Foliar Potassium Application on Olive Tree

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ABSTRACT

The objective of this work was to evaluate the effects of potassium (K) fertilization on vegetative growth, fruit production and leaf mineral content of olive tree (*Olea europeae* L.) under rainfed condition. Different fertilizer, techniques and rates of application were applied in 2003 on Chemlali olive. The potassium fertilizer used was potassium nitrate. 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 applied fertilization as used on the experiments region (Sfax).

The results did not show any significant effect of treatment on olive vegetative growth. However, foliar treatment increases significantly leaf area. Foliar fertilization at 100% accelerates fruit maturation, increases fruit weight, pit ratio and polyphenol, respectively to 0.81g, 3.65 and 59.37ppm. No significant differences on fat content and acidic composition were observed. Leaf mineral analysis revealed that K fertilization increased significantly K foliar content with no differences for the others mineral elements (N, P, Mg).

Key Words: olive tree, potassium, foliar fertilization, quality, foliar analysis

1. Introduction

The olive tree (*Olea europeae* L.) is one of the major crops in Tunisia, planted from the north to the south of the country and covering an area of 1.6 Mha, corresponding to 33 % of agricultural area. However, current olive practices in Tunisia largely ignored the mineral nutrition especially in arid and semi arid zones. Potassium is a major element with an important effect on fruit yield and quality (Soing, 1999).
This element could be applied with different methods. The foliar application is helpful to satisfy plant requirement and has a high efficiency (Inglese et al. 2002). Potassium is easily adsorbed and distributed trough leaf tissues (California Fertilizer Association, 1998). The foliar application is an attractive solution especially in arid zone under rainfall conditions where the lack of water in summer reduces drastically nutrient absorption by the tree.

The aim of this research was to study the effect of different potassium fertilization methods on vegetative growth, olive and oil quality and on leaf mineral content.

2. Material and method

This experiment was carried out in an experimental station at the Olive Institute, in a fine sandy soil, located 26 km North of Sfax in the Center of Tunisia during year 2003. The zone is characterized by a semi arid climate with an annual precipitation of 200 mm.
A commercial olive orchard of Chemlali cultivar was used for this experiment. The tree 24 * 24 m apart were grown using standard cultural practices for the Sfax region, i.e. under rainfall condition and without any fertilization.

At the beginning of the season, an estimate of potassium requirement was made based on the yield (200 kg / tree) and the pruning wood. The potassium was applied by two different methods and on two quantities as indicated on table 1.

Table 1. The different potassium treatments

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

Potassium was applied as potassium nitrate KNO_3.
The soil spreading was done on one application on April 22nd 2003 during the flower bud swell.
The foliar fertilization treatments were applied using a 400l sprayer as fellows:

1. 30% during the flower bud swell
2. 40% during the second fruit development stage
3. 30% just at the beginning of the fruit color change.

Four single tree replications were used for each treatment. The vegetative growth was measured once a month and the single leaf area after harvest with a laser area meter CI203, CID, INC. After fruit set, every 15 days fruit weight was measured on a sample of 200 fruits (50 per tree). At harvest the oil was extracted using an oil mill on 4 samples of 2.5 kg olives per treatments.

3. Results and discussion

3.1. Vegetative Growth and leaf area

No effect of the different potassium fertilization treatment was observed on vegetative growth (figure 1). However, the leaves of the two foliar treatments had a higher leaf area than the control and the treatments with K applied in soil fertilization (Table 2). This increase could enhance the leaf photosynthetic capacity, as mentioned by Bongi and Palliotti (1994), inducing a higher assimilates availability for fruit growth.

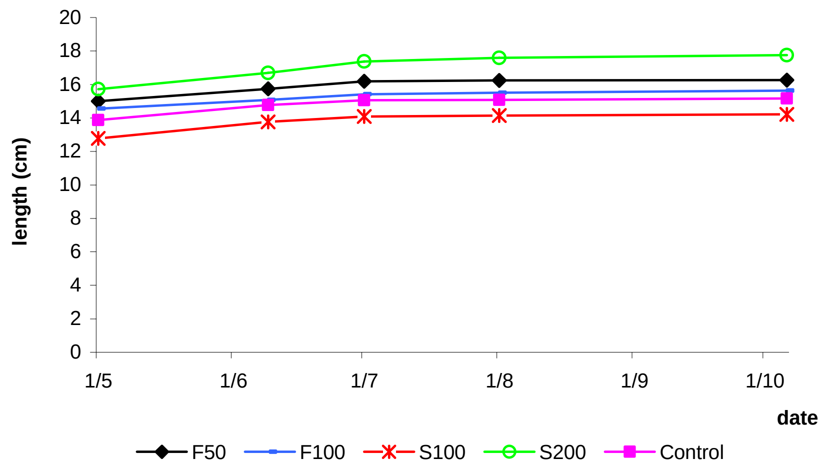

Figure 1. The shoot growth (cm) for the different potassium fertilization treatments

Table 2. The different potassium treatments effect on Leaf area (cm²)

Treatments		Mean leaf area (cm^2)
Control		**3.89** [a]
KNO_3	F50	**4.38** [b]
	F100	**4.36** [b]
	S100	**3.94** [a]
	S200	**4.24** [a b]

Test Duncan [a,b]

3.2. Fruit maturity and quality

The pattern of fruit growth was not influenced by fertilization treatment (fig. 2) although fruit growth was higher during stage 3 for the 100% foliar treatment but this increase was not statistical significant. The same result was observed by Inglese et al (2002).
At maturity, fruit fresh weight and flesh to pit ratio were lower in untreated trees (Table 3). The higher value was observed for the 100% foliar treatment. This result could be a consequence of a higher assimilates availability.
Foliar nutrition decreased oil content in the fruit with no differences between the control and the soil fertilization.

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

Treatments		**Fruit Weight (g)**	**Flesh to Pit ratio**	**Oil content (%)**
Control		0.61 [a]	2.94 [a]	21.68 [bc]
KNO_3	**F50**	0.66 [b]	3.19 [b]	20.30 [a]
	F100	0.81 [d]	3.65 [c]	20.18 [a]
	S100	0.70 [c]	3.25 [bc]	21.26 [b]
	S200	0.69 [bc]	3.10 [b]	22.01 [c]

Test Duncan [a, b, c]

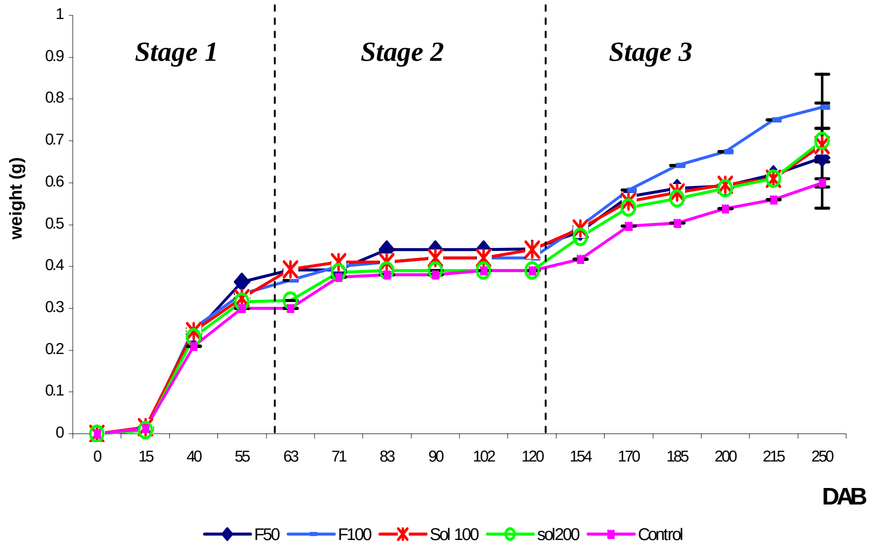

Figure 2. The fruit growth (g) for the different potassium fertilization treatments

The potassium fertilization decreases the chlorophyll content with lower value for foliar treatment, which could be an indication of fruit maturity. Lazzez et al. (2002) working with Chemlali cultivar observed a decrease from 6.7 ppm to traces during maturity process.
All the oil has an extra virgin quality; the highest value is 0.32 % lower than the 1% reference value for this quality (C.O.I, 1998). No significant differences were observed for the polyphenols (Table 4). Inglese et al (2002) got the same results with KNO_3 treatment.

Table 4. The different potassium treatments effect on oil qualitative characteristics

Treatment		Chlorophyll content (ppm)	Acidity (%)	Polyphenols content (ppm)
Control		4.48	0.24	38.90
	F50	3.86	0.26	47.19
KNO_3	**F100**	2.95	0.32	59.37
	S100	4.38	0.24	43.50
	S200	4.12	0.22	44.04

The oil chromatography analysis shows no effect of the potassium fertilization treatment (Table 5) as reported previously by Simeos et al. (2002) working on nitrogen and potassium fertilization effect on the qualitative profile of the oil.

Table 5. The different potassium treatments effect on olive oil acidic composition

Treatment		C16:0	C16:1	C18:0	C18:1	C18:2	C18:3	C20:0	C20:1
Control		16.73	1.97	2.11	63.89	13.98	0.66	0.37	0.18
	F50	16.74	1.88	2.15	64.31	13.52	0.68	0.40	0.20
KNO_3	**F100**	16.50	1.82	2.11	65.01	13.23	0.65	0.37	0.19
	S100	16.44	1.87	2.19	65.00	13.17	0.65	0.40	0.18
	S200	16.59	1.90	2.14	64.42	13.68	0.61	0.38	0.17

3.3. Leaf Analysis

The foliar analysis showed no effect of the treatment on N, P and Mg content (Table 6). However, for nitrogen and phosphorus the concentration were consistently below the normal range showing an important deficiency situation (Freeman et al., 1994).
For the potassium, the control concentration was approaching the normal range. The potassium applications increase its mineral content to the optimum range with higher values for foliar treatments.

Table 6. The different potassium treatments effect on Leaf mineral composition compared to Freeman et al. (1994) norms

Treatments		**Foliar analysis (%)**			
		N	**P**	**K**	**Mg**
Freeman et *al*. (1994) norms		1.50-2.00	0.10-0.30	0.80	0.10
Control		0.84 [a]	0.07 [a]	0.75 [a]	0.13
KNO_3	F50	0.87 [a]	0.07 [a]	0.96 [b]	0.16
	F100	0.77 [a]	0.07 [a]	1.01 [b]	0.15
	S100	0.77 [a]	0.08 [a]	0.96 [b]	0.17
	S200	0.91 [a]	0.06 [a]	0.80 [a]	0.18

Test Duncan [a, b, c]

4. Conclusion

In this study the objective was to determine the effect of the K fertilization and the better application methods. As with many fruit crops, K fertilization is expected to improve olive yield and quality. During this first year of the experiments, the potassium fertilization enhanced the fruit weight and the flesh to pit ratio while no significant effect was observed on vegetative growth, fat content and acidic composition of the extra virgin oil obtained. The better results were observed with the 100% requirement foliar fertilization. Also the results show a potassium leaf deficiency for the control justifying K fertilization.

Those experiments should be continued for at least two other years. A lot of fertilization experiments on olive trees start showing results only after three years (Villalta, 1997).

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