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Effect of Gibberellic Acid and Potassium Spray on Fruit Quality of Navel Oranges.

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ABSTRACT

Gibberellic acid or potassium sulphate as a spray treatment was used either alone or in different formulations to improve fruit quality of Navel oranges during 1994 and 1995 seasons.The formulation containing GA_3 plus potassium sulphate in the presence of ethanol caused a significant increase in fruit weight in both seasons without an adverse effect on peel thickness. Furthermore, other treatments did not cause a significant change in peel thickness as compared with the control in both seasons. The formulation containing GA_3 plus potassium sulphate in the presence of ethanol resulted in a significantly higher vitamin C than the control in the first season. Other treatments of either potassium sulphate or GA_3 alone or in the presence of ethanol were not consistent in improving Navel orange quality. There was a possibility of a synergistic effects between GA_3 and potassium under field conditions, especially on increasing fruit weight.

Key Words :Gibberellins, potassium, fruit quality, formulations, spray applications, fertilization, nutrition.

INTRODUCTION

Navel orange is a demanded fresh fruit due to its seedlessness. Considerable attention has been paid to the use of gibberellic acid to improve the quality of these fruits with varying degrees of success (

Gilfillan et al., 1974; Shawki et al., 1978). Certain fruit quality of Navel oranges is desired and producers are suffering from sorting out fruits that don't meet the requirements for export. Gibberellic acid is generally used at concentrations between 10 to 40 ppm depending on the time of application (Lima and Davies, 1981, 1984). Since it is required to spray frequently on a large scale with GA_3, cost is a limiting factor for many orange growers. It is needed to reduce the concentration of sprayed GA_3 without sacrificing its effectiveness on fruit quality.

Potassium, on the other hand, was reported to increase fruit size(Okada et al., 1995) and other fruit characteristics such as peel thickness and juice percentage (Smith and Rasmussen, 1960) or titratable acidity (Embleton et al., 1956). Most studies have been focussing on soil applications of potassium using large quantities of its salts (Bevington, 1986; Beridze, 1986; Chapman, 1982; Valenzuela et al., 1986). Soil applications of potassium at different rates in addition to other nutrients such as nitrogen, phosphorus, magnesium or sulfur could have antagonistic effects (Hume et al., 1985; Androulakis et al., 1994; Desai et al., 1986). Furthermore, soil application of potassium sulphate alone may not be effective in improving fruit quality (Plessis, 1983).

The spray application of potassium could be more effective and economic. Potassium might be able to directly diffuse to the target tissues of fruits.

The objectives of this study were to use GA_3 at a relatively low concentration than that reported in the literature and to investigate the effect of potassium spray on fruit quality. The possibility of synergistic effect between GA_3 and potassium as a spray treatment was a major objective addressed in this study.

MATERIALS AND METHODS

The field trials were conducted during the two successive seasons 1994, 1995 at a private orchard near Al-Mamoura, Alexandria. Navel orange trees were 15 years old and grafted on sour orange rootstock. Trees were uniform and grown in a loamy soil under the standard commercial program with an established furrow irrigation system. Using a hand sprayer, fruits of each tree were sprayed to the run off at each growing season. The first spray was done on May 26 while the second was on Aug. 13 in both seasons. The surfactant Tergitol was included in all sprayed solutions at a concentration of 0.1%, v/v. The treatments were: water, ethanol (2.5%, v/v), GA_3 at 5 ppm, potassium sulphate (1%, w/v), GA_3 plus ethanol, potassium sulphate plus ethanol, and GA_3 plus potassium sulphate and ethanol. The chemicals used at the last three combinations were at the same mentioned concentrations above. Three replications were used with each treatment in a completely randomized design. One tree represented one replication.

At horticultural maturity, Navel oranges were harvested (10 fruits per tree) for the determination of some physical and chemical properties such as fruit weight (g), fruit length, diameter and peel thichness using a hand calipar (cm), peel percentage relative to the total fruit weight (%), juice volume by using a cylindrical tube (ml), total soluble solids (TSS) by a hand refractometer, total acidity by titration against 0.1 N NaOH (%), and vitamin c content of the juice using the endophenol method (mg/100 ml juice) reported by A.O.A.C. (1984).

Data was statistically analyzed using the SAS (1982) computer software and the differences among the treatments mean were determined using the least significant difference.

RESULTS AND DISCUSSION

The data indicated that GA_3 sprayed fruits tended to have higher fruit weight when compared with the control. The difference in fruit weight between the control and GA_3 treatment was significant in the second season only. When potassium sulphate was sprayed alone, there was a slight increase in fruit weight and the difference was not statistically significant in both seasons (Tables 1 and 2). However, when ethanol was added to potassium sulphate, this combination resulted in significantly greater fruit weight in the first season only (Table 1). Similar trend was obtained with the addition of ethanol to GA_3 in terms of significantly increasing fruit weight in the first season only. Moreover, when the formulation of GA_3 plus potassium sulphate and ethanol was used, it resulted in significantly higher fruit weight in both seasons (Tables 1 and 2).

With regard to fruit length, there was a trend of greater values especially with the use of either potassium sulphate plus ethanol or GA_3 plus ethanol as compared with the control. However, the only significant difference for fruit length was obtained with the formulation of GA_3 plus potassium sulphate in the presence of ethanol during the second season (Tables 1 and 2).

Regarding fruit diameter, the data showed that there was a consistent trend of higher diameter in the first season especially with the use of ethanol containing solutions (potassium or GA_3 solutions or their combination) but the differences were not significant. Furthermore, the difference in fruit diameter was significant in the second season with GA_3, potassium, potassium plus ethanol and the formulation of potassium plus GA_3 in the presence of ethanol (Tables 1 and 2).

None of the treatments caused a significant change in peel thickness in both seasons (Tables 1 and 2) when compared with the control. However, peel percentages were significantly higher than that of the control with all treatments in both seasons except with ethanol alone or GA_3 plus ethanol in the first season.

Juice volume tended to increase with all treatments when compared with the control. However, the only significant difference was obtained with the application of GA_3 alone or the combination of GA_3 plus potassium and ethanol in the second season (Table 2).

Total soluble solids were not statistically different between treatments and the control in the two studied seasons. Furthermore, there were no statistical differences among all sprayed solution treatments in both seasons. (Tables 1 and 2).

Fruit acidity was not significantly affected by treatments as compared with the control during the first season (Table 1). Fruits had slightly reduced acidity when treated with GA_3, potassium sulphate, potassium sulphate plus ethanol or the formulation of potassium plus GA_3 and ethanol. However, in the second season

(Table 2) there was a significant reduction in fruit acidity by all treatments when compared with the control.

Potassium treated fruits attained significantly higher vitamin C content in the first season (Table 1). Moreover, when potassium was combined with GA_3 in the presence of ethanol, fruits also contained significantly higher vitamin C than the control. This trend was not consistent in the second season (Table 2).

The present study provided evidence about a possible synergistic effect between potassium and GA_3. The formulation containing GA_3 plus potassium sulphate was able to consistently increase fruit weight in both seasons without adversely affecting peel thickness. When either GA_3 or potassium sulphate was used alone, results were not consistent from season to season. The use of potassium as a spray treatment was also recommended in the studies of Erner et al. (1993); Cicala and Catara (1994). Attention has been only made to soil applications of potassium (Bevington, 1986; Beridze, 1986; Chapman, 1982). There is a need for using potassium as a spray treatment since it was reported that it is difficult if not impossible to raise levels of potassium in citrus trees growing on calcareous or alkaline soil to the level easily achieved on acid sands (Reitz and Long, 1952). The possible antagonistic effects between potassium and other nutrients, through soil addition, such as nitrogen, magnesium, or phosphorus were also reported (Hume et al., 1985; Androulakis et al.,1994; Desai et al., 1986). Furthermore, other studies reported no effects of potassium sulphate application to soil on fruit number, fruit size, fruit shape, or fruit peel or pulp weight of citrus (Valenzuela et al., 1986; Plessis, 1983). Peel thickness was reported to increase with soil applications of potassium (Babu et al., 1986; Chapman, 1982)

Reduction of acidity by potassium applications in this study is supported by others (Cicala and Catara, 1994). In Kordize and Kuznetsov (1983)they reported that potassium sulphate caused an increase in vitamin c in Satsuma fruits which agrees with our finding in the first season. However, potassium sulphate application as a soil dressing had no effect on fruit quality of grapefruits (Valenzuela et al., 1986).

The inconsistent results related to fruit quality, found in this study, with GA_3 treatment was also supported by the study of Shawki et al., 1978 on Navel oranges. Applications of GA_3 in September did not influence fruit size, shape, rind thickness, or internal quality (Coggins and Hield, 1962). Results of GA_3 application were not consistent. Lima and Davies (1984) applied GA_3 at 20 ppm two months prior to harvest and found that fruit size was increased. A combination of GA_3 (5-20 ppm) plus 2,4-D was an important part of the production program for navel oranges in California for effective delay of rind softening and preventing fruit drop but had little effect on internal fruit quality (Coggins et al., 1960).

The consistent increase in fruit weight without an accompanied increase in peel thickness in both seasons by the formulation of GA_3 plus potassium in the presence of ethanol suggests the possibility of affecting such characteristics by a spray application.

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Table 1. Fruit quality characteristics of Navel oranges as influenced by GA_3, potassium or their combination during 1994 season.

Treatments	Fruit Weight (g)	Fruit Length (cm)	Fruit Diameter (cm)	Peel Thickness (cm)	Peel (%)	Juice Volume (cm^3)	TSS (%)	Acidity (%)	Vitamin C Mg/100 ml
Control	282.0	10.6	10.4	0.28	22.2	104.7	10.3	1.07	48.8
EtOH	290.0	10.8	10.6	0.30	23.4	107.7	10.1	1.08	47.5
GA_3	314.0	10.5	10.3	0.32	27.1	116.1	10.3	1.02	53.6
K_2SO_4	306.0	11.2	11.0	0.31	26.4	113.4	9.8	0.98	56.3
GA_3+EtOH	340.0	11.8	11.4	0.36	24.5	112.4	10.4	1.06	51.6
K_2SO_4+EtOH	325.0	11.6	11.4	0.34	26.4	119.7	10.8	0.94	57.7
GA_3+K_2SO_4+ EtOH	360.0	11.4	11.2	0.42	28.6	123.3	10.4	1.00	60.3
LSD (0.05)	38.0	2.2	2.7	0.20	3.4	23.1	1.0	0.29	6.1

Table 2. Fruit quality characteristics of Navel oranges as influenced by GA_3, potassium or their combination during 1995 season.

Treatments	Fruit Weight (g)	Fruit Length (cm)	Fruit Diameter (cm)	Peel Thickness (cm)	Peel (%)	Juice Volume (cm^3)	TSS (%)	Acidity (%)	Vitamin C Mg/100ml
Control	265.0	8.4	8.3	0.29	22.8	92.5	11.0	1.25	49.5
EtOH	290.0	9.2	9.0	0.24	25.0	101.4	9.9	0.88	52.2
GA_3	335.0	10.6	11.4	0.33	28.4	116.9	11.0	1.07	46.2
K_2SO_4	312.0	9.9	9.8	0.37	28.0	109.4	10.6	1.03	50.8
GA_3+EtOH	283.0	9.4	9.3	0.29	26.9	98.7	10.2	0.65	56.3
K_2SO_4+EtOH	300.0	9.8	9.7	0.34	27.5	104.8	10.4	0.88	48.8
GA_3+K_2SO_4+ EtOH	352.0	11.2	11.0	0.32	30.1	122.8	10.4	0.96	43.7
LSD (0.05)	54.0	2.3	1.4	0.13	1.9	19.2	1.5	0.14	7.8