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# Evaluation of Soil Application Amendment Effect of Anti-salt Materials (Gypsum, Humic acid fertilizer and antisalt® fertilizer) on the Yield of Pistachio

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**ABSTRACT: In order to evaluation of soil application amendment effect of anti-salt materials (gypsum, humic acid fertilizer and antisalt® fertilizer) on the yield of pistachio, an experiment was carried out on one acre "Akbari" cultivar of pistachio orchard for 2 years by using completely randomized block design with three replications and 7 treatments in Ghatroyeh region near Neyriz city in Fars province. Treatments were: gypsum (1500 and 3000 Kg/h), humic acid (1500 and 3000 Kg/h), antisalt® fertilizer (1500 and 3000 Kg/h) and control (without anti salt compounds). According to sampling from 2 different layers of the soil, data analysis was done in completely randomized block design based on factorial. Factors included anti-salt treatments (in 7 levels) and different layers of the soil (in 2 level of 0-40 cm and 40-80 cm depth of the soil). The treatments implicated in autumn and samplings of soil properties (EC, pH, ESP, SAR and lime percentage) were done 2 years later in September from 2 layers of soil randomize. Pistachio yield in each treatment were also measured simultaneously. Data analysis and mean comparisons were done by using SAS and SPSS software's and Duncan's test, respectively. The results showed that treatments had significant impact ($\alpha$<0.01) on all of the mentioned soil properties and yield of "Akbari" cultivar of pistachio. Furthermore, all of the soil properties between two layers of soil (0-40 cm and 40-80 cm) indicated significant difference. The interaction effect of anti-salt × soil depth was significant only for SAR (Sodium Absorbance Ratio) and ESP (Exchange Sodium Percentage). The positive and significant correlation between all of the soil properties in two layers of soil indicated that closed relations among ESP, EC, PH, SAR and lime percentage and influencing of these properties on each other. Negative and significant correlation between yield with all of the measured soil properties, indicated that negative influence of pistachio yield from this properties. 3.5 fold increases of pistachio yield with using 3000 Kg antisalt® fertilizer compared with control which indicated that the salinity and sodic stress in soil was very high. Also, the obtained result showed the high power of new compound of antisalt® fertilizer on decrease of the destructive impacts of salinity and sodic stress. Other treatments (gypsum and humic acid fertilizer) had not competitive power with it. According to the results of this experiment, 3000 Kg antisalt® fertilizer was recommended as the best and effective treatment on control and decrease of destructive impacts from salty and sodic soils and followed it, improve of yield in pistachio orchards. Also, by comparing the values of negative correlations between soil measured properties in layers of 0-40 cm and 40-80 cm with pistachio yield found that the damaging effects of salt in the topsoil layers is much stronger.**

**Keywords:** Akbari, pistachio, anti-salt, humic acid, gypsum

## INTRODUCTION

The salinity of water and soil is one of factors restricting plant's growth. In regions where precipitation is not enough for evaporation and transpiration of plants, the salt is not leached from the soil thus it accumulates in the soil. About 60% of lands suffer from the salinity of water and soil. Totally, it is estimated that 27 million acers of Iranian lands (above half of cropping lands) are covered by saline-sodic soils.

Therefore, arable lands may be unusable due to extreme accumulation of salts. Pistachio is recommended as the most appropriate product in arid regions of Iran due to its potential properties such as acclimation with unfavorable environmental condition, the salinity of water and soil, relative resistance against drought (Mozafari, 2005). Pistachio, as the last arable crop in most regions of Iran, plays the role of the first agricultural exporting product. Many experimental studies in Iran and the USA showed that pistachio trees can tolerate salt up to 8 dS/m without any disturbance in pistachio's yield. It is a wonder because few plants can tolerate salt with acceptable yield. On the other hand, solubility of trace elements is low and plants growing in such soils lack such elements, but it does not mean that pistachio can tolerate very high salinity, thus, it can produce an acceptable crop. There are many nutritional problems due to saline calcareous soils, improper water for irrigation of pistachio regions leading to reduction of pistachio production in such conditions (Ruiz *et al.*, 1997). The most appropriate range of pH is between 5.5 and 7.5 for most cropping plants. But according to results of reports in most regions of Iran, pH ranges between 8 and 9. Therefore, concerning the increasing number of effective elements in the increasing pH of soil and water as well as calcification of waters in such regions, the risk of non-absorption of nutrients in the soil is available.

One of effective strategies on reduction of soil's salinity and alkalinity is to use different compounds of organic matters as well as some mineral compounds in the soil. Soil's organic matters mostly consist of humic and folic acids known as humous substances, nitrogenic compounds such as decomposed amino acids and aromatic compounds. Organic structure of such matters influences on different properties of soil as well as physiological properties of the plant due to carboxylic and phenolic groups (Schnitzer, 1992). Humic acid is a natural polymeric compound that is resulted from decay of soil's organic matters, peat, and lignin and so on thus it can be used for enhancement of the product and its quality (Nardi *et al*., 2002). There are many reports on the effect of humic acid but such effect can be divided into two classes: direct effect is considered as a hormonic-like compound (Nardi *et al*., 2002; Zheng *et al*., 2004) and indirect effect is considered as the increasing absorption of nutrients via chelation & reclamation, protection of membrane permeability (Chen & Aviad, 1990; Sanchez-Sanchez *et al*., 2002), the increasing metabolism of soil microorganisms, improvement of physical property of soil and the increasing growth of root and stem (Atiyeh *et al*., 2002). All positive effects related to humic acid and other anti-salt and alkaline compounds on plants' growth and yield are due to positive effects of such compounds on many physical and chemical properties of the soil such as EC, pH, SAR and ESP leading to improved availability of nutrients in plants as well as the increase of water accessibility to interfaces of phenolic and carboxylic groups of such compounds (Khaled & Fawy, 2011; Hafez and Magda, 2003). Humic acid increases the absorption of nitrogen, potassium, calcium, magnesium, phosphor and iron in the plant (Rahi *et al.*, 2012). Many researchers studied the effect of humic acid on the growth of different plants (O'Donnell, 1973; Vaughan, 1974; Lee & Bartlett, 1976; Rauthan & Schnitzer, 1981; Tattini *et al.*, 1991; and Reynolds *et al*., 1995). Some of researchers believe that there are humic-like substances leading to the increasing growth of root (O'Donnell, 1973; Vaughan, 1974; Mylonas & McCants, 1980). Mervat *et al.* (2013) studied the effect of some matters such as humic acid, magnetic iron and mycorrhiza arbuscular on prevention and reduction of saline risk in grapes' growth and yield. They found that all treatments had significant effect on stimulation of different growth properties of the grape. Furthermore, it was found that the increasing amounts of treatments decreased soil's EC. Humic acid was more effective on reduction of soil's salinity as well as the increase of quality and quantity of the product (Mervat *et al*., 2013). Webb & Bings (1988) studied the effect of humates on citruses under stress and they concluded that either the combination of humates and micronutrients or humates and $CaNO_3$ increases the growth, fruit number and body diameter in *Citrus reticulata* L. which previously showed stresses. In addition, the effect of different amounts of humate on water amount consumed by *Citrus sinensis* L. "Valencia" showed that plants treated with humate showed relative increase of water consumption compared to control during the first twelve months of the experiment. Such researchers studied the effect of different amounts of humate on "Hamlin" orange and "Ruby Red" grapefruit. After 10-11 months, they found that the trees treated by humate showed the increasing size of stem compared to the controls (Webb & Bings, 1988). Celik *et al.* (2010) studied the effect of humic acid on the growth of corns in calcareous soils. They found that different spraying concentrations of humic acid had different and significant effect on dry matter amount of the plant and humic acid solution had positive and significant effect on absorption of copper, zinc, magnesium, phosphor and sodium in 0.01 concentrations (Celik *et al.*, 2010). Russo & Berlyn (1992) studied the effect of Roots$^{TM}$ on a number of trees, grass of Poaceae and vegetable products.

This commercial product includes humic acid, cytokinin, thiamin and ascorbate leading to growth improvement of all plants. Use of commercial product of Gro-Mate [(GM)] increased the growth of Chardonnay grape (Reynolds *et. al*., 1995). Khaled and Fawy (2011) studied the effect of different levels of humic acid (used in soil as well as spraying) on nutrient content of the soil, plant's growth and soil properties under saline (NaCl) conditions. It was found that saline stress influenced negatively on the growth of corn and decreased absorption of nutrients except for sodium and magnesium leading to reduction of plant's dry weight. Humic acid had a significant effect on control and reduction of such adverse impacts. Kafi *et al.* (2009) studied the effect of humic acid spray and compared it with himic acid solution on Malibo variety of Gerbera flower. Results indicated that although humic acid spray could not improve absorption of many elements, it could increase the yield. The spray of humic acid improved significantly the stability of cellular membrane of petals thus the stress resulted from stem aging was reduced. Humic acid could improve the post-harvest lifetime of flowers by hormonic-like effects as well as physiologic condition of the plant.

Gypsum is one of amendments for saline-sodic soils which are inexpensive and easy to access in most arid regions. In addition to failure of the quality of water sources, detrimental minerals such as boron have been observed in many regions under pistachio cultivation such that this element causes toxicity. To reduce the impact of such minerals, gypsum is suggested. Calcium and sulfur available in gypsum are easily accessible to the plant's root due to proper solubility of gypsum as well as it improves and strengthens the soil structure (Bresler *et al*., 1982). Mann *et al.* (1982) studied on a saline-sodic soil in Portugal and concluded that the application of gypsum reduced exchange sodium of soil and increased water permeation and drainage. Koo *et al.* (1990) studied experimentally amendment of sodic soil in South Korea and concluded that soil leaching after application of 4.5 ton/hectare gypsum is the most effective treatment in amendment of sodic soils. Hanay *et al.* (2004) studied amendment of saline-sodic soils in Turkey and showed that application of 50 ton/hectare gypsum with 150 ton/hectare compost of urban wastes amended effectively such soils. Ghaneie Motlagh *et al*. (2010) studied the effect of some amendment substances (gypsum, sulfuric acid and sulfur) on chemical properties of saline-sodic soils. They found that the application of gypsum and sulfuric acid increased the amount of soluble calcium and magnesium ions and reduced the amount of soluble sodium ion within 60 cm from top soil. Therefore, the application of gypsum and sulfuric acid reduced significantly the amount of sodium absorption, electrical conduction of saturated extract as well as soil reaction in 60 cm from top soil. The application of gypsum and sulfuric acid has been known as the most effective treatments for amendment of surface soils. Since antisalt® fertilizer used in this experiment has been produced for the first time, there are no researches about it.

## MATERIALS AND METHODS

This experiment was done in a 6-acre orchard located at Ghatroyeh region near Neyriz city, Fars province. Table 1 shows the properties of soil.

**Table 1: Some properties of experimental soil.**

| Soil depth | Soil texture | Lime percent | pH | EC | SAR | ESP |
|---|---|---|---|---|---|---|
| 0-40 cm | Sandy loam | 34.45 | 8.05 | 17 | 12.8 | 14.98 |
| 40-80 cm | Sandy loam | 44.7 | 8.07 | 12.5 | 9.8 | 11.65 |

The experiment was conducted and aimed to study the effect of some anti-salt compounds on the reduction and control of soil's salinity and alkalinity leading to improvement of pistachio yield. A relatively homogenous piece of land with one-acre area was selected from a 6-acre pistachio orchard of “Akbari” cultivar, for treatments in the mentioned region. Then, soil specimens were extracted randomly in 0-40 cm as well as 40-80 cm from the soil and they were sent to the laboratory. Before application of treatments, soil samples were analyzed statistically in terms of some properties such as EC, pH, ESP, SAR, lime percent and soil texture. There was no statistically significant difference between samples in terms of all properties. Therefore, the soil of such piece of land was uniform and homogenous based on mentioned properties. The experiment was done in complete random block design with seven treatments and three replications. The treatments include control (water leaching without anti-salt compounds), gypsum (1500 and 3000 kg/acre), humic fertilizer (1500 and 3000 kg/acre) and antisalt® fertilizer (1500 and 3000 kg/acre). Since samplings were done from two different layers of the soil at the end of experiment, data were analyzed in factorial-based complete random block designs. Factors include anti-salt treatments (seven levels) and different layers of soil (0-40 cm and 40-80 cm from the soil).

The amounts of gypsum, humic fertilizer and antisalt® fertilizer treatments were spread manually on the land and they were plowed deeply within 30 cm of the soil, then heavy irrigation was applied. Gypsum treatment was supplied from calcium sulfate and humic fertilizer was supplied from leonhardite. Antisalt® substance, a new compound made of gyps mineral with formula of $CaSo_4.4H_2O$ (extracted from mines around Yazd), humic acid and some other compounds were tested in this research. After heavy irrigation simultaneous with application of treatments, irrigation was repeated in three replications in winter of the first year. The region was irrigated every 35 days in summer and other cultivation operations (irrigation, fighting with weeds and pests) were done routinely on the trees within two years. Since, there was no appropriate effect from application of anti-salt compounds on properties of the soil as well as plant yield during one crop year, after passing two crop years from application of treatments, samplings were done randomly from two different layers of the soil (0-40 cm and 40-80 cm) in September of two years later. Some chemical properties of the soil were measured in samples such as EC, pH, ESP, SAR and lime percent. The products were harvested simultaneously from different plots of each treatment. The total yield of pistachio trees was measured in mentioned treatments and mean yield of a tree was calculated per kilogram based on the number of trees in each treatment. After determining the amounts of soil parameters as well as pistachio yield, data variance analysis and correlation were done using SAS and SPSS software tools. Mean comparison of parameters was done by Duncan's multirange test. Furthermore, Excel was used to plot diagrams.

## RESULTS AND DISCUSSION

Data variance analysis showed that the treatments used in this test had very significant effect ($\alpha < 0.01$) on all soil properties (EC, pH, SAR, ESP and lime percent) and there was also a very significant difference between two layers (0-40 cm and 40-80 cm) in terms of aforementioned parameters. The effect of the treatment × soil's depth was only significant about sodium absorbance ratio ($\alpha<0.01$) and exchange sodium percentage ($\alpha<0.05$). The block effect was not significant on all properties except for soil pH. The highest amount of electrical conduction with mean of 15.41 dS/m and the lowest amount of electrical conduction with mean of 10.81 dS/m associated, respectively with control and 3000 kg/acre anti-salt treatments. This treatment reduced 30% of electrical conduction. After application of antisalt® fertilizer, humic fertilizer reduced more effectively electrical conduction of the soil than gypsum but their differences was close to each other (Table 2). There is a very significant difference ($\alpha<0.01$) between two different layers of soil (0-40 cm and 40-80 cm) in terms of soil depth. Mean electrical conduction of the first layer and the second layer was respectively 15.05 and 10.41 dS/m (Table 3). 30% increase of salinity in surface layers of soil shows the increasing amount of evaporation and respiration leading to salt accumulation in topsoil layers. The highest amount of pH (8.3 mean) associated with control treatment followed by 1500 kg humic fertilizer, 3000 kg humic fertilizer, 1500 kg gypsum, 1500 antisalt® fertilizer and 3000 kg gypsum. Like electrical conduction, 3000 kg antisalt® fertilizer with mean of 6.99 was the most effective treatment on reduction of soil alkalinity (Table 2). The amount of soil alkalinity was reduced by increase of soil depth between 0-40 cm as well as 40-80 cm layers of soil. Mean pH in the first layer and the second layer was respectively 7.83 and 7.3 (Table 3). The treatments were placed in four groups in terms of sodium absorbance ratio such that mean control treatment (11.78) was the highest in the first group. The mean of 3000 kg antisalt® fertilizer (5.75) was the lowest in the fourth group. There was no significant difference between two treatments of gypsum and 1500 kg humic fertilizer and all of them were in the third group. The third group includes two treatments of 3000 kg humic fertilizer and 1500 kg antisalt fertilizer (Table 2).

**Table 2: comparing mean electrical conduction (EC), PH, sodium absorbance ratio (SAR), exchange sodium percentage (ESP) and lime percent for different treatments that control salinity using Duncan multirange test in confidence level of 5%.**

| Treatment | EC | pH | SAR | ESP | Lime percent |
|---|---|---|---|---|---|
| control | 15.41a | 8.3a | 11.78a | 13.62a | 39.61a |
| 1500 Kg gypsum | 13.63b | 7.58b | 9.75b | 11.98b | 36.11b |
| 3000 Kg gypsum | 12.96bc | 7.35bc | 9.14b | 10.6c | 34.11bc |
| 1500 kg humic fertilizer | 12.82bc | 7.77b | 9.16b | 10.27c | 34.63bc |
| 3000 kg humic fertilizer | 12.03cd | 7.6b | 7.59c | 8.95d | 33.79c |
| 1500 kg antisalt fertilizer | 11.45d | 7.36bc | 7.07c | 8.34d | 32.72c |
| 3000 kg antisalt fertilizer | 10.81d | 6.99c | 5.75d | 6.23e | 28.36d |

Means with similar letters in each column with 5% probability level are not statistically different

50% reduction of sodium absorbance ratio (SAR) via 3000 kg antisalt® fertilizer was considerable compared to the control treatment. Mean sodium absorbance ratio in 0-40 cm layer as well as in 40-80 cm layer was respectively 10.21 and 7 (Table 3). The increasing soil depth reduced sodium absorbance ratio. The effect of antisalt® treatment in soil depth was significant on sodium absorbance ratio. It means that the effect of such treatments was different on reduction or control of sodium absorbance ratio depending on soil depth. The highest rate with mean of 12.93 associated with the interaction of control × 0-40 cm depth and the lowest amount with mean of 5.3 associated with 3000 kg antisalt® fertilizer × 40-80 cm depth (Table 4). The treatments were placed in five statistical groups in terms of soil's exchange sodium percentage. Control treatment with mean of 13.62% had the highest amount of exchange sodium followed by 1500 kg gypsum, 3000 kg gypsum, 1500 kg humic fertilizer, 3000 kg humic fertilizer and 1500 kg antisalt® fertilizer. 3000 kg antisalt® fertilizer with mean of 6.23% allocated to the lowest exchange sodium percentage as well as it was the most effective treatment on reduction of exchange sodium percentage of soil (Table 2). Like SAR, ESP of control and 3000 kg antisalt® fertilizer reduced by 50%. Mean exchange sodium percentage in the first and second layers was respectively 12.25 and 7.74 (Table 3). The increasing soil depth reduced 37% of exchange sodium. Like sodium absorbance ratio (SAR), the effect of treatments on reduction and control of exchange sodium percentage was different depending on the soil depth. The highest amount with mean of 15.72 and the lowest amount with mean of 5.53 allocated respectively to control × 0-40 cm and 3000 kg antisalt® fertilizer × 40-80 cm (table 4). The highest lime percent with mean of 39.61% belonged to control treatment, and then the treatment of 1500 kg gypsum with mean of 36.11 was placed in the second group with significant difference. The order of other treatments is as follows: 1500 kg humic fertilizer, 3000 kg gypsum, 3000 kg humic fertilizer, 1500 kg antisalt® fertilizer and 3000 kg antisalt® fertilizer. 3000 kg antisalt® fertilizer with mean of 28.36% was placed alone in the last group and it was the most effective treatment on reduction of lime percent (Table 2). Lime percent in 40-80 cm layer (with mean of 38.52) was tangibly higher than that in 0-40 cm layer (29.85) (Table 3). The increasing soil depth increased significantly the lime percent. Data variance analysis indicated that the treatments controlling salinity and alkalinity of soil influenced significantly ($\alpha<0.01$) on productive yield of “Akbari” cultivar. The treatments were placed in four statistical groups. The first group includes 3000 kg antisalt® fertilizer with mean yield of 7.66 kg product per tree.

**Table 3: comparing mean electrical conduction (EC), PH, sodium absorbance ratio (SAR), exchange sodium percentage (ESP) and lime percent for different treatments that control salinity for two different layers of the soil using Duncan multirange test in confidence level of 5%.**

| Soil depth | EC | pH | SAR | ESP | Lime percent |
|---|---|---|---|---|---|
| 0-40 cm | 15.05 a | 7.83 a | 10.21 a | 12.25 a | 29.85 b |
| 40-80 cm | 10.41 b | 7.3 b | 7 b | 7.74 b | 38.52 a |

Means with similar letters in each column with 5% probability level are not statistically different

**Table 4: comparing means of the interaction of antisalt treatment × soil depth for sodium absorbance ratio and exchange sodium percentage of the soil using Duncan multirange test in confidence level of 5%.**

| Treatment | SAR | ESP |
|---|---|---|
| Control× 0-40 cm | 12.93 a | 15.72 a |
| Control × 40-80 cm | 10.63d | 11.52 e |
| 1500 kg gypsum × 0-40 cm | 12.20 b | 14.76 b |
| 1500 kg gypsum × 40-80 cm | 7.30 f | 9.21 h |
| 3000 kg gypsum × 0-40 cm | 11.39 c | 13.89 c |
| 3000 kg gypsum × 40-80 cm | 6.89 f | 7.31 i |
| 1500 kg humic fertilizer × 0-40 cm | 11.34 c | 13.47 d |
| 1500 kg humic fertilizer × 40-80 cm | 6.98 f | 7.07 i |
| 3000 kg humic fertilizer × 0-40 cm | 8.87 e | 10.85 f |
| 3000 kg humic fertilizer × 40-80 cm | 6.32 g | 7.06 i |
| 1500 kg antisalt fertilizer × 0-40 cm | 8.52 e | 10.17 g |
| 1500 kg antisalt fertilizer × 40-80 cm | 5.61 h | 6.51 j |
| 3000 kg antisalt fertilizer × 0-40 cm | 6.21 g | 6.93 i |
| 3000 kg antisalt fertilizer × 40-80 cm | 5.3 h | 5.53 k |

Means with similar letters in each column with 5% probability level are not statistically different

1500 kg antisalt® and 3000 kg humic fertilizers with means of 5.73 and 5.26 kg were placed in the second statistical group. The third statistical group contains 1500 kg humic fertilizer and 3000 kg gypsum with means of 3.2 and 3.06 kg, respectively. The lowest yield associated with 1500 kg gypsum and control treatments with means of 2.4 and 2.23 kg without statistically significant difference (Table 5). The effect of block was not significant on pistachio yield. The positive and significant correlation among all soil properties in two soil layers shows the close and effective relationship among EC, pH, SAR, ESP and lime percent. The negative and significant correlation between the yield and all soil properties shows negative effect of such properties on pistachio yield (Table 6). Mean pistachio yield in different treatments indicates that intake of 3000 kg humic fertilizer increases pistachio yield above two folds. It is interesting that such amount increases with intake of 1500 kg antisalt® fertilizer with insignificant difference. Therefore, one treatment should be selected between 3000 kg humic acid and 1500 kg antisalt® treatments based on economic cost and other effective factors. 3.5-fold increase of pistachio yield by application of 3000 kg antisalt® treatment (compared to control) suggests that strong stress and restriction of pistachio production were due to saline and alkaline stresses in experimental region. On the other hand, it shows high power of antisalt® fertilizer in control and reduction of adverse effect of saline and alkaline stresses such that other treatments were not able to compete with it. Therefore, based on results of such experiment, 3000 kg antisalt® treatment is suggested as the best and the most effective treatment in reduction and control of soil salinity and alkalinity leading to improvement of pistachio yield in the orchards. The reason for superiority of antisalt® substance is due to its structural composition because gyps mineral with formula of $CaSo_4.4H_2O$ extracted from mines around Yazd was granulated by a special method as well as other compounds that prevent loss of four water molecules in gyps structure during granulation. Since, gyps minerals are placed as complexes inside humic acid granules, it seems that such minerals with humic molecules are more efficient in soil amendment than each of them lonely (humic and Gyps lonely).

**Table 5: Comparing mean yield of pistachio under different treatments that control salinity using Duncan multirange test in 5% confidence level.**

| Treatment | Yield (kg per tree) |
|---|---|
| Control | 2.233 d |
| 1500 kg gypsum | 2.4 d |
| 3000 kg gypsum | 3.066 c |
| 1500 kg humic fertilizer | 3.2 c |
| 3000 kg humic fertilizer | 5.266 b |
| 1500 kg antisalt fertilizer | 5.733 b |
| 3000 kg antisalt fertilizer | 7.666 a |

Means with similar letters in each column with 5% probability level are not statistically different

**Table 6: Pearson correlation coefficient for electrical conduction (EC), PH, sodium absorbance ratio (SAR), exchange sodium percentage (ESP) and lime percent of the soil.**

| | EC 0-40 cm | PH 0-40 cm | SAR 0-40 cm | ESP 0-40 cm | LIME 0-40 cm | EC 40-80 cm | pH 40-80 cm | SAR 40-80 cm | ESP 40-80 cm | LIME 40-80 cm | YIELD |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EC (0-40 cm) | 1 | | | | | | | | | | |
| pH (0-40 cm) | 0.658** | 1 | | | | | | | | | |
| SAR (0-40 cm) | 0.794** | 0.586** | 1 | | | | | | | | |
| ESP (0-40 cm) | 0.876** | 0.611** | 0.918** | 1 | | | | | | | |
| LIME(0-40 cm) | 0.921** | 0.636** | 0.854** | 0.854** | 1 | | | | | | |
| EC (40-80 cm) | 0.729** | 0.58** | 0.635** | 0.743** | 0.608** | 1 | | | | | |
| PH (40-80 cm) | 0.462* | 0.424ns | 0.563** | 0.449* | 0.499* | 0.309ns | 1 | | | | |
| SAR(40-80 cm) | 0.716** | 0.627** | 0.672** | 0.708** | 0.693** | 0.689** | 0.495* | 1 | | | |
| ESP (40-80 cm) | 0.824** | 0.616** | 0.798** | 0.774** | 0.831** | 0.715** | 0.638** | 0.813** | 1 | | |
| LIME(40-80 cm) | 0.784** | 0.755** | 0.811** | 0.827** | 0.808** | 0.671** | 0.513* | 0.773** | 0.882** | 1 | |
| YIELD | -0.84** | -0.53* | -0.865** | -0.95** | -0.84** | -0.6** | -0.41ns | -0.68** | -0.67** | -0.74** | 1 |

* Significance in 5% level, ** significance in 1 % level, ns: non-significance

Comparing numbers related to negative correlation between soil properties and pistachio yield in 0-40 cm and 40-80 cm layers, it is found that adverse effects of salt on topsoil layers are stronger than beneath layers. The reason may be the spread of active roots in 0-40 cm depth. Therefore, it is required presenting strategies for reduction of saline and alkaline stresses in this layer of soil.

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