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Response of Grand Naine Banana Plants Grown under Different Soil Moisture Levels to Antitranspirants Application

A.S.El-Khawaga
Department of Horticultural, Faculty of Agriculture, South Valley University Qena, Egypt

ABSTRACT

The effect of two soil moisture potential 40 and 60% of the available water depletion with spraying three types of antitranspirants at 2% each on water consumptive, water use efficiency, growth, nutritional status, yield and fruit quality were studied . Results indicated that, varying soil moisture contents had no effect on leaf nutrient content, yield and fruit quality. However, using 60% of the available water depletion effectively reduced water consumption use and enhanced water use efficiency rather than using 40%. Most of the growth, yield and quality parameters as well as water use efficiency were improved significantly influenced by spraying antitranspirants which were responsible for reducing water consumptive use. Only, the number of green leaves they had no effect comparing with the check treatments. The effectiveness clearly showed with using calcium carbonate, Green miracle and kaolin in descending order in the previously studies. Under these conditions ,using calcium carbonate weekly at 2 and 60% of the available water depletion that improved productivity as well as saving irrigation water amounts of Grand Naine banana plants.

Key words: Grand naine banana, soil moisture levels, antitranspirants, calcium carbonate, green miracle, kaolin

INTRODUCTION

It is well known that bananas need large amounts of water to maintain productivity (Girona *et al*., 1993). At the same time, the increasing limitation of water availability for irrigation in large areas of the world, there was an increased risk of losing irrigated land. Since, any material could improve the Water Use Efficiency (WUE) for mature fruit trees and reducing applied water must be used (Glenn, 2000).

Water use is the water that is incorporated in plant tissue, evaporated by the plant, soil and is controlled by the environment, plant and soil factors. High temperature degree that increasing evaporation rate and the amount of needed water for banana plants, especially when it was planted in new reclaimed area which characterized with low water supply. Under subtropical conditions like Egypt, using antitranspirants may decreasing transpiration rate from plant leaves and improving water use efficiency (Makus, 1997; Singh *et al*., 1999). On the other hand, water deficits not only decreased vegetative growth but also yield, and fruit quality were affected (Daniells *et al*., 1987) that lead to a slower fruit growth rates or a shift in the relationship between fruit growth (size) and greenlife (Ke, 1979; Holder and Gumbs, 1983; Robinson and Alberts, 1986; Asoegwu and Obiefuna, 1987).

In general adjusting of irrigation in various banana cultivars was essential for improving water use efficiency as well as yield quantitatively and qualitatively. There are numerous studies

showing that anitranspirants for saving water and improving production of fruit crops (Hassan and Seif, 1997; Prakash and Ramachandran, 2000; Sophocleous, 2004; Saleh and El-Ashry-Soad, 2006; Ebrahiem-Asmaa, 2012; Ahmed *et al*., 2012). They reported that antiranspirants very effective for reducing water consumption for several plants.

The general effects of antitranspirants on saving water due to reduce transpiration through reduce the stomata opening by forming a film (kaolin) or reduction of stomata aperture (calcium carbonate) and reflecting materials (Green miracle). The decrease in stomata aperture and heat load on the leaf as well as reduction in transpiration about 10-35% over three weeks period, under field conditions (Mishra and Pradhan 1972; Shabaan *et al*., 1989; Han, 1990; Steinberg *et al*., 1990 and Nasaraoui, 1993).

The aim of this study was examining the effect of three types of antitranspirants (calcium carbonate, Green miracle and kaolin) under different soil moisture levels on vegetative growth, leaf mineral contents, yield and fruit quality of Grand Naine bananas.

MATERIALS AND METHODS

The study was carried out during 2009/2010 and 2010/2011 seasons under drip irrigation on the mother plants and first ratoons of Grand Naine banana plants grown on sandy soil at El- Marachda village, in Qena Governorate. Soil analysis was done according to the procedures outlined by Wilde *et al*. (1985) (Table 1).

Experimental treatments and design: The study design in split plot and the treatments were arrangement in complete randomized block .The two levels of soil moisture 40 and 60% of the available soil moisture were used as the main plot (factor A). The antitranspirant (calcium carbonate, Green miracle, kaolin at 2% each and control were arranged in the sub plate (factor B). The experiment contained eight treatments. Each treatment was replicated three times on three plants per hole.

Table 1: Soil analysis

Characters	Values
Sand (%)	86.92
Silt (%)	8.11
Clay	4.97
Texture	Sandy
pH (1:2.5 extract)	8.1
EC (on saturation extract) dS m^{-1}	0.67
$CaCO_3$	1.95
Total N	0.05
Available P (Olsen method) (ppm)	3.6
Available K (ammonium acetate) (ppm)	141.5
Soluble catious (meq L^{-1})	
Ca^{++}	2.50
Mg^{++}	2.00
Na^{+}	1.57
K^{+}	0.07
Soluble anious (meq L^{-1})	
HCO_3^-	1.90
SO_4^-	1.97
Cl^-	2.95

Suckers were planted at 3.5×3.5 m apart and three suckers were selected per each stool and the others were removed. One row guard plants on each side of each treatment was used to prevent cross feeding by the roots. Soil moisture content was estimated gravimetrically at four depths, 0-15, 15-30, 30-45 and 45-60 cm and computed on even dry weight basis periodically every two days. The three antitranspirants were sprayed every week from early July till the end of October only on upper surface of the older leaves, but the newly six leaves were left without spray. All the selected plants received the usual horticultural practices that are already applied in the orchard except drip irrigation.

During both seasons, the following parameters were measured:

- Water consumptive use (cm and m^3 fad^{-1}.) was calculated by the differences in soil moisture content in soil samples taken before and after each watering (Doorenbos and Pritt, 1984) using the following Equation:

$$C = D \times AD \times \frac{e_2 - e_1}{100}$$

where, C is water consumptive use (cm.), D is soil depth, AD is bulk density (g cm^{-3}) e_1 and e_2 is soil moisture percentage before and after irrigation, respectively. It was calculated in seasonal and monthly values from February to the same next year.

The field capacity, the permanent wilting percentage, the available water and bulk density were determined as soil content and shown in Table 2. Table 3 shows the meteorological data in the Qena region during the two seasons of the study:

Table 2: Percentages of soil moisture contents and bulk density (g cm^{-3}) of the tested orchard

Soil depth (cm)	Field capacity (%)	Wilting point (%)	Available water (%)	Bulk density (g cm^{-3})
0.0-15	8.50	2.30	6.20	1.55
15-30	8.10	2.20	5.90	1.57
30-45	7.90	2.10	5.80	1.59
45-60	7.80	2.10	5.70	1.60

Table 3: Meteorological date for Qena region during 2009-2010 and 2010-2011 seasons

	2009-2010			2010-2011		
Month	Maximum Temp. (C°)	Minimum Temp. (C°)	Relative humidity (%)	Maximum Temp.	Minimum Temp. (C°)	Relative humidity (%)
Jan.	22.5	9.0	56.0	21.0	9.0	63.0
Feb.	24.5	8.9	49.0	22.0	10.6	55.0
Mar.	29.3	14.0	47.0	27.8	13.5	55.0
Apr.	31.0	17.0	41.0	33.2	16.9	50.0
May.	34.6	19.0	38.0	34.5	18.9	47.0
June	35.0	22.0	40.0	36.7	21.0	51.0
July	36.6	23.3	48.0	37.3	22.7	58.0
Aug.	37.0	24.0	48.0	38.0	22.9	58.0
Sept.	35.0	23.0	49.0	35.2	22.0	57.0
Oct.	30.0	18.0	51.0	31.0	17.1	62.0
Nov.	26.3	14.0	52.0	22.7	15.0	62.0
Dec.	24.0	10.0	54.0	22.6	9.8	61.0

- Water use efficiency was estimated by dividing yield by m^3 water consumed fad^{-1}

Luxor meteorological station: At shooting stage, height and girth of pseudostem (cm), number of green leaves per plant while the third leaf from the top of each plant measured to express leaf area (Summer, 1985) by using the following equation according to Ahmed and Morsy (1999):

$$L.A = 0.67\ (L \times W) + 107.15$$

where, L.A is leaf area (cm^2), L is maximum leaf length (cm), W is maximum leaf width (cm).

In these leaves, percentages of N, P, K and Mg on dry weight basis were determined according to Wilde *et al.* (1985). At harvest, yield per fad. (Tons) was recorded. After artificial ripening, weight of finger (g), total soluble solids%, total and reducing sugars% (AOAC, 1995) and total acidity% (as g malic acid/100 g pulp) were determined.

Statistical analysis: was done using the method of new LSD at 5% to differentiate means (Snedecor and Cochran, 1972).

RESULTS AND DISCUSSION

The growth parameters had no effect between the two soil moisture levels. However, the enhanced on water consumptive and water use efficiency were observed at 60% of the available water depletion than using 40%. On the other hand , spraying calcium carbonate, was very effective than other the two antitranspirants in enhancing growth parameters, yield, fruit quality and water use efficiency. While, the best combination effects of two moisture levels and three types of antitranspirants on saving irrigation water amounts and improving productivity of Grand Naine banana plants, was observed by using 60% of the available water depletion with calcium carbonate weekly at 2%.

Water relations

Water consumptive use /plant: Data from Table 4 indicated that water consumptive use per plant (cm) was a significantly decreased as water stress increased (from 40-60%). It were 140.8 and 138.0 cm per plant in the first season and 157.0 and 151.0 cm in the second one for soil moisture levels namely 40 and 60%, respectively. At the same time, using the three antitranspirants significantly reduced water consumptive use per plant comparing with the check treatment. The great reduction on water consumptive was observed with using calcium carbonate which were (127.5 and 147.0), followed in ascending order by Green miracle (130.5 and 150.5) and kaolin (147.5 and 154.5). The same trend was observed in the second season. Irrigation at 60% available water depletion along with spraying calcium carbonate at 2% gave the lowest values of water consumptive use cm/plant which were (125.0 and 145.0). Untreated plants (control) at 40% gave the maximum values in water consumptive use cm/plant. Such findings could be attributed to the abiity of particle type of antitranspirants (calcium carbonate) than the other two antitranspirants in regulating water status of plants under these regions (Ranney *et al.*, 1989) furthermore, antitranspirants sprayer, under field conditions not only decreased the transpiration rate about 10-35% over a three week period, but also causes a clear reduction in stomata aperture of plants, this results lead to the improve of water use efficiency. (Mishra and Pradhan 1972; Shabaan *et al.*, 1989; Han, 1990; Steinberg *et al.*, 1990; Nasaraoui, 1993; Abd El-Kader *et al.*, 2006) noted that foliar sprays of magnesium carbonate as antitranspirants on 'Williams banana' decreased water consumptive use/plant.

Table 4: Effect of different moisture levels and antitranspirants on water consumptive use (cm and m^{-3} fad), yield (kg) per fad. and water use efficiency (kg m^{-3} water) of Grand Naine banana plants

	Soil moisture contents (A) (%)											
	Water consumptive use (cm) plant						Water consumptive nse (Thonsands) m^{-3} fad.					
	2009-2010			2010-2011			2009-2010			2010-2011		
Antitranspirants (B)	40	60	Mean (B)	40	60	Mean (B)	40	60	Mean (B)	40	60	Mean (B)
Control	156.0	148.0	152.0	167.0	161.0	164.0	6.6	6.2	6.4	7.0	6.80	6.9
Calcium carbonate	130.0	125.0	127.5	149.0	145.0	147.0	5.5	5.3	5.4	6.3	6.10	6.2
Green miracle	133.0	128.0	130.5	154.0	147.0	150.5	5.6	5.4	5.5	6.5	6.20	6.4
Kaolin	144.0	151.0	147.5	158.0	151.0	154.5	6.0	6.3	6.2	6.6	6.30	6.4
Mean (A)	140.8	138.0	00.0	157.0	151.0	000.0	5.93	5.80	0.0	6.60	6.35	0.0
New L.S.D at 5%	A	B	AB	A	B	AB	A	B	AB	A	B	AB
	2.1	2.0	2.8	2.0	1.9	2.7	0.2	0.2	0.3	0.2	0.20	0.3
	Water use efficiency (ton m^{-3} water)						Yield/ fad. (tons)					
Control	1.5	1.6	1.6	2.0	2.1	2.1	10.0	10.1	10.1	14.0	14.0	14.0
Calcium carbonate	2.5	2.7	2.6	3.4	3.6	3.5	14.0	14.1	14.1	21.5	22.0	21.8
Green miracle	2.3	2.4	2.4	2.9	3.1	3.5	13.0	13.2	13.1	19.0	19.5	19.3
Kaolin	2.0	1.9	2.0	2.5	2.7	2.6	11.9	12.0	12.0	16.5	17.0	16.8
Mean (A)	2.1	2.2	0.0	2.7	2.9	0.0	12.2	12.4	0.0	17.8	18.1	0.0
New LSD at 5%	A	B	AB	A	B	AB	A	B	AB	A	B	AB
	0.1	0.4	0.6	0.2	0.3	0.5	NS	1.0	NS	NS	1.8	NS

A, B and AB represent LSD value (Soil moisture contents) (A), Types of antitranspirants (B) and Soil moisture contents x Types of antitranspirants, respectively and NS means non significant

These results regarding irrigation treatments are in agreement with those obtained by Hassan and Seif (1997) and Sophocleous (2004).

The favorable influence of antitranspirants on reducing water consumptive use was emphasized by Liang *et al.* (2002), Saleh and El-Ashry-Soad (2006), Ebrahiem-Asmaa (2012) and Ahmed *et al.* (2012).

Seasonal water consumptive use m^{-3} fad^{-1}: Regardless of the effect of irrigation at consumption 40 and 60% of the available soil moisture and three type antitranspirants.

The results illustrated in Table 4 showed that water consumptive use m^3 fad^{-1}. significantly decreased as water stress increased (from 40-60%). It recorded (5930 and 6600) and (5800 and 6350) m^3water/faddan for soil moisture levels 40 and 60% in the first and second seasons. Also the three antitranspirants were significantly reduced Seasonal water consumptive use m^{-3} fad^{-1}. comparing with control. The great reduction on water consumptive/m^3 fad^{-1}. of Grand Naine banana was observed with using calcium carbonate (5400 and 6200), followed in decreasing order by Green miracle (5500 and 6400) and kaolin (6200 and 6400). The same trend was also obsorved in the second season.

The combination effects of moisture levels (40 and 60% of the available water depletion) and three type of antitranspirants on water consumptive use m^3 fad^{-1}. indicated that spraying of calcium carbonate alone at 2% gave the lowest values of water consumptive with watering at 60% available water depletion (5300 and 6100). Untreated plant (control) gave the maximum values in water consumptive use m^3 fad^{-1}. Previous results could be attributed to the ability of calcium

carbonate compared with the other antitranspirants in regulating water status of plants (Ranney *et al*., 1989).On the other hand, the clear response of other antitranspirants on water consumptive use fad^{-1} may be due to the important role of antitranspirants on saving water (Liang *et al*., 2002) decreasing the transpiration rate with also a clear reduction in stomata aperture of plants, resulting the improve of water use efficiency (Mishra and Pradhan 1972; Shabaan *et al*., 1989; Han, 1990; Steinberg *et al*., 1990; Nasaraoui, 1993; Abd El-Kader *et al*., 2006).

These previous finding in regarding irrigation treatments are in agreement with those reported by Hassan and Seif (1997) and Sophocleous (2004).

The beneficial effect of antitranspirants on reducing water consumptive use and improving productivity of fruit crops was supported by the results of Liang *et al*. (2002), Saleh and El-Ashry-Soad (2006), Ebrahiem-Asmaa (2012) and Ahmed *et al*. (2012).

Water use efficiency: Water use efficiency was used to show the yield (ton) fad^{-1} over water consumed m^3. It appears from the data in Table 4 that water use efficiency (ton m^{-3} water) significantly promoted with using soil moisture depletion at 60% which recorded (2.2 and 2.9) rather than using 40% (2.1 and 2.7) during the first and second seasons respectively on available water depletion. Also, water use efficiency significantly increased with using the three antitranspirants comparing with control. In descending order, using calcium carbonate, Green miracle and kaolin was significantly very effective in stimulating water use efficiency. The average values of both seasons were found to be (2.6 and 3.5), (2.4 and 3.5) and (2.0 and 2.6) with calcium carbonate, Green miracle and kaolin, respectively. As the interaction between water stress and antitranspirants treatment in water use efficiency/yield. The best and significant effect was observed at 60% of available water depletion accompanied with calcium carbonate at 2% they gave (2.7 and 3.6) m^3 water/ton. These results were true during both seasons. Such result might be reasonable since, more frequent irrigation period provide high evaporation opportunity from the relatively wet rather than dry soil surface (Devit *et al*., 1994; Levitt *et al*., 1995). On the other hand, the increment of WUE could be attributed to a particle type antitranspirants (calcium carbonate) which more effective than other in regulating water status and the photosynthetic activity of plants under these regions (Ranney *et al*., 1989). Furthermore, the antitranspirants sprayer, under field conditions not only decreased the transpiration rate about 10-35% over a three week period but also causes a clear reduction in stomata aperture of plants, decreasing water stress, these previous results lead to the improve of water use efficiency than control (Mishra and Pradhan, 1972; Shabaan *et al*., 1989; Han, 1990; Steinberg *et al*., 1990; Nasaraoui, 1993).

Yield fad^{-1}: There were no significant effects between two moisture levels on the yield in both seasons of study. However, treating the plants with any antitranspirants recorded a significant enhance in yield comparing with the check treatment. The best results to yield/fad observed with calcium carbonate, gave the best yield (14.1 and 21.8) in both seasons, respectively as compares with the other two treatments and the control. Followed in decreasing order by Green miracle (13.1 and 19.3) and kaolin (12.0 and 16.8) in this respect. The interaction between moisture content and application of antitranspirants had no significant effect on the yield/fad. In spite of the best results in this respect was found with calcium carbonate at 60% of the soil moisture depletion. These results were true during both seasons.

Such finding could be attributed to the important role of antitranspirants on saving water and improve fruit crops production Liang *et al.* (2002). At the same time (calcium carbonate) was more effective than other treatments in regulating water status and the photosynthetic activity of plants under this regions (Ranney *et al.*, 1989).

These results of irrigation treatments are in harmony with those obtained by (Hassan and Seif, 1997; Sophocleous, 2004). Similar results on the beneficial effects of antitranspirants in yield fad^{-1} were obtained by Saleh and El-Ashry-Soad (2006), Ebrahiem-Asmaa (2012) and Ahmed *et al.* (2012). Abd El-Kader *et al.* (2006) also noted that foliar sprays of magnesium carbonate as antitranspirants on 'Wiliams banana' increased growth parameters. In addition the lack of soil moisture levels under three type of antitranspirants sprayer failed significantly to show any effect on the yield/ unit on 'Wiliams banana'.

GROWTH CHARACTERS AND LEAF NUTRIENT STATUS

Height and girth pseudostem: In Table 5 clearly show that varying moisture levels had no significant effect on all growth characters namely height and girth of pseudostem (cm). However, treating the plants with any of the three antitranspirants significantly enhancing all growth characters.

The highest values of height and girth of pseudostem (cm) were noticed when trees sprayer with calcium carbonate (264.3 and 275.8) and (71.3 and 71.7) in height and girth pseudostem during the first and second seasons, respectively. Meanwhile the intermediate value in this respect recorded in Green miracle (260.5 and 271.3) and (68.3 and 69.1) in height and girth of pseudostem

Table 5: Effect of different moisture levels and antitranspirants on some vegetative growth characters of Grand Naine banana plants

	Soil moisture contents (A) (%)											
Character	Pseudostem height (cm)						Pseudostem girth (cm)					
	2009-2010			2010-2011			2009-2010			2010-2011		
Antitranspirants (B)	40	60	Mean (B)	40	60	Mean (B)	40	60	Mean (B)	40	60	Mean (B)
Control	246.0	245.6	245.8	252.0	251.5	251.8	65.9	65.0	65.5	65.6	65.2	65.4
Calcium carbonate	264.6	264.0	264.3	276.0	275.5	275.8	71.5	71.0	71.3	71.9	71.5	71.7
Green miracle	261.0	260.0	260.5	271.6	271.0	271.3	68.5	68.0	68.3	68.5	69.6	69.1
Kaolin	253.0	252.0	252.2	261.8	261.5	261.7	67.0	66.3	66.7	67.6	67.8	67.7
Mean (A)	256.2	255.4		265.4	264.8		68.2	67.6		68.4	68.5	
New L.S.D at 5%	A	B	AB	A	B	AB	A	B	AB	A	B	AB
	NS	1.9	NS	NS	2.0	NS	NS	0.8	NS	NS	0.9	NS
Character	Number of green leaves plant^{-1}						Leaf area (m^{-2})					
Control	12.0	12.0	12.0	12.0	12.0	12.0	1.22	1.21	1.22	1.24	1.26	1.25
Calcium carbonate	12.0	12.0	12.0	13.0	13.0	13.0	1.51	1.50	1.51	1.55	1.56	1.56
Green miracle	12.0	12.0	12.0	13.0	13.0	13.0	1.40	1.40	1.40	1.44	1.44	1.44
Kaolin	12.0	12.0	12.0	13.0	13.0	13.0	1.29	1.28	1.29	1.34	1.33	1.34
Mean (A)	12.0	12.0	00.0	12.8	12.8	00.0	1.36	1.35	0.0	1.39	1.40	0.00
New L.S.D at 5%	A	B	AB	A	B	AB	A	B	AB	A	B	AB
	NS	NS	NS	NS	NS	NS	NS	0.06	NS	NS	0.06	NS

A, B and AB represent LSD value (Soil moisture contents) (A), Types of antitranspirants (B) and Soil moisture contents × Types of antitranspirants, respectively (NS) means (non significant)

in both seasons respectively. The less effect of antitranspirants clearly observed with kaolin (252.2 and 261.7) and (66.7 and 67.7) in both seasons. The check treatment (control) gave the lowest values in height and girth of pseudostem in both studied seasons. The best and significant interaction between the of soil moisture levels and types of antitranspirants on height and girth pseudostem (cm) were noticed with calcium carbonate at 2 and 40% of available water depletion which gave (264.6 and 276.0) and (71.5 and 71.9) on height and girth pseudostem during the first and second seasons, respectively.

Such findings could be attributed to the positive effect of antitranspirants on protecting cells against stress by stabilizing the quaternary structure of proteins such as membranes and enzymes (Taravati *et al*., 2007).

The effect of irrigation at consumption 40 and 60% of the available soil moisture was confirmed by Hassan and Seif (1997) and Sophocleous (2004).

Similar findings on beneficial effect of antitranspirants on growth were reported by Abd El-Kader *et al*. (2006), Saleh and El-Ashry-Soad (2006), Ebrahiem-Asmaa (2012) and Ahmed *et al*. (2012).

Number of green leaves and leaf area: In Table 5 showed the number of green leaves/plant in response to irrigation at consumption 40 and 60% of the available soil moisture and three type antitranspirants, trees was not significantly affected in both studied seasons by the different soil moisture levels and antitranspirants.

Concerning the third leaf area (m^2) from Table 5 data showed that antitranspirants treatments significantly increased leaf area. On the other hand no significant were observed with the soil moisture levels. The best results in this respect were obtained by calcium carbonate (1.51 and 1.56 m^2) in both seasons, respectively followed by Green miracle (1.40 and 1.44 m^2), kaolin (1.29 and 1.34 m^2) and then in the check treatment (control) in both seasons respectively. The best combination and significant effects on leaf area (m^2) (1.51 m^2) were showed in calcium carbonate at 2% in combination with irrigation at 40% of available water in the first seasons where as in the second one were observed in calcium carbonate at 2 with 60% of available water they gave (1.56 m^2) than the other treatments.

These results may be due to the positive effect of antitranspirants on decreasing of transpiration rate as well as protecting cells against stress by stabilizing the quaternary structure of proteins such as membranes and enzymes, such finding improved leaf area (Taravati *et al*., 2007; Shanan and Shalaby, 2011).

Similar results regarding irrigation treatments were in line with those obtained by Hassan and Seif (1997), Sophocleous (2004) and Abd El-Kader *et al*. (2006).

The results of current study regarding the beneficial effect of antitranspirants on growth was supported the by results of (Saleh and El-Ashry-Soad, 2006; Ebrahiem-Asmaa, 2012; Ahmed *et al*., 2012).

Leaf content% (n, p, k and mg): It is obvious from Table 6 that the percentage of leaf mineral content (N, P, K and Mg) were not significantly affected by either of moisture treatments or antitranspirants. However, spraying plants with any of antitranspirants slightly increased most nutrients than control when the plants irrigated at 40 or 60% of the available soil moisture. The interaction between the two factors (A and B) did not exhibit any significant effect with the leaf area (Abd El-Kader *et al*., 2006).

Table 6: Effect of different moisture levels and antitranspirants on the percentages of N, P, K and Mg in the leaves of Grand Naine banana plants during 2009/ 2010 and 2010/ 2011 seasons

Character	Soil moisture contents (A) (%)											
	Leaf N (%)						Leaf P (%)					
	2010			2010-2011			2009-2010			2010-2011		
Antitranspirants (B)	40	60	Mean (B)	40	60	Mean (B)	40	60	Mean (B)	40	60	Mean (B)
Control	2.80	2.82	2.81	2.69	2.70	2.70	0.11	0.12	0.12	0.12	0.13	0.13
Calcium carbonate	2.81	2.82	2.81	2.72	2.72	2.72	0.13	0.13	0.13	0.13	0.13	0.13
Green miracle	2.81	2.83	2.82	2.71	2.72	2.72	0.12	0.12	0.12	0.13	0.13	0.13
Kaolin 2.81	2.83	2.82	2.70	2.71	2.71	0.11	0.12	0.12	0.13	0.13	0.13	0.00
Mean (A)	2.81	2.83	0.00	2.70	2.71	0.00	0.12	0.12	0.00	0.13	0.13	0.00
New L.S.D at 5%	A	B	AB	A	B	AB	A	B	AB	A	B	AB
	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Character	Leaf K (%)						Leaf Mg (%)					
Control	3.11	3.13	3.12	3.15	3.16	3.16	0.41	0.43	0.42	0.47	0.51	0.49
Calcium carbonate	3.13	3.13	3.13	3.16	3.16	3.16	0.42	0.43	0.43	0.50	0.51	0.51
Green miracle	3.13	3.13	3.13	3.15	3.16	3.16	0.42	0.43	0.43	0.50	0.51	0.51
Kaolin	3.12	3.13	3.13	3.15	3.16	3.16	0.42	0.43	0.43	0.49	0.51	0.50
Mean (A)	3.12	3.13	0.00	3.15	3.16	0.00	0.42	0.43	0.00	0.49	0.51	0.00
New L.S.D at 5%	A	B	AB	A	B	AB	A	B	AB	A	B	AB
	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

A, B and AB represent LSD value (Soil moisture contents) (A), Types of antitranspirants (B) and Soil moisture contents x Types of antitranspirants, respectively, (NS) means (non significant)

The results of irrigation treatments were confirmed with those obtained by Hassan and Seif (1997) and Sophocleous (2004).

The promising effect of antitranspirants on the leaf mineral content were emphasized by Saleh and El-Ashry-Soad (2006), Ebrahiem-Asmaa (2012) and Ahmed *et al.* (2012).

QUALITY OF THE FRUITS

Finger weight: In Table 7 showed the effect of finger weight (g) in response to irrigation at consumption of 40 and 60% of the available soil moisture and three types of antitranspirants. It can be noticed that finger weight did not significantly affected with varying soil moisture levels in both seasons. On the other hand, the finger weight significantly increased with any of the three antitranspirants.

The highest and significant value of finger weight (g) was observed with calcium carbonate (106.7 and 107.5 g) in both seasons, respectively. Also Green miracle gave significant effect on the finger weight (102.7 and 104.8 g) as compared with kaolin which gave (100.7 and 101.8) and the control (98.8 and 98.5) in both seasons, respectively. The best antitranspirants in this respect in ascending order was kaolin, Green miracle and calcium carbonate, i.e., the increment of finger weight as a rate of control were (7.4 and 8.37%) with calcium carbonate while were (3.8 and 6.01%) and (1.89 and 3.24%) in Green miracle and kaohn in the first and second seasons respectively. The best interaction between the two soil moisture levels and three type of antitranspirants were found in calcium carbonate 2% as compound with irrigation at 40% of available water on finger weight (gm) attaining (106.8 and 108.0) in both seasons, respectively.

Table 7: Effect of different moisture levels and antitranspirants on some physical and chemical characteristics of the fruits of Grand Naine banana plants

Character	Soil moisture contents (A) (%)											
	Finger weight (g)						Total soluble solids %					
	2009-2010			2010-2011			2009-2010			2010-2011		
Antitranspirants (B)	40	60	Mean (B)	40	60	Mean (B)	40	60	Mean (B)	40	60	Mean (B)
Control	99.5	98.0	98.8	98.9	98.0	98.5	18.0	18.0	18.0	18.5	19.0	18.8
Calcium carbonate	106.8	106.5	106.7	108.0	107.0	107.5	21.0	21.0	21.0	21.0	21.0	21.0
Green miracle	102.8	102.7	102.7	105.0	104.5	104.8	20.0	20.5	20.3	20.0	20.0	20.0
Kaolin	100.9	100.5	100.7	102.0	101.5	101.8	19.0	19.5	19.3	19.0	19.3	19.2
Mean (A)	102.5	101.9	0.00	103.5	102.8	000.00	19.5	19.8	00.00	19.7	19.8	00.00
New L.S.D at 5%	A	B	AB	A	B	AB	A	B	AB	A	B	AB
	NS	1.2	NS	NS	1.5	NS	NS	0.4	NS	NS	0.5	NS
Character	Total sugars (%)						Total acidity (%)					
Control	13.0	13.3	13.2	13.0	13.0	13.0	0.316	0.315	0.316	0.331	0.327	0.329
Calcium carbonate	15.5	15.8	15.7	15.5	15.5	15.5	0.240	0.238	0.239	0.360	0.257	0.259
Green miracle	15.0	15.2	15.1	14.8	15.0	14.9	0.270	0.266	0.268	0.294	0.290	0.292
Kaolin 14.0	14.3	14.2	14.0	14.2	14.1	00.3	0.297	0.299	0.311	0.305	0.308	0.000
Mean (A)	14.4	14.7	00.0	14.3	14.4	0.00	0.282	0.279	0.000	0.299	0.295	0.00
New L.S.D at 5%	A	B	AB	A	B	AB	A	B	AB	A	B	AB
	NS	0.4	NS	NS	0.4	NS	NS	0.015	NS	NS	0.016	NS

A, B and AB represent LSD value (Soil moisture contents) (A), Types of antitranspirants (B) and Soil moisture contents x Types of antitranspirants, respectively (NS) means non significant

These results could be attributed to the successful role of antitranspirants in counteracting the adverse effect of higher temperature stresses and delaying plant water stress, during growth and fruiting as well as increase relative growth rate (Ranney *et al*., 1989).

These results of irrigation treatments are in harmony with those obtained by Hassan and Seif (1997) and Sophocleous (2004).

The above results were in accordance with those obtained by Saleh and El-Ashry-Soad (2006), Ebrahiem-Asmaa (2012) and Ahmed *et al*. (2012) who stated that using antitranspirants was very favorable in improving fruit quality.

Chemical characteristics: In Table 7 show clearly that the three chemical attributes percentage of (T.S.S%, total sugars percentage and total acidity percentage) did not alter significantly with varying soil moisture levels. On the other hand, spraying Grand Naine banana with any of the three antitranspirants significantly increased fruit quality. However, total soluble solids percentage and total sugars were increased where as total acidity percentage was decreased. The best average percentage of antitranspirants in total soluble solids percentage were obtained by calcium carbonate which recorded (21.0 and 21.0%) in the first and second seasons respectively, followed by Green miracle which recorded (20.3 and 20.0%) at the same time the less effect of antitranspirants observed when trees treated with kaolin registered (19.3 and 19.2%) in both seasons, respectively. The lowest values in total soluble solids percentage under this study were in check treatment (control). The same trend was noticed in total sugars percentage and total acidity percentage during both seasons. Regarding the effect of the interaction between soil moisture levels

and the three type of antitranspirants it was noticeable that under irrigation at available soil moisture 60% was more effective than 40% on increasing both total soluble solids percentage and total sugars percentage as well as decreasing total acidity percentage. These may be due to the increase of soil moisture supply increasing of the levels and movement of certain nutrients in plant leaves.

The enhancing of chemical characteristics could be attributed to the successful role of antitranspirants in counteracting the adverse effect of higher temperature stresses and delaying plant water stress, during growth and fruiting as well as increase relative growth rate (Ranney *et al*., 1989). On the other hand, a particle type of (calcium carbonate) was more effective than other two treatments in regulating water status, photosynthetic activity and decreasing transpiration of plants under these regions (Ranney *et al*., 1989). In ascending order were kaolin, Green miracle and calcium carbonate similar results were announced during both seasons in chemical characteristics.

These results regarding irrigation treatments were in line with those obtained by Hassan and Seif (1997) and Sophocleous (2004).

The beneficial effect of antitranspirants on quality of the fruits was supported by the results of Abd El-Kader *et al*. (2006), Saleh and El-Ashry-Soad (2006), Ebrahiem-Asmaa (2012) and Ahmed *et al*. (2012).

So, it is suggested for spraying the antitranspirant calcium carbonate at 2% as well as watering Grand Naine banana plants at 60% of the available water depletion to reduce the total amount of irrigated water through the growth season and at the same time promote the production.

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