

Effect of Soil Moisture Levels and Some Antitranspirants on Vegetative Growth, Leaf Mineral Content, Yield and Fruit Quality of Williams Banana Plants

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Abstract: This investigation was carried out during two successive seasons 2002/03 and 2003/04 to study the effect of soil moisture levels, 40 and 60% of the available water depletion and weekly foliar sprays with three types of antitranspirants namely kaolin (aluminum silicate), epoxy linseed oil emulsion (ELO) and magnesium carbonate ($MgCO_3$) on water consumptive use, water use efficiency, vegetative growth, leaf mineral contents, yield and fruit quality of Williams banana plants grown at El- Kanater Horticultural Research Station, Hort. Res. Inst, A.R.C.. Egypt. The obtained results indicated that: 1. Water consumptive use (W.C.U.) ranged between 115.40 and 141.62 cm. in the first season and 116.66 and 152.83 cm. in the second one, corresponding to 4846.80, 5948.04 $m^3/fed.$ in the first seasons and, 4899.72, 6418.86 $m^3/fed.$ in the second season respectively. 2. Interaction between soil moisture levels treatments and foliar antitranspirations treatments was not significant in all characters under study. 3. The monthly W.C.U. began to rise in March to reach their peak during June and July then they declined again. 4. Crop roots from the top foot of soil values extracted more than 2/3 moisture content. 5. Crop coefficient (Kc) was 0.44, it reached its maximum in July then it declined until March. 6. The mean of water use efficiency was 3.34 kg yield/ m^3 water consumed/fed, in the two seasons of study. 7. The results clearly showed that, no differences were detected between antitranspirant treatments on N, P and K content in the leaves, while foliar sprays of $MgCO_3$ increased growth parameters and improved yield weight and fruit characteristics. 8. There is no different significant effect between 40% and 60% soil moisture depletion of available water in all studied growth or yield parameters in the two successive seasons. So we suggest that spraying magnesium carbonate ($MgCO_3$) at 5% as antitranspirant and irrigate banana plants at 60% of the available water depletion is the promising treatment to reduce the total amount of irrigated water through the growing season of Williams banana plants.

Key words: Williams banana, soil moisture levels, antitranspirants, vegetative growth, yield.

INTRODUCTION

Water consumptive use (W.C.U.) or evapotranspiration (ET.) is defined as the combined processes by which water is transferred from soil surface to the atmosphere, including evapotranspiration of liquid or solid water from soil and plant surfaces, plus transpiration of liquid water through plant tissues^[1]. Reference evapotranspiration (ETO) are calculated from the climatic data during the growing period, according to the modified Penman's formula^[2].

It is generally accepted that bananas need large amounts of water to maintain productivity^[3]. Therefore, it is necessary to determine the optimum water requirements for banana plants in order to reach the best irrigation schedules for maximum crop production.

Water use is the water that is incorporated in plant tissue, evaporated by the plants and soil and is controlled by the environment, plant and soil factors. High

temperature degree increases evaporation rate, consequently the amount of needed water by banana plants, especially when planted at new reclaimed area which characterized with low water supply. Under subtropical conditions like Egypt, using antitranspirants may reduce transpiration rate from the plant; consequently the amount of used water and improved the water use efficiency^[4,5].

There are different types of antitranspirants^[6]:

- Film- forming: these are base fatty acids and when applied as powders, they plug the stomata and act as an artificial cuticle and are used mainly for control of plant disease.
- Metabolic or stomata: (only affect stomata) reduction of stomata aperture used mainly for combating drought and increasing drought resistance in the plants, transplants and stocking.
- Reflecting materials.

The aim of this study is to investigate the effect of three types of antitranspirants under different soil moisture levels on vegetative growth, leaf mineral contents, yield and fruit quality of Williams banana plants.

MATERIALS AND METHODS

The present investigation was carried out in two successive seasons of 2002/03 and 2003/04 on the mother plant and first ratoon of Williams banana plants grown on clay loamy soil at El Kanater Horticulture Research Station, Qalubia Governorate, Egypt. Suckers were planted at 3.5X3.5 meter apart and three suckers were selected per each hole and the others were removed. The aim of this study is to investigate the effect of irrigation at different soil moisture levels (40 and 60% of the available water depletion) and weekly foliar application of antitranspirations on leaf mineral content, vegetative growth, yield and fruit quality of Williams banana.

Three types of antitranspirants namely kaolin (aluminum silicate) as a metabolic agent at 5%, magnesium carbonate (MgCO₃) as a reflecting material at 5% and 1.25% Epoxy linseed oil emulsion (ELO) as a film-forming agent were sprayed every week (from early July till end of October). Only on upper surface of the older leaves were sprayed, but the newly six leaves were leaved without spray.

I- The irrigation treatments were as follow:

- Irrigation at consumption 40% of available soil moisture.
- Irrigation at consumption 60% of available soil moisture.

II- Antitranspiration treatments were as follow:

- Spraying with water only (Control).
- Spraying with 5% kaolin (aluminum silicate)
- Spraying with 5% magnesium carbonate (MgCO₃).
- Spraying with 1.25% Epoxy linseed oil emulsion (ELO).

Generally, each treatment was replicated four times on three plants per hole and the randomized complete block design was arranged.

In addition, one row of guard trees on each side of each treatment was used to prevent cross feeding by the roots.

For planning irrigation, soil moisture content was estimated gravimetrically at four depths, 0-15, 15-30, 30-45 and 45-60 cm. and computed on oven dry basis, periodically every two days.

The data obtained every season were the following:

Table 1: Soil moisture constants (% by weight) and bulk density (gm/ cm³) of the experimental field in the 0-60 cm. depth.

Constants Depth (cm)	Field Capacity %	Wilting Point %	Available Water %	Bulk Density (gm/cm ³)
00 - 15	35.80	18.80	17.00	1.30
15 - 30	33.40	17.30	16.10	1.35
30 - 45	31.90	15.10	14.50	1.35
45 - 60	31.70	16.80	14.90	1.37

Table 2: Physical and chemical properties of El-Kanater studied soil.

Soil properties	Values
Physical:	
Coarse sand	1.10%
Fine sand	34.00%
Silt	33.50%
Clay	31.40%
Textural class	Clay loam
Chemical:	
SP (saturation percentage)	48.0
PH (1: 2.5 w/v soil: suspension)	8.10
EC (on saturation extract) d Sm ⁻¹	0.66
Soluble ions (me L ⁻¹)	
Ca ⁺⁺	3.10
Mg ⁺⁺	1.10
Na ⁺	1.90
K ⁺	0.60
HCO ₃ ⁻	2.50
CO ₃ ⁻	0.00
CL ⁻	1.90
SO ₄ ⁻	3.30

Water relations:

Water consumptive use: (cm. and m³ /fed.) is the combined processes by which water is transferred from soil surface to the atmosphere, including evapotranspiration of liquid water from soil and plant surfaces, as well as transpiration of liquid water through plant tissues^[2]. It is calculated by the differences in soil moisture content in soil samples taken before and after each watering, using the following formula: $C_u = D \times AD \times (e_2 - e_1) / 100$, where: C_u : the water consumptive use (cm.); D: the soil depth (cm.); AD: bulk density (g/cm³); e_1 and e_2 : soil moisture % before and after irrigation, respectively. It was calculated in seasonal and monthly values.

The soil texture in El- Kanater is clay loam soil. The field capacity, the permanent wilting percentage, the available water and bulk density were determined as soil content and shown in Table (1), Physical and chemical properties of the experiments are illustrated in Table (2), while, Table (3) shows the meteorological data in the district, during the two seasons of the study.

Water uptake pattern: (soil moisture extraction %) from different soil depths, was calculated in order to show the water uptake pattern by roots, at different depths^[7].

Table 3: Meteorological data for El-Kanater district during 2002 and 2003 seasons of the study.

Season 2002			Season 2003			
Month	Te. Max.	Te. Min.	R.H.	Te. Max.	Te. Min.	R.H.
Jan.	21.0	88.7	57	20.8	9.0	67
Feb.	21.9	8.6	50	22.0	10.5	59
Mar.	27.7	14.0	49	26.88	13.3	59
Apr.	30.4	17.1	43	32.1	16.4	51
May	33.4	19.9	39	33.5	188.4	47
Jun.	35.6	21.5	42	35.7	20.0	52
Jul.	35.8	23.4	50	36.2	21.0	60
Aug.	36.2	24.6	50	35.9	22.7	59
Sep.	34.7	23.1	50	35.2	21.0	59
Oct.	29.1	18.2	56	30.9	17.2	64
Nov.	25.5	13.9	53	21.6	14.6	64
Dec.	22.7	9.7	55	21.5	9.6	63

Where: Tmax, Tmin. = Maximum and minimum temperatures (°C), R.H. = Relative humidity (%).

$$S.M.E.P = \frac{C.U \text{ from a layer}}{C.U \text{ from all root-zone depth}}$$

Water use efficiency (W.U.E.): The production of Williams banana plants by one cubic meter of irrigation water fruit yield in kg/fed / m³ water consumed /fed., as affected by different treatments was calculated by the following equation^[8]:

$$W.U.E = \frac{\text{Fruits yield (kg)/fed}}{\text{Seasonal ET (m}^3/\text{ water consumed)/fed}}$$

Crop coefficient (kc): value was used for quantifying crop water use, was calculated from the equation: Kc = Et_c / Et_o; where: Kc=Actual evapotranspiration (ET), potential evapotranspiration (ETO) mm/day, which was calculated using a modified Penman's equation^[2] as follows:

ETO = [W x Rn + (1 - W) x f(u) x (ea - ed)].
Where: W = is the temperature weighing factor. Rn = net radiation. f(u) = wind function., (ea - ed) = the differences between the saturated vapor pressure at mean air temperature and the mean actual pressure of the air. ETO values were calculated using the collected data from meteorological station at El-Kanater district.

Vegetative growth: All plants received the traditional and regular fertilization program as follows:

About 40 kg balady manure (FYM) + 250 gm superphosphate (15.5% P₂O₅) /plant/year added in December, about 500 gm N/plant as ammonium sulphate (20.5% N) divided into fourteen equal doses from April to October intervals and 1200 gm potassium sulphate

(48-52% K₂O)/plant/year added in three equal doses (April, June and July). The other cultural practices were the same for all plants.

At shooting stage, leaf sample was taken from the middle of the third leaf from the top of each plant[9], washed with tap water then with distilled water and dried at 70°C till constant weight and finally ground and digested to determine total nitrogen, phosphorus and potassium content as percentage on dry weight bases^[10].

Also the following determinations were measured at shooting for each plant:

- Length and girth of pseudostem.
- Number of green leaves per plant.
- Length, width and area of the third leaf.
- Leaf dry matter percentage.

At harvest stage, bunch, hand and finger weight were determined, also number of hands and fingers per bunch were measured for each plant; and total yield per feddan was calculated. The statistical analysis data were subjected to analysis of variance and the method of Duncan was used to differentiate means^[11].

RESULTS AND DISCUSSIONS

Banana plants water relations parameters:

Seasonal water consumptive use: Seasonal water consumptive use by Williams banana plants were gradually decreased as water stress increased, in both seasons. As it registered 130.90 and 125.94 cm. in the first season and 143.07 and 135.65 cm. in the second one for soil moisture levels, respectively, corresponding to (5493.70 and 5283.23) and (6004.63 and 5691.26) m³ water/feddan in the first and second season, respectively

Table 4: Seasonal water consumptive use (cm.) for Williams banana plants as affected by soil moisture levels.

Antitranspirant Treatments	Season 2002/03			Season 2003/04		
	Available soil water depletion			Available soil water depletion		
	40 %	60 %	Average	40 %	60 %	Average
Control	141.62	135.66	138.64	152.83	150.76	151.8
Kaolin	140.54	134.43	137.49	141.89	137.1	139.5
MgCO ₃	119.07	115.4	117.24	135.57	116.66	126.12
ELO	121.97	117.66	119.82	141.57	137.49	139.53
Average	130.9	125.94		143.07	135.65	

Table 5: Water consumptive use (cm and m³/fed.) yield (Kg. /fed.) and water use efficiency (Kg fruit/ m³ water) for Williams banana plants as affected by soil moisture levels.

Depletion available water %	Antitranspirant Treatment	Season 2002/03				Season 2003/04			
		cm.	m ³ /fed	Kg/fed.	W.U.E.	cm.	m ³ /fed	Kg/fed.	W.U.E.
40 %	Control	142	5.95	11.25	1.89	153	6.42	15	2.34
	Kaolin	141	5.9	14.7	2.49	142	5.96	16.2	2.72
	MgCO ₃	119	5	15	3	136	5.69	18.75	3.29
	ELO	122	5.12	11.47	2.24	142	5.95	18	3.03
Mean		131	5.49	13.11	2.41	143	6.01	16.99	2.84
60 %	Control	136	5.7	12.45	2.19	151	6.33	14.25	2.25
	Kaolin	134	5.65	13.72	2.43	137	5.76	15.22	2.64
	MgCO ₃	115	4.85	12.97	2.68	117	4.9	17.47	3.57
	ELO	118	4.94	12.97	2.62	137	4.03	17.47	4.33
Mean		126	5.28	13.03	2.48	136	5.26	16.1	3.2
Means of Antitranspiration Treatments									
	Control	139	5.82	11.85	2.04	152	6.38	14.63	2.29
	Kaolin	137	5.77	14.21	2.46	140	5.86	15.71	2.68
	MgCO ₃	117	4.92	13.99	2.84	126	5.3	18.11	3.43
	ELO	120	5.03	12.22	2.43	140	4.99	17.74	3.68

(Table 4 and 5). Such result might be reasonable, since more frequent irrigation period provide high evaporation opportunity from the relatively wet rather than dry soil surface^[2,12,13].

The seasonal water use values were obtained from the sum of water consumptive use for all irrigations per treatment, from March until February in each season.

Monthly evapotranspiration: Monthly water consumptive use values by Williams banana plants were obtained from daily water use multiplied by the number of days in one month. It began to raise during March then, ET value gradually increased to reach its maximum at early summer during June and July (Fig.1). This might be due to the increase in growth during summer months afterwards, the daily consumptive use, again, gradually decreased. Such pattern was attained by Williams banana

plants, regardless of factors studied. In this concern During April and early May little growth will appear, but towards the end of November the plants slow down into steady progress. Similar results were obtained since water management practices resulted in maximum yield, and plants growth depending on crop load and yearly climatic change^[14]. There was increase in transpiration and water uptake from summer to autumn followed by a decrease until spring.

Soil moisture extraction pattern within the root-zone of 60 cm (S.M.E.P.): SMEP was calculated according to the equation of (Israelsen & Hansen, 1962).

$$S.M.E.P = \frac{C.U \text{ from a layer}}{C.U \text{ from all root-zone depth}}$$

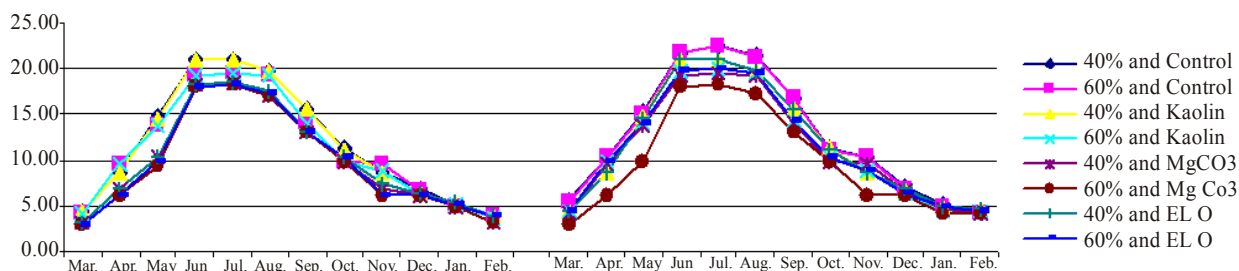


Fig. 1: monthly consumptive use (ET. In cm.) By Williams banana plants under different soil moisture levels during the two seasons.

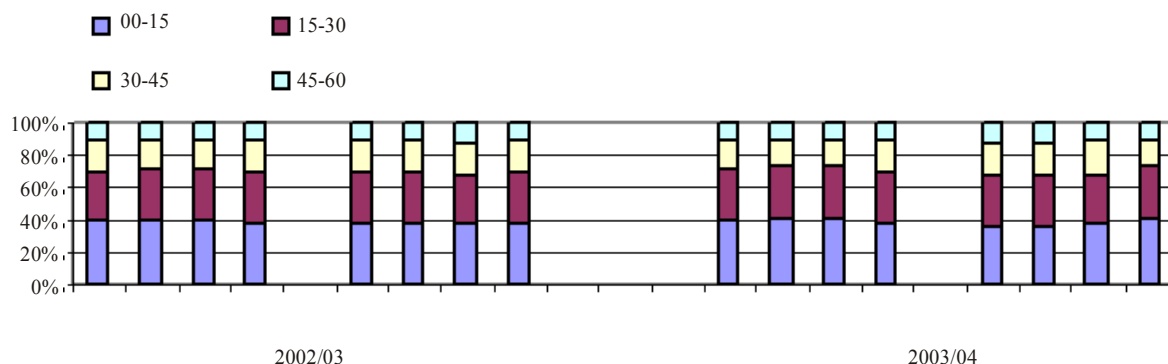


Fig. 2: Moisture extraction % in different soil depth by Williams banana plants as affected by soil moisture levels and antitranspirants.

C.U (layer) = amount of soil moisture extracted by Williams banana plants in each soil layer.

C.U (root-zone depth) = total sum of moisture extracted in all soil depths i.e. 60 cm.

Water uptake by the roots of Williams banana plants is illustrated in Fig. (2). Exhibit the percentage of moisture extraction from the different soil depths, as affected by various water stress and antitranspirant agents.

Results clearly indicated that Williams banana roots extracted about 70% of their moisture needs, from the first foot (30 cm.) depth, at all treatments of the experiment, during the two seasons, and soil was more densely occupied by roots at first surface foot depth. Similar results were mentioned^[13] on two landscape trees species in Tuscon. Medium water stress level caused slight decrease in moisture extract % in the (0-30) cm depth, when compared with the other two treatments. This would be an indication to the root density distribution in soil depths under water stress levels. In this concern, plants which had lower water use, were characterized by higher root percentage and water consumptive use in the deeper soil depths. Nevertheless, nitrogen levels seemed to have slight effect on the water consumptive use at the different soil depths^[15,16].

Water use efficiency: Water use efficiency, is used to show the yield (kg.) per unit area over water unit required in evapotranspiration. It appears from Table (5) that this trait was markedly profitable under the medium soil

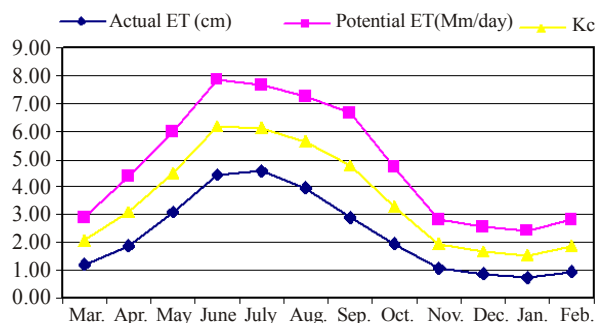


Fig. 3: Actual, Potential ET. (Mm/day) and (Kc.) For Williams banana plants during two seasons.

moisture stress level (60%), as it registered (3.34 yield kg. /m³ water of irrigation / fed., as average of two seasons of study.

Crop coefficient (Kc): Crop coefficient was calculated according to the actual ET derived from the Medium treatment, to estimate the amount of water required to meet evapotranspiration of Williams banana plants during the season. Data in Fig.3 and Table 6 reveal that seasonal crop coefficient of Williams banana plants were 0.44 during the two seasons attained its highest value in July. Then, it gradually decreased until it reached its lowest value at November. But, afterwards it showed inconsistent response until it began to increase during March, in both seasons. Doorenbos & Prit^[2] and Levitt *et al.*^[13] on

Table 6: Vegetative growth parameters of Williams banana plants as affected by soil moisture levels and antitranspirant treatments during two studied seasons.

Treatments	Pseudo. length (cm)		Pseudo. girth (cm)		Number of green leaves		Third leaf length(cm)		Third leaf width (cm)		Third leaf area (cm)		Dry matter (%)	
	2002/03	2003/04	2002/03	2003/04	2002/03	2003/04	2002/03	2003/04	2002/03	2003/04	2002/03	2003/04	2002/03	2003/04
40 % Cont	242 bc	237 d	63.3 b	75.3 ab	12.8	12.5	202 ab	209	74.3	69.3	1.19 ab	1.15	20.7	21.1 b
Kaolin	253 ab	253 cd	73.3 ab	77.3 ab	11.9	12.2	218 ab	238	72	70.3	1.26 ab	1.34	28.7	22.5 ab
Mg CO ₃	275 a	274 ab	76.3 a	79.3 ab	13.1	12.9	205 ab	236	78.3	72.6	1.39 ab	1.37	21	21.0 b
ELO	254 ab	284 a	70.0 ab	85.3 a	11	12	208 ab	225	68.3	73	1.15 ab	1.31	27	24.1 ab
60 % Cont	223 c	243 cd	68.0 ab	71.3 b	12.1	12.2	209 ab	227	71	69.3	1.18 ab	1.25	22.2	21.2 b
Kaolin	254 ab	254 cd	71.0 ab	73.6 b	12.5	12.1	182 b	240	71.6	71.3	1.05 b	1.36	22.4	22.0 ab
Mg CO ₃	255 ab	264 bc	76.3 a	80.3 ab	12.1	12.6	244 a	248	77.6	73.6	1.49 a	1.46	20.7	20.4 b
ELO	247 abc	248 cd	70.3 ab	75.6 ab	10.9	12.4	188 ab	237	67.3	72	1.02 b	1.37	27.3	26.0 a
Significance at 5% level	S	S	S	S	N.S	N.S	S	N.S	N.S	N.S	S	N.S	N.S	S

Table 7: Leaf mineral contents of Williams banana plants as affected by soil moisture levels and antitranspirant treatments during two studied seasons.

Treatments		N%		P%		K%	
		2002/03	2003/04	2002/03	2003/04	2002/03	2003/04
40 %	Cont	2.8	2.9	0.11	0.12	3.36	3.5
	Kaolin	2.79	2.94	0.11	0.11	3.40	3.46
	Mg CO ₃	2.91	2.95	0.10	0.11	3.26	3.43
	ELO	3.29	3.27	0.11	0.11	3.40	3.43
60 %	Cont	2.98	2.93	0.12	0.12	3.23	3.26
	Kaolin	2.97	2.89	0.10	0.10	3.33	3.43
	Mg CO ₃	2.72	3.00	0.11	0.12	3.23	3.30
	ELO	2.91	3.06	0.11	0.11	3.30	3.50
Significance at 5% level		N.S	N.S	N.S	N.S	N.S	N.S.

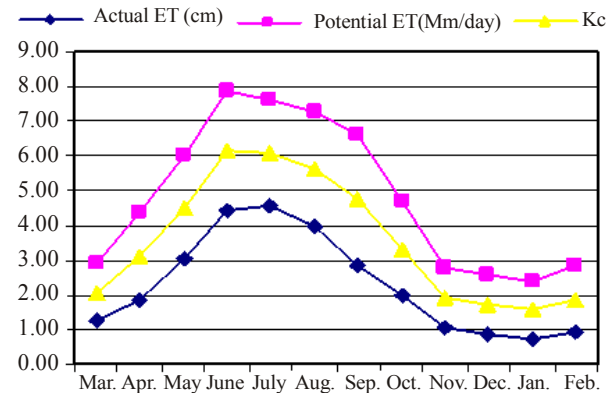


Fig. 4: Actual and Potential ET mm/day for Banana plants, during the two seasons.

different crops some workers suggested that Kc values would provide a method of adjusting the water use rates to compensate for variation in climatic conditions that

influence evaporative demand^[2,13]. On the other hand, the use of crop coefficient was not practical due to its variability during the growing cycle but depending to yearly climatic change^[14].

Growth characteristics:

Vegetative growth: Data in Table (6) showed the effect of antitranspirants and soil moisture levels on vegetative growth of Williams banana plants.

As for length and girth of pseudostem, all antitranspirant treatments increased these parameters than the control; the higher values of length and girth of pseudostem were obtained when the plants were sprayed with magnesium carbonate in both seasons and epoxy linseed oil emulsion (ELO) in the second one only. On the other hand, no differences were detected between soil moisture levels on these parameters.

Regarding number of green leaves, there was no effect for antitranspirant agents or time of irrigation on this parameter in both studied seasons.

Table 8: Yield and fruit quality of Williams banana plants as affected by soil moisture levels and antitranspirant treatments during two studied seasons.

Treatments	Yield / feddan (ton)		Bunch weight (kg)		Number of fingers/bunch		Number of hand/bunch		Finger weight(gm.)		Hand weight (gm.)	
	2002/03	2003/04	2002/03	2003/04	2002/03	2003/04	2002/03	2003/04	2002/03	2003/04	2002/03	2003/04
40% Cont	11.25b	15.00bc	15.0 b	20.0 bc	160	180 d	9.3 b	9.3	96	108	1.61 b	2.13 b
Kaolin	14.70a	16.20abc	19.6 a	21.6 abc	167	194 bc	9.3 b	9.3	119	111	2.12 a	2.16 ab
Mg CO ₃	15.00a	18.75a	20.0 a	25.0 a	170	212 a	9.3 b	10.3	116	117	2.14 a	2.42 a
ELO	11.47b	18.00ab	15.3 b	24.0 ab	159	202 ab	9.3 b	10.6	91	118	1.64 b	2.25 ab
60% Cont	12.45ab	14.25c	16.6 ab	19.0 c	173	186 cd	10.6 a	10.3	99	101	1.55 b	1.83 c
Kaolin	13.72ab	15.22bc	18.3 ab	20.3 bc	183	200 ab	9.6 ab	9.6	99	101	1.90 ab	2.10 b
Mg CO ₃	12.97ab	17.47ab	17.3 ab	23.3 ab	161	207 ab	10.3 ab	10	108	111	1.67 b	2.33 ab
ELO	12.97ab	17.47ab	17.3 ab	23.3 ab	165	204 ab	9.6 ab	10.3	104	114	1.76 ab	2.25 ab
Significance at 5% level	S	S	S	S	N.S	S	S	N.S	N.S	N.S	S	S

Concerning length, width and area of the third leaf, it is observed that anti-transpiration treatments significantly increased length and area of the third leaf in the first season only especially when the plants were sprayed with magnesium carbonate and irrigated at 60% of the available water depletion, which gave the highest value. On the other hand, width of the leaf was not affected by any treatment through the two seasons of the study.

Dry matter percentage was significantly affected in the second season only and the highest value was obtained with spraying epoxy linseed oil emulsion followed by kaolin (aluminum silicate) treatments.

Leaf mineral content: Results in Table (7) showed the effect of anti-transpiration treatments and soil moisture levels on leaf mineral content of Williams banana plants. In this respect, no differences were detected between antitranspiration treatments or soil moisture levels on nitrogen, phosphorus or potassium content in the leaves. However, spraying plants with epoxy linseed oil emulsion slightly increased N and K percentage than the other antitranspirant either when the plants irrigated at 40 or 60% of the available water depletion.

Yield and fruit quality: Data in Table (8) indicated that irrigation treatments had no effect on bunch weight or yield per feddan, while spraying antitranspirants showed a significant differences comparing with the control plants and no differences were detected through the antitranspirant treatments. Generally, magnesium carbonate gave the heaviest bunches and yield /feddan comparing with the other treatments including the control.

Number of fingers per bunch was not affected in the first season, while in the second one; magnesium carbonate gave the highest number followed by epoxy linseed oil especially when the plants were irrigated at 60% of the available water depletion. In this respect,

irrigation treatments did not show any significant effect on this parameter.

Number of hands per bunch was significantly affected in the first season only. In general, plants irrigated at 60% of the available water depletion significantly increased the number of hands and gave the highest value comparing with those irrigated at 40% of the available water depletion.

Finger weight was not affected by treatments either as irrigation or antitranspirations. While, hand weight was significantly affected by treatments, since the heaviest hand was obtained by spraying magnesium carbonate especially with 40% of the available water depletion.

The previous results are in agree with those obtained when Washington navel and Succary orange trees were sprayed with antitranspirants, which enhanced leaf mineral contents, improved yield (kg/tree) and fruit quality^[17]. Also when 3% vapor-gard was sprayed on Jaffa and Balady orange, it was superior in increasing yield^[18]. Moreover, using antitranspirants increased yield of soybean and wheat plants^[19,20,21]. On the other hand, magnesium carbonate had better effect on the yield of barely varieties than sodium salicylate and the untreated plants under water stress condition^[22].

From the abovementioned results it could be concluded that irrigation treatments had no effect on growth or yield of Williams banana plants, while there was a positive effect for antitranspirant treatments on growth and yield parameters especially when using magnesium carbonate. This may be explained due to the reduction effect for magnesium carbonate as a reflected agent on high temperature degree under such region conditions.

So, we suggest spraying magnesium carbonate at 5% as antitranspirant and irrigate banana plants at 60% of the available water depletion to reduce the total amount of irrigated water through the growing season.

ACKNOWLEDGMENTS

The authors would like to thank (The National Campaign for Development of Banana in Egypt) that support the financial side of this study.

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