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Investigation on Effects of Calcium Nitrate, Calcium Sulfate (soil application) and Calcium chelate as Foliar spray on Endocarp Lesion Disorder and Some Qualitative Characteristics of pistachio nut Cv. Akbari

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Abstract
Calcium deficiency causes Endocarp Lesion disorder in pistachio nut. To investigate the effects of various calcium treatments on Endocarp Lesion disorder and some nut qualitative characteristics in Pistachio cv. Akbari, an experiment was done in completely randomized design with four treatments (1- control treatment, 2- calcium chelate foliar spray, 3- calcium nitrate and 4– calcium sulfate (gypsum), calcium nitrate and calcium chelate foliar spray) in three replications in 2010. The results showed that the percentage of non-contaminated nuts and the percentage of contaminated nuts to mentioned disorder were significant ($P < 0.01$). The most percentage of non-contaminated nuts and the least percentage of contaminated nuts were observed in three calcium treatments, but there was no significant difference between them. Qualitative characteristics of nut such as the percentage of splitting nuts, non-splitting nuts, small nuts and immature nuts were significant ($P < 0.01$) but the percentage of blank nuts wasn't significant. The most percentage of splitting nuts, the least percentage of non-splitting nuts and small nuts were obtained in gypsum, calcium nitrate and calcium foliar treatment (T4) and in calcium nitrate treatment (T3) respectively but there was no significant difference between two treatments. The least percentage of immature nuts was measured in gypsum, calcium nitrate and calcium foliar treatment (T4). The result of leaf nutrients amount measure (calcium, magnesium, sodium, calcium to magnesium ratio) showed magnesium was significant ($P < 0.05$), sodium and calcium to magnesium ratio were significant level but amount of calcium was not significant. The least amount of magnesium and sodium and the most ratio of calcium to magnesium (Ca / Mg) in leaves were observed in gypsum, calcium nitrate and calcium foliar treatment (T4). High ratio of calcium to magnesium reduces magnesium poisoning and also the Endocarp Lesion. According to the results, application of gypsum, calcium nitrate and calcium foliar treatment (T4) can be more favorable than other treatments in reducing Endocarp Lesion disorder and improving nut quality in pistachio cv. Akbari

Keywords: Pistachio; Calcium deficiency; Endocarp Lesion disorder; nut qualitative characteristics.

INTRODUCTION

Endocarp Lesion disorder in pistachio nut has spread in country especially in Kerman province recently. This disorder has caused crop severe damage and decrease on different cultivars of pistachio such as Akbari commercial cultivar. According to the study was done by Mahmoudi meimand (2006), Endocarp Lesion exists by calcium deficiency, and indisposition of calcium to magnesium ratio causes lack of calcium absorption by the plant. Studies also have shown irrigation in early May increases this disorder efficiently because of elements balance indisposition. Checking role of Macro elements and Microelements in connection with the mentioned disorder shows that elements other than calcium and magnesium have no role in this disorder (Hashemi Rad and Heidari Nejad, 2006). Fruits with a little calcium have respiration rate higher than another fruits therefore, they decay faster. For delay in fruit corruption, it is necessary to accelerate and strengthen calcium absorption and transfer to fruit in ways, at the first time this action was performed in form of foliar application in crops such as apple, pear, tomato, strawberry and showed satisfactory results (Rozen and Kader, 1989; Lima, 1990; Khaladbarin and Islam Zade, 2001). Calcium deficiency in tomato causes Blossom – End Rot

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(Karen, 2003). This element deficiency in apple trees appears in form of brown spots that is called Bitter Pit. Also calcium foliar application on apple causes more strength in fruit structure and increases its warehousing property (Pscheidt, 2003). Studies have also shown to protect cell membranes against damage caused by various stresses, presence of calcium in the external environment is essential (Netonda et al., 2004). Raid and Smith (2000) showed although the growth of wheat seedlings are strongly prevented by high concentrations of sodium chloride but adding calcium to growth environment causes growth improvement. In calcium deficiency conditions sodium negative effects are much. Some researchers (Banuls et al., 1991; Hawkins and Lewis, 1993; Davenport et al., 1997) have shown that calcium can act as a corrector and moderator of salinity effects. The role of calcium has been observed as an actuator of cell messages transfer system and also as a regulator of plant osmosis. Up to now a study in connection with the use of various calcium treatments to remove or reduce Endocarp Lesion disorder hasn't been done in pistachio cv. Akbari, this experiment was conducted for this purpose.

MATERIALS AND METHODS

Because of the widespread distribution of pistachio trees Cv. Akbari in Rafsnjan pistachio plantation area, study of the different calcium treatments was performed on 20 years old pistachio trees contaminated to Endocarp Lesion disorder in Anar's Ahmadabad area. The experiment was done with four treatments of calcium including: control treatment (T1), calcium chelate foliar spray (T2), calcium nitrate (T3) and calcium sulfate (gypsum), calcium nitrate and calcium chelate foliar spray (T4) in completely randomized design, each treatment was conducted on three rows of trees (40 to 45 trees per row) and in three replications. At the first, in late February, gypsum (40 ton per ha) was added to the soil. Adding calcium nitrate (75 kg per ha) to the soil as a fertilizer was done in mid-April. Calcium chelate foliar spray (15% concentration) was done at the beginning of endocarp rapid growth and it was repeated after two weeks. Factors such as the number of non-contaminated nuts, contaminated nuts, splitting nuts, non-splitting nuts, small nuts, blank nuts, immature nuts and also the leaf nutrients content were measured. To investigate the effect of treatments on contamination rate, the non-contaminated and contaminated nuts were counted in a sampling by gleaning 10 pistachio clusters of 5 trees randomly for each treatment and in three replications in mid-June. Counting the number of splitting nuts, non-splitting nuts, small nuts, blank nuts and immature nuts were performed by gleaning 15 clusters of 5 pistachio trees randomly for each treatment and in three replications at harvest. In order to determine the amount of leaf nutrients including calcium (Ca), magnesium (Mg) and sodium (Na), calcium to magnesium ratio (Ca/Mg), sampling of leaves were done for each treatment in three replications on 20 July and leaf analysis were conducted in laboratory of Iran's Pistachio Research Institute (IPRI)soil analysis laboratory. The statistical analysis was performed using SAS software, and Tukey test at 5% level was used to compare the means.

RESULTS

In this research, according to the results, the percentage of non-contaminated nuts and contaminated nuts were significant at one percent level ($P < 0.01$). The comparison of the means showed the most percentage of non-contaminated nuts and the least percentage of contaminated nuts were in calcium sulfate (gypsum), calcium nitrate and calcium foliar treatment (T4), calcium nitrate treatment (T3) and calcium foliar treatment (T2) respectively, but there was no significant difference between three treatments. The least mean was observed in control treatment (T2) (Fig. 1). The results of some fruit qualitative characteristics measure including the percentage of splitting nuts, non-splitting nuts, small nuts and immature nuts were significant at one percent level but the percentage of blank nuts was not significant. The comparison of the means showed the most percentage of splitting nuts, the least percentage of non-splitting nuts and small nuts were in gypsum, calcium nitrate and calcium foliar treatment (T4) and calcium nitrate treatment (T3) respectively, but there was no significant difference between them. Also the percentage of splitting nuts decreased in foliar calcium treatment (T2) and control treatment (T1) respectively but the percentage of non-splitting nuts and small nuts increased in these two treatments. The Least percentage of immature nuts was observed in gypsum, calcium nitrate and calcium foliar treatment (T4) and the most percentage was measured in control treatment (T1) (Fig. 1). According to the results of leaf nutrients Measure, magnesium was significant at five percent level, sodium and calcium to magnesium ratio were significant at one percent level but amount of calcium wasn't significant. By comparison of the means, the least amount of magnesium and sodium were obtained in three calcium treatments, but there was no

significant difference between three treatments; the least mean was observed in control treatment with significant difference. The most leaf calcium to magnesium ratio (Ca / Mg) was measured in the gypsum, calcium nitrate and calcium foliar treatment (T4), there was no significant difference between foliar calcium treatment (T2) and calcium nitrate treatment (T3); the least ratio was observed in control treatment (T1) (Fig. 2).

Figure 1: Effect of control treatment (T1), calcium foliar (T2), calcium nitrate (T3) and calcium sulfate (gypsum), calcium nitrate and calcium foliar (T4) on percentage of non-contaminated nuts, contaminated nuts, splitting nuts, non-splitting nuts, small nuts and immature nuts.

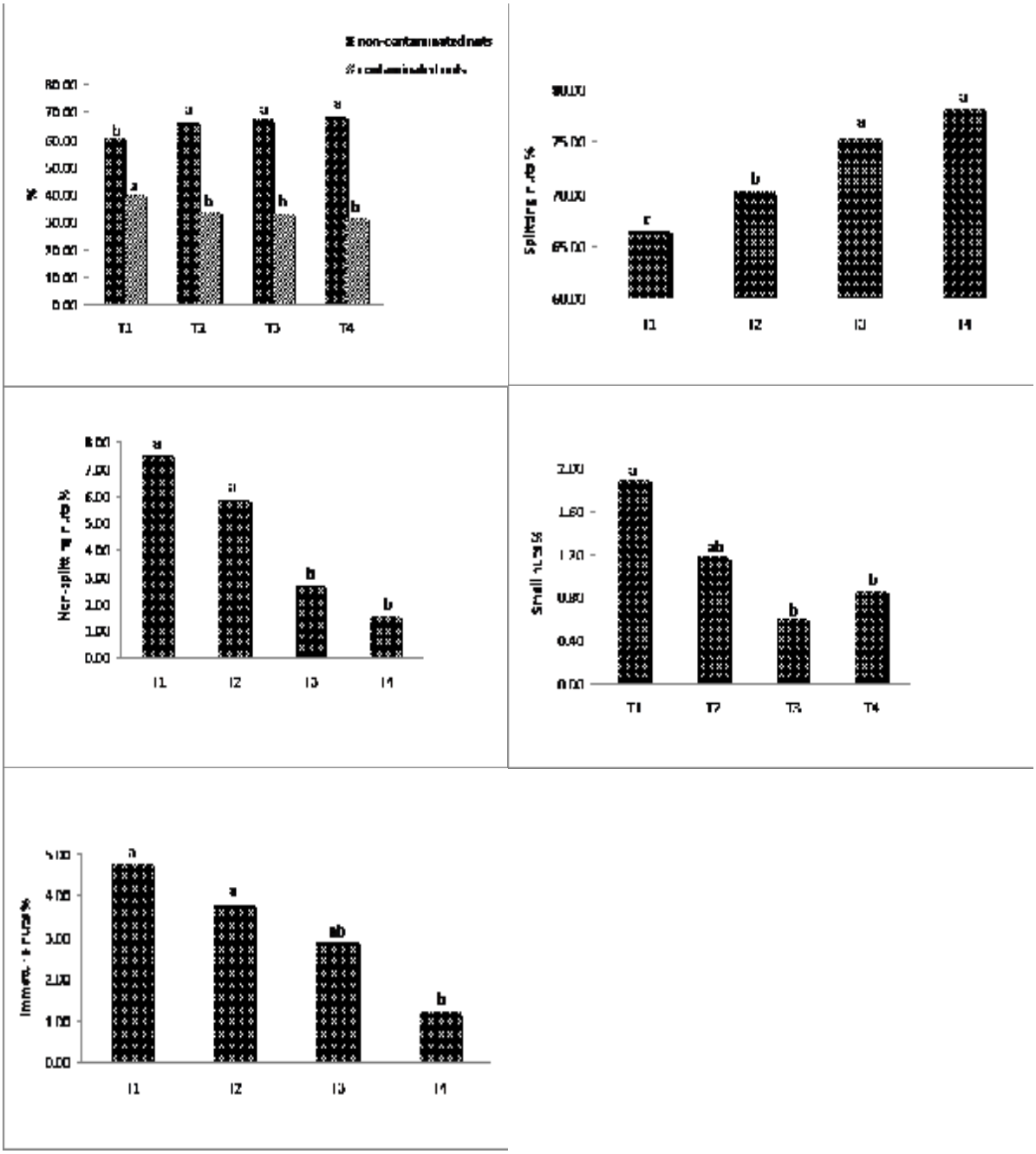
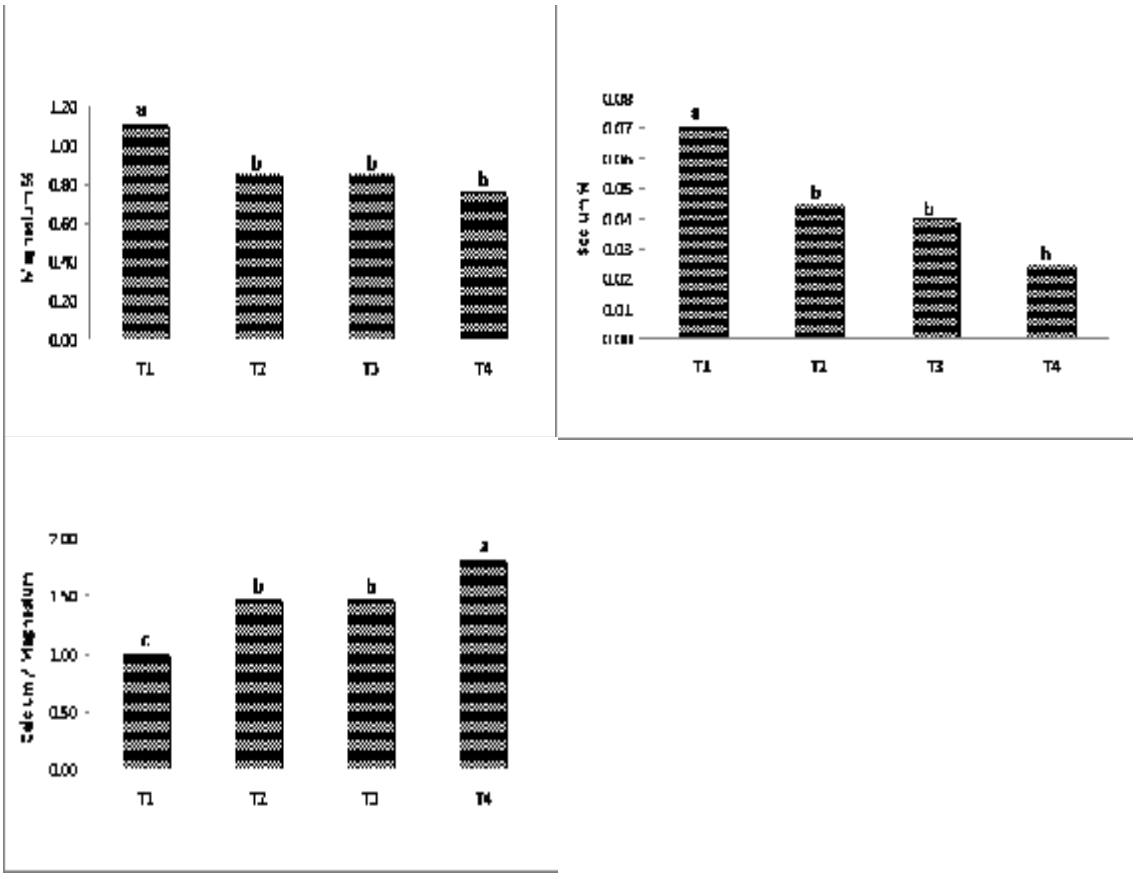


Figure 2: Effect of control treatment (T1), calcium foliar (T2), calcium nitrate (T3) and calcium sulfate (gypsum), calcium nitrate and calcium foliar (T4) on percentage of magnesium, sodium and calcium to magnesium ratio.



DISCUSSION

Calcium is one of the most important mineral elements that it is effective in fruit quality and shelf life. This element exists in structure of cells' middle lamella in a compound that called calcium pectate and until its amount is enough prevents pectin wall demolition (Marschner, 1995; Khaladbarin and Islam Zade, 2001) According to the theory of Conway and Sam (1987) calcium in the cell wall protects fruit against of the microbes that are trying to inter into it by breaking pectin. Strength of pistachio endocarp in formation time depends on presence of calcium ion. Calcium absorption by the roots of the pistachio tree is disabled; it means the amount of transpiration defines amount of absorption and causes calcium ion movement in the xylems toward organ that needs calcium. Transpiration rate of leaf surface is more than fruit surface, so in calcium lack situation, the amount of calcium that is placed at the disposal of fruit is much less than the amount of calcium that is placed at the disposal of leaves, so it is possible that the symptoms of calcium deficiency aren't observed in the leaves, whereas it has calcium deficiency in fruit, especially in endocarp severely (Mahmoudi Meimand, 2006). Our results showed that usage of different calcium treatments than control treatment decreased disorder and combined using of several calcium combinations had more favorable effects on disorder decrease. Our results conforming to others results showed calcium foliar application in mid-April and compare with contaminated trees to mentioned disorder (controls) has shown that disorder rate has decreased in treated trees by calcium (Hashemi Rad and Heidari Nejad, 2006). Probably Endocarp Lesion disorder was occurred because of calcium to magnesium ratio indisposition as a result of more magnesium increase in irrigation water in pistachio gardens, truly increase of magnesium causes false calcium deficiency in fruit. It appears that increase of magnesium in soil and irrigation water disorders calcium absorption and calcium deficiency in pistachio fruit appears in form of Endocarp Lesion. The best ratio of calcium to magnesium is when the ratio is more than 2 and when this ratio is less than one we are facing with magnesium poisoning (Mirzaei et al., 2002). Based on our results, the best ratio of calcium to magnesium (1/80) was obtained in treatment of gypsum, calcium nitrate and calcium foliar (T4). Our results conforming to others results showed that adding gypsum to the pistachio gardens can be useful in modifying calcium to magnesium ratio in favor calcium and it can decrease disorder rate (Mahmoudi Meimand, 2006). Consumption of Gypsum in pistachio gardens in addition to decrease in disorder rate causes increase in penetration of water and soil moisture storage, increase in irrigation water efficiency, improving soil structure, decrease in sodium soil PH, etc (Mahmoudi Meimand, 2006). According to the results we can improve plant need to calcium in endocarp lignifications stage by using of gypsum as a soil corrector and calcium source, calcium nitrate as a fertilizer and liquid calcium in form of spray (calcium foliar) and prevent disorder efficiently. Our results showed that application of gypsum, calcium nitrate and calcium foliar treatment can be more favorable than other treatments in reducing Endocarp Lesion disorder and improving fruit quality in Pistachio cv. Akbari.

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