been of considerable interest (e.g. Lychuk et al., 2017; German et al., 2017; Masse et al., 2017; Noto and Shurin, 2017; Baastrup-Spohr et al., 2015; Fortunel et al., 2014; Cleland et al., 2013; Mirkka et al., 2008). Many researchers have investigated

the importance of soil characteristics on plant community (e.g Wernerehl and Givnish, 2015; El-Bana et al., 2002) and crop yield (Viliana, 2015; Muñoz Vallés et al., 2015; Vasu et al., 2016, Whetton, 2017). However, identification of soil attributes most determinant to crop yield is still a matter of debate (Nyiraneza et al., 2009). Studies regarding the relationships between soil properties and crops yield remain very scarce particularly for the crops which mainly grow in arid