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ORIGINAL ARTICLE

Investigating the Effects of Potassium Nitrate Foliar Application with a Reduction in pH on the Potassium Absorption and Some Pistachio Nut Characteristics cv. Kalleghouchi

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ABSTRACT
Potassium is an essential macro-element that has a key role and beneficial effects in yield increase and quality improvement of agricultural products. To investigate the effects of potassium nitrate foliar application with a reduction in pH on the potassium absorption and some nut characteristics of Pistacia vera cv. Kalleghouchi, an experiment was conducted in completely randomized design with seven treatments in three replications in Rafsanjan. The treatments included T1- control, T2- potassium nitrate 2000 mg/l, T3- potassium nitrate 2000 mg/l with pH 6, T4- potassium nitrate 2000 mg/l with pH 5, T5- potassium nitrate 4000 mg/l, T6- potassium nitrate 4000 mg/l with pH 6 and T7- potassium nitrate 4000mg/l with pH 5 that applied in nut filling stage. According to results, leaf potassium content was significant at 1% level. The maximum leaf potassium was obtained in T7 but there was no significant difference between the T7 and T6; the minimum was in T1. Nut characteristics such as the percentage of split nuts and non-split nuts and the number of grains per ounce were significant at 1% level. The most percentage of split nuts, the least percentage of non-split nuts and the least number of grains per ounce were obtained in T7. According to the results, a reduction in pH caused the more absorption of potassium and applying potassium nitrate 4000mg/l with pH 5 had more favorable effect than other treatments in potassium absorption and the improvement of nut characteristics.
Keywords: Potassium nitrate, Pistachio, pH, Nut characteristics.

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INTRODUCTION

Potassium is the third basic nutrient element for plant growth which plays a leading role in enzyme activity, protein synthesis and plant photosynthesis [1]. In pistachio trees, experiments of Zeng et al [1] showed that after nitrogen, potassium is the second element with maximum absorption from the soil per year. The main symptom of lack of potassium in the trees is leaf's margin burn; but it should be noted that this burn is not seen in the early season and gradually becomes clear. Another outcome of lack of potassium is sensitivity to sun burn and smaller split of ripe nuts [3]. This element plays an important role in increasing the performance of pistachio trees. Studies showed that during "on-years" of pistachio trees, the absorbed potassium is directly consumed in the embryo or pith but during "off-years" the absorbed potassium by the roots is stored in other organs; hence, the concentration of potassium in the leaves at the "on-years" is less than "off-years". As a result, potassium fertilizers should be added in orchards during "on-years" [4]. Zeng et al [5] stated that the concentration of potassium is changed in the trees in a seasonal manner, i.e. the need of tree for potassium is little and potassium absorption is minimum in the spring (April to May) and the concentration of potassium is usually less than 1 percent; meanwhile during nut growth and nut filling stage potassium concentration is increased and reaches to its maximum from July to September. This study showed that the concentration of potassium in the leaves after the harvest season in September had a sharp reduction. In studies by Rosecrance et al [6-7] it was found that nitrogen absorption is often done during spring growth and nut setting stage, but potassium absorption and its release is done during pistachio nut filling stage, the nuts function as sink at this time.

Suitable potassium nutrition is the key of efficiency and better yield in pistachio orchards [2]. Ashworth et al [8] reported that with increase of potassium levels in the soil, potassium concentration of leaves of pistachio trees increases. Many pistachio orchards in Iran are located in arid and semi-arid areas and water shortages and lack of water resources as a major problem of the orchards in this area. According to studies of Beede et al [9], soil humidity has a significant effect on the efficiency and better absorption of potassium; and the soil draught especially in the summer reduces the absorption of this element by the trees; unfortunately this is the time when the trees most needed this vital element. Also, Bilgen et al [10] reported that due to the deep root system, pistachio tree is not able to use adequately the fertilizers which are at the surface of soil and foliar fertilization system has the best result for increasing the efficiency of fertilizer. The benefit of foliar application is faster absorption by leaves compared to the roots [11]. One of potassium fertilizers that are used as a foliar application is potassium nitrate. It was reported that potassium nitrate foliar spray increased yield in mango [12], 'Washington navel' orange [13], clementine [14], pomegranate [15], olive [16] and grapes [17]. Potassium nitrate foliar application increased fruit size in pear [18], peach [19], nectarine [20], 'Valencia' orange [21], and grapefruit [22] and leaf potassium content in olive [23], clementine [24] and avocado [25]. Regarding others presented reports in relation with positive effects of potassium nitrate foliar application on different plants the aim of this study was evaluation of the effects of potassium nitrate foliar spray with a reduction in pH on the potassium absorption and some pistachio nut characteristics.

MATERIALS AND METHODS

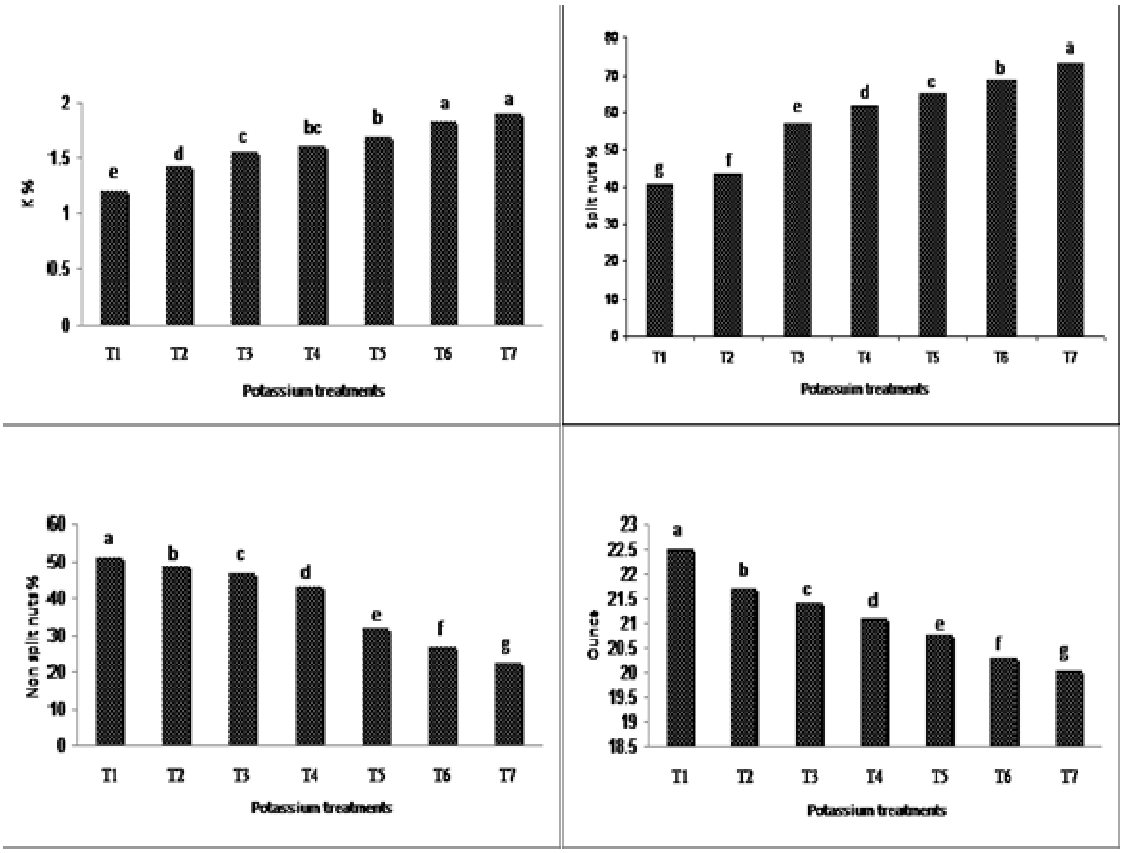
This experiment was conducted in completely randomized design with seven treatments in on 25-year-old pistachio trees cv. Kalleghouchi in Rafsanjan in "on-year" of trees. Each treatment was applied on three rows of trees (45 to 50 trees in each row) and in three replications. The treatments included T1-control, T2- potassium nitrate 2000 mg/l, T3- potassium nitrate 2000 mg/l with pH 6, T4- potassium nitrate 2000 mg/l with pH 5, T5- potassium nitrate 4000 mg/l, T6- potassium nitrate 4000 mg/l with pH 6 and T7- potassium nitrate 4000mg/l with pH 5. First in laboratory to reduce pH, different amount of citric acid was added to potassium nitrate solution and was measured with pH meter until reach to six and five (Table 1). Solution was sprayed in nut filling stage between 7 a.m. and 9 a.m. in mid-June. To measure potassium and some else nutrients, sampling of leaves was done from treated trees after 24 hours. After moving samples to laboratory, plant extract was prepared with dry ash method [26]. For this purpose, after washing leaf samples and drying them in air, they were grounded and placed in oven 70^0C for 24h. Then 1g of each sample was weighted and burnt in electric furnace 550^0C for 5h to change to white ash. When the samples were cooled 10cc HCL 3 normal was added to each sample and reached to volume 100mm with distilled water. In obtained extract, potassium was measured with Flame Photometer, phosphorus, calcium and magnesium with Atomic Absorption Spectrometer. To investigate some nut characteristics, the numbers of split nuts, non-split nuts, immature nuts, small nuts and the numbers of grains per ounce were counted by gleaning 30 clusters of 5 pistachio trees randomly for each treatment and in three replications at harvest. Data were analyzed with SAS 9.1 Software and means were compared with Tukey test at 5% level.

Table 1. Different pH of potassium nitrate by adding citric acid

KNO_3	Citric acid	pH
2000 mg/l	---------	7.6
2000 mg/l	300 mg/l	6
2000 mg/l	550 mg/l	5
4000 mg/l	----------	7.9
4000 mg/l	300 mg/l	6
4000 mg/l	600 mg/l	5

RESULTS

In this research, the analysis of variance (ANOVA) for leaf nutrient content, amount of potassium was significant at 1% level but amounts of phosphorous, calcium and magnesium were not significant. In the mean comparison, the maximum of potassium was obtained in T7, there was no significant difference between T7 and T6 and it reduced in T5, T4, T3, T2 and T1 respectively (Figure 1). The analysis of variance for some nut characteristics including the percentage of split nuts, non-split nuts and the number of grains per one ounce were significant at 1% level but the percentage of immature nuts and small nut were not significant. In the mean comparison, the most percentage of split nuts was obtained in



T7 and it reduced in T6, T5, T4, T3, T2 and T1 respectively. The least percentage of non-split nuts and the least number of grains per ounce was observed in T7 and the most was in T1 (Figure 1).

Figure 1. The effect of different potassium nitrate treatments on the percentage of potassium, split nuts, non-split nuts and the number of grains per ounce.

DISCUSSION

Potassium is effective on quantity and quality of pistachio product. If adequate potassium is available to pistachio tree, the number of clusters and fruits, split nut percentage and nut dry weight increase significantly [9]. Previous studies showed that application of potassium through foliar spray system increased the percentage of potassium in leaves of pistachio tree and luckily did not have a negative effect on reduction of other elements of the leaves such as nitrogen, phosphorus, and magnesium. The percentages of other elements in the leaves were reported at an optimum level [27]. In accordance with these findings, our results showed that potassium nitrate spray on the leaves increased the concentration of potassium, the split percentage and the number of grains per ounce; however, it did not change the amount of phosphorus, magnesium and calcium. If the amount of potassium in the leaves is within the range of 1.6% to 2%, the maximum yield will be observed in the pistachio [5]. The results of this experiment showed that after potassium nitrate spray, the highest concentration of leaf potassium (1.9 %) was obtained at the treatment of 4000 mg/l potassium nitrate with pH 5, where the best result was observed. Sarcheshmepour and Malakouti [4] reported that potassium increases the pistachio trees resistance against water and soil salinity, droughts, pests and diseases, as well as the quality of nuts especially the nut splitting percentage and number of grains per ounce. This report is also consistent with our finding that potassium nitrate spray increased the nut splitting percentage and number of grains per ounce. In a field experiment, Zeng et al [2] examined the effects of potassium fertilizers on the potassium of leaf, yield and quality of pistachio nut. They observed that a positive relationship exists between yield and the concentration of leaf potassium during filling the nut. According to our findings, through increasing the concentration of potassium nitrate spray in the nut filling stage, the potassium of leaf increased which in turn improved nut characteristics. Nut splitting may be associated with the role of potassium in translocation of carbohydrates to growing fruit, as reported by Zeng et al [2], Zeng and Brown [28], Beede et al [9] and Ben-Mimoun et al [27]. The positive effect of potassium nitrate have also been reported in other products, potassium nitrate spray increased olive leaf potassium content [23] its

fruit growth and oil quality [29]. Spray during the inflorescence development period reduced post fruit set drop and increased tree yield in mango [30]. Potassium nitrate sprays increased peach fruit weight and potassium content in the leaves [31]. It increased flowering and fruit weight of strawberry [32] and enhanced fresh and dried fig quality [33]. According to the findings, a reduction of pH in potassium nitrate spray increased the absorption of potassium nitrate; and among the treatments the maximum absorption and the best nut quality was observed in T7. Since 90 percent of potassium absorption by pistachio tree occurs during nut filling stage, foliar spray of fertilizers with high percentage of potassium and decreasing the pH of solution helps to better absorption of this element and improving the quality of crop.

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