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EFFECTS OF IRON AND POTASSIUM FERTILIZATION ON 'BALADY MANDARIN' TREES GROWN IN CALCAREOUS SOIL

[52]

Maksoud, M.A.[1]; M.M.S. Saleh[1]; L.F. Haggag[1] and B.N. Boutros[1]

ABSTRACT

The effects of foliar iron application and soil application of potassium on leaf chlorophyll content, fruit yield and fruit quality of 'Balady mandarin' grown in calcareous soil were studied. Treatments applied were : 1) foliar application of $FeSO_4$ (250 mg/L and 500 mg/L), 2) soil application of K_2 SO_4 (800 gm / tree and 900 gm/tree), 3) combinations of foliar and soil treatments. All treatments produced significant increases of leaf chlorophyll content compared to control treatment. Combination of foliar $FeSO_4$ and soil application of K_2SO_4 produced synergistic increases of total leaf chlorophyll content higher than foliar or soil application alone. The same trend was obtained also with fruit yield. Parameters of fruit quality (TSS, fruit weight, fruit volume and fruit juice weight) showed improvements due to the treatments applied . The higher rate of foliar iron application combined with either of the two rates of soil application of potassium produced the highest values..

Key words: Iron, Potassium, Citrus, Calcareous soil

INTRODUCTION

Calcareous soils containing free calcium carbonate characterized by high pH. In these soils, iron deficiency has been noted worldwide in a wide variety of fruit trees. Iron chlorosis considered a nutritional problem responsible for significant decreases of yield, fruit size and fruit quality (**El-Kassas, 1984; Sanz, 1997; Tagliavini *et al* 2000**).

Soil correction of Fe chlorosis in fruit trees is normally achieved by Fe^{++} chelates (**Papastylianou, 1990 and Legaz *et al* 1992**). On the other hand, absorption of some metals such as Mn, Cu and Ni may be affected by chelating agents (**Wallace *et al* 1992**). Besides, it has to be repeated every year because Fe is rapidly immobilized in the soil.

Potassium had been reported to play an important role concerning Fe chlorosis as potassium salts, particularly K_2SO_4, decrease pH value and thereby iron converted from ferrichydroxide and ferric chelates to mobilized forms. (**Oertili and Opoku, 1974 a & b**). Additionally, potassium shortages have been reported to

1- Pomology Research Department, National Research Center, Dokki, Cairo, Egypt

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stimulate iron deficiency (**Chapman *et al* 1947 and Bolle-Jones, 1955**).

The objective of this research was to further investigate the role of foliar $FeSO_4$ application and soil application of K_2SO_4 on leaf chlorophyll content, yield and fruit quality of 'Balady mandarin' grown in calcareous soil.

MATERIAL AND METHODS

The study was carried out in orchard located at west of Alexandria where the soil is classified as calcareous. In the year 2001, thirty six 'off trees' uniform in vigour and size of 'Balady mandarin' were chosen to receive iron and potassium treatments.

Trees were 15 years old. Details of physico-chemical characteristics of the soil are presented in Table (1):

Table 1. Some physico-chemical characteristics of soil

Characteristics		Value
pH		8.60
Total N	(ppm)	200.00
Total P	(ppm)	12.00
Total Fe	(ppm)	270.00
Total Mn	(ppm)	55.00
Total Zn	(ppm)	50.00
Organic matter	(%)	00.20
Calcium carbonate	(%)	21.00
Soil texture		Loamy sand

$FeSO_4$ at rates: 250 mg / L and 500 mg/L were applied as foliar iron application at beginning of March 2001 and 2002 (just before blooming). Soil potassium treatments were added in form K_2SO_4 at rates: 800 gm/tree and 900 gm/tree in May of the above mentioned years. Doses of K_2SO_4 were mixed with the soil around canopy of trees. Combinations of $FeSO_4$ and K_2SO_4 were also used. All trees received the fertilization programme applied at the farm (25 Kg/tree of organic manure; 1 unit N/tree as urea, and 0.25 unit P_2O_5 /tree as superphosphate). Treatments inducted in this study were as follows :

Control (Trees received only the usual treatments of the form)....... T_1
Foliar application of $FeSO_4$ (250 mg/L)................................ T_2
Foliar application of $FeSO_4$ (500 mg/L)................................ T_3
Soil application of K_2SO_4 (800 gm / tree).......................... T_4
Soil application of K_2SO_4 (900 gm/tree) .... T_5
Foliar application of $FeSO_4$ (250 mg/L)+Soil application of K_2SO_4 (800gm/tree)........................ T_6
Foliar application of $FeSO_4$ (250 mg/L)+Soil application of K_2SO_4 (900gm/tree)........................ T_7
Foliar application of $FeSO_4$ (500 mg/L) + Soil application of K_2SO_4 (800gm/tree)........................ T_8
Foliar application of $FeSO_4$ (500 mg/L)+Soil application of K_2SO_4 (900gm/tree)........................ T_9

In early October of each season, leaf samples from non-fruiting terminals of spring growth were collected. Each sample was composed of 10 leaftets. The leaves was cleaned with damp cloth, then washed three times with redistilled water.

Total chorophyll content was determined by spectrophotometer after acetone extraction (**Bruinsma, 1963**). Harvesting was applied when fruits attained maturity; mid December of years 2001 and 2002. Fruit yields were recorded as Kg/tree. Fruit samples were taken to determine TSS, fruit weight, fruit volume and fruit juice weight.

The experiment established on the same trees during the two seasons in a randomized complete block design with four replicates (one replicate = one tree). The effects of treatments subjected to analysis of variance and means compared using Duncan Multiple Range Test (DMRT) at 0.5 level (**Duncan, 1955**).

RESULTS

Compared to control (T_1), all treatments showed significant differences concerning total leaf chlorophyll content either in 1st season or in 2nd one (Tables 2 and 3). Comparison between foliar $FeSO_4$ application and soil application of K_2SO_4 either at the low rate (T_2 & T_4) or at the higher one (T_3 & T_5) revealed that foliar $FeSO_4$ had superiority over soil application of K_2SO_4 in exerting improvements of leaf chlorophyll content. Additionally, results presented in Tables 2 and 3 cleared that combination of foliar $FeSO_4$ and soil application of K_2SO_4 produced synergistic increases of total leaf chlorophyll content higher than foliar or soil application alone. When foliar $FeSO_4$ combined with soil application of K_2SO_4, results showed that lower rate of foliar $FeSO_4$ (250 mg/L) combined with soil application at the higher rate (900 gm/tree), resulted more increases of chlorophyll content than produced when combined with the lower rate (800 gm/tree). On the other hand, non-significant differences of chlorophyll content between the two rates of soil application of K_2SO_4 when combined with the higher rate of foliar $FeSO_4$ (500 mg/L) were noted.

The yield of the treated trees appeared to be possitively influenced by foliar $FeSO_4$ or soil application of K_2SO_4 (Tables 2 and 3). Yield of all treatments showed significant increments compared to control in spite of non-significant differences between some treatments, as follows : (T2 & T5) and (T8 & T9) at the 1st season; (T2 & T4 & T5) and (T8 & T9) in the 2nd one. Furthermore, results indicated that combination of foliar $FeSO_4$ and soil application of K_2SO_4 exerted pronounced increments of fruit yeild compared to that resulted when foliar or soil treatments applied alone.

In general, paramders of fruit quality (TSS, fruit weight, fruit volume and fruit juice weight) of treated trees had grater values compared to control. (Tables 2 and 3). Highest values of fruit quality were achieved by T8 and T9.

DISCUSSION

As iron is essential for chlorophyll synthesis is that it is necessary for the synthesis of γ amino levulinic acid, a precusor of chlorophyll (**Bogorad, 1966**), a reduction of photosynthesis due to Fe-deficiency is expected (**Bottrill *et al* 1970; Basiouny and Biggs** 1976). Such reductions of photoassimilate production would be responsible for decreasing of carbohydrates allowed to reproductive and vegetative development. Fe-deficiency play an important role on leaf and flower composition (**Sanz *et al* 1994**). Additionally, it is known that essential elements affected on fruit set in one way or another (**Chaplin and**

Table 2. Effect of different treatments of foliar of $FeSO_4$ and soil application of K_2SO_4 on total chlorophyll, yield, and fruit quality of 'Balady mandarin' planted in calcareous soil (First season).

Determinations / Treatments	Total chlorophyll (μ mole m^{-2})	Yield Kg/tree	TSS %	Fruit wt. (gm)	Fruit vol. (Cm^3)	Fruit juice wt. (gm)
T1	304 h.	19.00 c	8.81 c	80.21 g	90.20 h	32.00 f
T2	350 f	20.50 bc	9.92 bc	80.95 f	92.04 f	33.09 e
T3	375 d	20.85 bc	9.99 bc	83.00 d	93.50 d	33.98 cd
T4	344 g	20.00 c	9.88 bc	80.30 g	91.85 g	33.00 e
T5	367 e	21.20 bc	9.94 bc	82.50 e	93.00 e	33.80 d
T6	406 c	22.50 b	10.01 bc	85.60 c	93.86 c	34.12 c
T7	420 b	24.90 a	10.09 ab	86.00 b	94.99 b	34.90 b
T8	503 a	26.00 a	10.29 a	87.90 a	95.50 a	35.00 ab
T9	507 a	26.20 a	10.31 a	88.00 a	95.60 a	35.11 a

Means in a column followed by the same letter(s) are not significantly different at the 95% probability level according to Duncan test.

Table 3. Effect of different treatments of foliar of $FeSO_4$ and soil application of K_2SO_4 on total chlorophyll, yield, and fruit quality of 'Balady mandarin' planted in calcareous soil (second season).

Determinations / Treatments	Total chlorophyll (μ mole m^{-2})	Yield Kg/tree	TSS %	Fruit wt. (gm)	Fruit vol. (Cm^3)	Fruit juice wt. (gm)
T1	309 g.	9.70 f	8.76 d	80.19 fg	90.16 g	31.80 g
T2	347 f	10.00 e	9.88 c	80.01 g	92.09 f	33.12 e
T3	379 d	11.50 d	10.02 bc	83.22 d	93.44 d	34.00 c
T4	300 h	10.00 e	9.95 bc	80.21 f	91.92 fg	32.95 f
T5	360 e	10.20 c	9.99 bc	82.61 e	93.00 e	33.76 d
T6	409 c	12.40 c	10.10 bc	85.76 c	93.91 c	34.21 b
T7	428 b	13.00 b	10.13 ab	86.40 b	94.94 b	35.02 a
T8	509 a	13.50 a	10.29 ab	87.80 a	95.62 a	35.15 a
T9	509 a	13.70 a	10.33 a	88.09 a	95.70a	35.15 a

Means in a column followed by the same letter(s) are not significantly different at the 95% probability level according to Duncan test.

Westwood, 1980). Therefore, decreasing of fruit yield due to Fe-chlorosis can be interpreated as a result of negative effects of Fe-deficiency on fruit set and development as discussed previously. The improvement of leaf chlorophyll content that achieved by treatments applied indicated the important role of foliar $FeSO_4$ and soil K_2SO_4 application on amelioration of Fe-chlorosis of "Balady mandarin" which reflected on fruit quantity and quality.

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مجلة حوليات العلوم الزراعية، كلية الزراعة ، جامعة عين شمس ، القاهرة ، م(٤٨)، ع (٢)، ٧٤١-٧٤٦، ٢٠٠٣

تأثير التسميد بالحديد والبوتاسيوم على اشجار اليوسفى البلدى المنزرعة فى أرض جيرية

[٥٢]

محسن البرت مقصود[١] - محمد ماهر سعد صالح[١] - ليلى فؤاد حجاج[١] - بطرس نصر بطرس[١]

١- قسم بحوث البساتين - المركز القومى للبحوث - الدقى - القاهرة - مصر

تم دراسة تأثير التسميد بسلفات الحديدوز رشا فى شهر مارس بمعدلات (صفر، ٢٥٠ ملليجرام / لتر ، ٥٠٠ ملليجرام /لتر) وسلفات البوتاسيوم كإضافة أرضية فى شهر مايو بمعدلات (صفر، ٨٠٠ جم / شجرة، ٩٠٠ جم / شجرة) على محتوى الأوراق من الكلوروفيل ومحصول الثمار وجودتها لاشجار اليوسفي البلدى المنزرع فى ارض جيرية على مدى موسمين.

وقد أظهرت النتائج المتحصل عليها ان كل المعاملات قد ادت الى زيادة معنوية فى محتوى الأوراق من الكلوروفيل قياسا على المقارنة، وان المعاملات التى جمعت بين الحديد رشا والبوتاسيوم كإضافة أرضية قد أدت الى زيادة محتوى الأوراق من الكلوروفيل بدرجة اكبر عما لو استخدام كل منهما منفردا. أيضا أظهرت النتائج تأثر المحصول بنفس الاتجاهات السابقة.

من ناحية أخرى تحسنت جودة الثمار نتيجة لجميع المعاملات المستخدمة قياسا على المقارنة وسجلت أعلى قيم لقياسات جودة الثمار فى حالة التركيز الأكبر للحديد رشا مع ايا من التركيزين المستخدمين للبوتاسيوم كاضافة أرضية.

تحكيم: ا.د زينب حسين بحيـــرى

ا.د ممدوح حسيب عباس