Foliar Potassium Application on Pistachio Tree

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ABSTRACT

The objective of this work was to evaluate the effects of potassium (K) fertilization on the vegetative growth, the fruit production and leaf mineral content of pistachio tree (Pistacia vera L.) under rainfed conditions. Several fertilizer methods and rates of application were applied in 2003 to Mateur pistachio variety. Both potassium nitrate and potassium sulfate were used. The foliar fertilizer rates were 50 and 100% of the tree requirement and for soil spreading the rates were 100% and 200% of the tree needs. A control was also observed with no fertilization as done by farmers on the experiments region (Sfax).

Potassium fertilization accelerated the maturation process only with potassium sulfate foliar fertilization, improved the nut quality (fruit weight and percentage of split nuts). Concerning the foliar diagnostic, K fertilization increased leaf potassium concentration with no effect observed on N, P and Mg leaf contents.

Key Words: pistachio tree, potassium, foliar fertilization, nuts quality

1. Introduction

The total pistachio (Pistacia vera L.) area has increased dramatically during the last 30 years to be closed to 43000 ha. However the average nut yields is still ridiculous. This situation is the results of many factor, one of them is the complete absence of fertilization practices.
Optimal potassium (K) nutrition is essential to maximize pistachio nut yields (Zeng et al, 1998). K is an essential mineral for production and quality (Soing, 1999).
The majority of the pistachio production occurs in arid or semi-arid regions where the trees are frequently affected by water stress. The soil moisture regime is one of the factors affecting the potassium release or fixation (Brown, 1995). So in summer, K availability is reduced in the production areas.
The foliar fertilization could be a solution to this problem. K is easily adsorbed and distributed trough leaf tissues (California Fertilizer Association, 1998).
The objectives of this research were to study the effect of different potassium fertilization methods on vegetative growth, pistachio nuts quality and leaf mineral content.

2. Material and method

This experiment was carried out at Taous, which is an Olive Institute experimental station located 26 km North of Sfax in the Center of Tunisia during year 2003. The region is characterized by a semi arid climate with an annual rainfall of 200 mm.

A commercial pistachio orchard of Mateur cultivar was used for this experiment. The trees were twenty years old, 12 x 12 m density grafted on P. vera rootstocks and receiving all the usual horticultural cares.

The estimation of the tree requirement was made using the "Potassium Nitrogen Model" (Rosecrance et al, 2003) applied to the experimental orchard.

The fertilizers used were either potassium nitrate (KNO_3) or potassium sulfate (K_2SO_4).

The different treatments used on this experiments were as indicated on table 1.

Table 1. The different potassium treatments

Treatments	Fertilizer	Method	Quantity
Control			
F50	K_2SO_4	Foliar spray	50% of tree requirement
F100	K_2SO_4	Foliar spray	100% of tree requirement
S100	K_2SO_4	Soil spreading	100% of tree requirement
F50	KNO_3	Foliar spray	50% of tree requirement
F100	KNO_3	Foliar spray	100% of tree requirement
S100	KNO_3	Soil spreading	100% of tree requirement
S200	KNO_3	Soil spreading	200% of tree requirement

The soil spreading was done on one application on April 24th 2003 during the flowering period.
The foliar fertilization treatments were applied using a 400l sprayer as fellows:

1. 20% at the end of fruit set
2. 40% during the second fruit development stage (shell lignification)
3. 40% during the third fruit development stage (kernel growth).

Three blocs composed of three single tree replications of each treatment were used. The vegetative growth was measured once a month and the single leaf area after harvest wit a laser area meter CI203, CID, INC. After fruit set, every 15 days fruit weight was measured on a sample of fruits from three clusters. At harvest, the fruit characteristics were measured.

3. Results and discussion

3.1. Vegetative Growth and leaf area

The vegetative growth shows no differences between the treatments (Figure 1) as reported previously by Ashworth et al (1985) on the K effect on pistachio shoot growth. The higher vegetative growth for 100% K_2SO_4 soil spreading could be explain by the competition for assimilates between vegetative and fruit growth. The yield of the trees of this treatment is lower than the others (respectively 8 kg compare to 11 to 12 kg). Marra et al. (1998) show the effect of crop load on vegetative growth, the pistachio nuts is the major sink for assimilates.

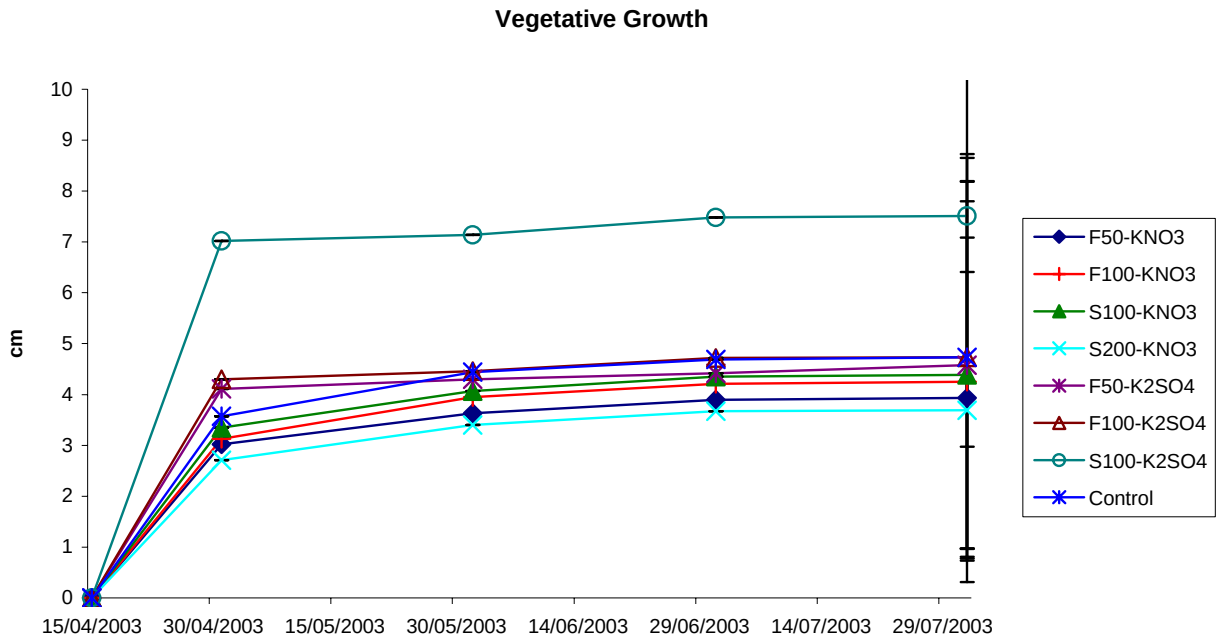

Figure 1. The shoot growth (cm) for the different potassium fertilization treatments

The leaf area was enhanced by the foliar potassium spraying for both the fertilizer (Table 2). This increase could improve the source availability and so the offer of assimilates for the different sink and specially the nuts.

Table 2. The different potassium treatments effect on Leaf area (cm^2)

Treatments		Mean leaf area (cm^2)
Control		103.13 ^{a}
KNO_3	F50	141.54 ^{de}
	F100	131.61 ^{cde}
	S100	107.63 ^{ab}
	S200	118.43 ^{abc}
K_2SO_4	F50	123.34 ^{bcd}
	F100	143.98 ^{e}
	S100	122.00 ^{abc}

Test Duncan^{a,b}

3.2 Fruit maturity and quality

At harvest, the fruit maturity shows a variation ranging from a maximum of 70 % in 100% K_2SO_4 foliar treatment to a minimum of 61% in KNO_3 soil spreading (Fig. 2). However no statistical significant effect was observed. The same results were obtained for the pistachio splitting with a higher but not significant percent with the foliar treatment.

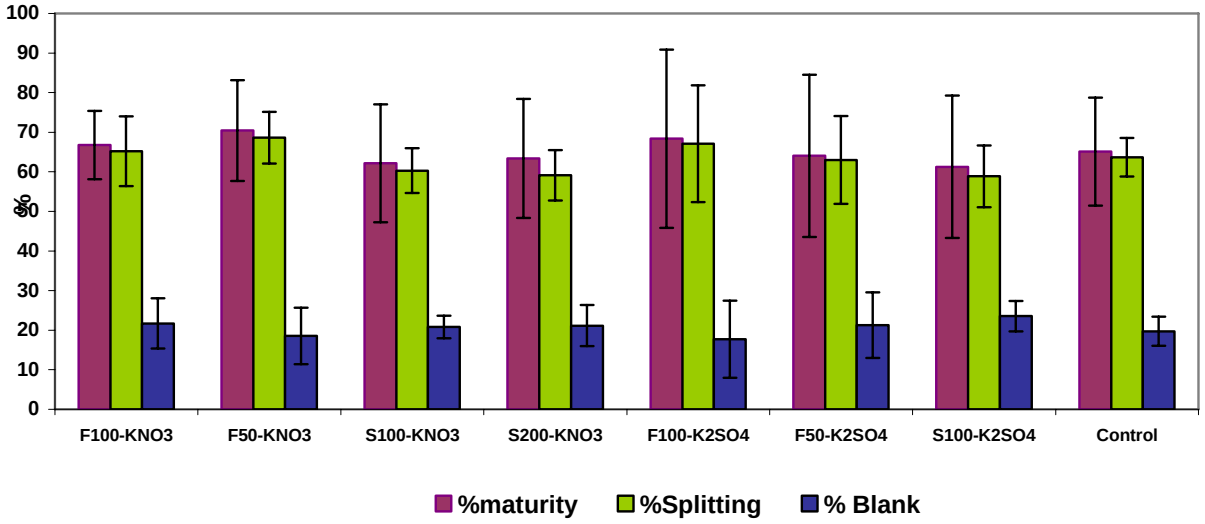

Figure 2. The fruit maturity, splitting and blank nuts percent for the different potassium fertilization treatments

The maximum fresh fruit weight was obtained with the K_2SO_4 foliar fertilization. It's significantly higher than all the other treatment weight (Table 3). Others research shows the K effect on fruit weight (Zeng et Brown 1998, Zeng et al., 1999 and 2001) however the effect was observed only after three years of experiments.
The 100% K_2SO_4, 50% and 100% KNO_3 foliar treatments enhanced the kernel weight. So the assimilates accumulation was higher for those treatments as shown by Weinbaum et al. (1994), potassium increases the kernel weight.

Table 3. The different potassium treatments effect on fruit pomological characteristics

Treatment		Fresh weight	Kernel weight
Control		1.10 ^{ab}	0.57 ^{a}
KNO_3	F100	1.18 ^{bc}	0.70 ^{b}
	F50	1.15 ^{ab}	0.66 ^{b}
	S100	1.09 ^{a}	0.60 ^{a}
	S200	1.11 ^{ab}	0.61 ^{a}
K_2SO_4	F100	1.26 ^{c}	0.71 ^{b}
	F50	1.11 ^{ab}	0.61 ^{a}
	S100	1.08 ^{a}	0.62 ^{a}

Test Duncan $^{a, b, c}$

3.3. Leaf Analysis

The concentrations were consistently below the normal range showing an important deficiency situation for all minerals analyzed except Mg (Brown, 1995).
The potassium applications increase the mineral content compare to the control. However, the optimal range was not achieved using Brown norms (1995). Ashworth et al. (1985) suggested the critical leaf K level for K deficiency in pistachio should be 0.7 to 0.9%, a more near value to our results. Nevertheless, our results could be explained by the wrong yield estimation

made at the beginning of the season and used for the K tree requirement. The estimation was made based on 15 years yield average of the orchard (5 kg/ tree) and the obtained yield for 2003 was 11 kg /tree.

Table 4. The different potassium treatments effect on Leaf mineral composition compared to Brown. (1995) norms

Treatments		Foliar Content (%)			
		N	P	K	Mg
Brown (1995) norms		2.30	0.14	1.00	0.60
Control		1.34 ^{b}	0.07 ^{a}	0.40 ^{a}	0.66
KNO_3	F100	0.71 ^{ab}	0.06 ^{a}	0.65 ^{bc}	0.65
	F50	0.56 ^{a}	0.06 ^{a}	0.75 ^{c}	0.66
	S100	1.12 ^{ab}	0.06 ^{a}	0.65 ^{bc}	0.75
	S200	0.90 ^{ab}	0.07 ^{a}	0.55 ^{b}	0.70
K_2SO_4	F100	0.91 ^{ab}	0.07 ^{a}	0.65 ^{bc}	0.81
	F50	1.13 ^{ab}	0.10 ^{b}	0.57 ^{b}	0.67
	S100	0.80 ^{ab}	0.06 ^{a}	0.82 ^{d}	0.67

Test Duncan $^{a, b, c}$

4. Conclusion

K fertilization is expected to improve nut yield and quality in pistachio tree. In this study the objective was to determine the effect of the K fertilization and the better application methods. During this first year of the experiments, foliar K fertilization improved the nut quality (fruit weight and percentage of split nuts). Mineral deficiencies were observed for N, P and K. Potassium fertilization increased leaf concentration with no effect observed on N, P and Mg leaf contents. However, the value remains under the optimal range.

Those experiments should be continued. Pistachio is a strong alternate bear tree with nut yield varying 3 to 5 times between "on" and "off" year, inducing a different K demand and uptake between years. In another hand, a lot of fertilizing experiments with fruit trees show a significant effect only after some years of application.

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