WATER REQUIREMENTS AND USE EFFICIENCY OF WILLIAMS ZIV BANANA UNDER DIFFERENT MICROIRRIGATION SYSTEMS AND WATER QUANTITY IN SANDY SOIL

IBRAHIM, E. G., AMANY M. HAMED AND SAMIA S. HOSNY

Tropical fruits Res. Dep., Hort. Res. Inst., ARC, Giza, Egypt.

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Abstract

This experiment was carried out during two successive crop cycles of 2009/2010 (first ratoon plant) and 2010/2011(second ratoon plant) on Williams Ziv banana (Giant Cavendish AAA sub-group)grown in sandy soil to determine the optimum water requirement under two irrigation systems (drip and minisprinkler systems). Four rates of water (7000, 8750, 10500 and 12250 m^3/Fed./year) and the plants were fertilized with organic cattle at the rate of 150 m^3/Fed.year. Results show that: Growth parameters of plant i.e. pseudostem height, circumference, in Dec. number of green leaves and assimilation area at bunch shooting stage significantly increased by increasing the amount of applied water. Drip irrigation gave the highest values for the two above characters compared with minisprinkler system. Time of flowering, harvesting and growth cycle of plants tended to decrease as irrigation water was increase. Drip system shortened the growth cycle duration of Williams Ziv binan. The highest yield per fed., average bunch and finger weight and fruit were achieved from Williams Ziv banana plants received of water 8750 m^3/Fed./year under drip irrigation system. Water utilization efficiency (WUE) was affected with the amount of water and worked irrigation system. The better value of WUE (4.05 &3.47 Kg.fruit / one m^3 water) was obtained from plants received 8750 m^3/Fed./year water under drip irrigation system. Adding organic manure had a favorable results on growth might be related to the improvement on the physical, chemical and biological properties of the soil which increase the availability water and nutrients for plants.

Under similar condition it is a recommend for Williams Ziv banana growers to apply of water 8750 m^3/Fed./year under drip irrigation in sandy soil for the promising yield of good fruit quality, the following excretion water irrigation program could be suggested in Jan. 250 m^3 water / Fed, Feb. 312.2 m^3 water / Fed, Mar. 562.5 m^3 water / Fed, April 750 m^3 water / Fed, May 812.5 m^3 water / Fed ,Jun. 937.5 m^3 water / Fed , July 1125 m^3 water / Fed, Aug. 1125 m^3 water / Fed, Sep. 937.5 m^3 water / Fed., Oct. 875 m^3 water / Fed., Nov. 625 m^3 water / Fed and Dec. 437.5 m^3 water / Fed.

Key word: William Ziv, banana, drip irrigation, yield, minisprinkler irrigation, water requirement, water use efficiency

INTRODUCTION

Banana and plantains (Musa Spp.) are important staple food crops for many people in the tropical zones of the world. Banana and plantains are the second largest food –fruit crops of the world produced in the tropical and subtropical regions of mostly the developing counties. During recent years, growth of banana cultivation has witnessed great strides reaching 95.60 million tones (150 countries across the world) in 2009. Banana is some of the earliest crop plants having been domesticated by humans.(Singh *et. al.,* 2011).

Water is probably the most limiting non-biological factor in banana production . Water requirements of this crop are known by the effective rainfall and the proportion of water for banana irrigation derived from these two sources and varies widely throughout the world (Robinsons, 1995). One of the important problems limiting the production of banana especially under the new reclaimed sandy soil is the deficiency of water. The supply of water for use in agriculture is becoming increasing limited(Simpson, 1981). Research on irrigation of banana has emphasized the need for the determination of crop water requirements under various environmental conditions ranged between 5000 - 14470 m^3 /ha (Lahav & Kalmar,1981, Robinson&Alberts,1987 and Sanchez &Ojeda,1996) While in Egypt, water requirements of banana reached to 5510-12000 m^3 / fed./year (Behairy & Hassan, 1987, Ibrahim,1993, Ibrahim *et. al.,* 2002 and Ibrahim, 2003).

In micropropagation, water is applied to the plants throw ametters so that water lives the ammeter as a droplet. Water is suppled to the ammeter (dreppers or microsprinklers) throw a network of main line and lateral piplines that are usually made of plastics.A head unit as used to regulate pressure, filter the water and add nutrients. Drip irrigation has assumed considerable importance in recent raised in view of the general need for water economy. This clearly be seen by many workers (Srinivas & Hegde, 1990, Robinson & Nel, 1994, Goenage *et. al.,*1995 Ray & Chakrabarty,1998, Metochis, 1999, Savin *et. al.,* 2000, Ibrahim,2003 and Singth *et. al.,* 2011) working on the banana. The minisprinkler (micro-sprayers emitters system was combined system with drip and sprinkler methods in applying water to the from of spray and advantage of drip irrigation concerning amount of water used. This clearly had be seen by many workers (Rebinson & Alberts, 1987, Ibrahim, 1993, Robinson & Nel,1994, Ibrahim *et. al.,* 2002 and Ibrahim, 2003).

Water use efficiency was high with drip irrigation cost a saving of water due to reduced evaporation from the non-wetted soil surface area (Eckstein *et. al.*, 1998 and More *et. al.*, 1999). Banana has been known as a plant with a rapid growth rate, high consumption of water, shallow and spreading root distribution. Several investigators reported that adequate water supply gave available soil moisture and increased the vegetative growth (Robinson & Nel, 1994, Bisn *et. al.*, 1996, Salvin *et. al.*, 2000 and Ibrahim, 2003). There is a little information concerning water, irrigation system of Williams Ziv of Williams ziv cultivar on the water use, irrigation system and water requirements of banana plant.

The purpose of this study was to determine the optimum growth, yield and water use- efficiency as affected by irrigation system (drip and minisprinkler irrigation systems) and water regimes (7000, 8750,10500 and 12250 m^3/ fed./year)of banana plant (Williams Ziv cultivars) .

MATERIALS AND METHODS

This investigation was carried out at sandy soil at El-Khatatba Minofia Governorate Egypt, through the two successive seasons 2008/2009 (first ratoon) and 2009/2010 (second ratoon) of Williams Ziv cultivar, Giant Cavendish AAA sub- group (the plentlets developed from germplasm from selection Williams cultivars). mother plant were planted at 3× 3.5 m. apart in March 2008. The experimental soil in texture and deficient in fertility according to mechanical and chemical analysis (Table, 1).

Table 1. Soil characteristics of the banana plantaion at the start of the experiment.

Properties	Depth (cm)		
	0-30	30-60	60-90
Coarse %	51.50	44.60	64.0
Fine sand %	23.0	28.40	22.0
Silt %	15.25	16.50	11.0
Clay %	13.25	10.50	3.0
Texture	Loamy sand	Sandy	Sandy
Black density gm/cm	1.56	1.64	1.70
Ph	5.0	8.2	8.4
E.C.m.mhos/cm	0.53	0.61	0.70
$CaCO_3$	0.72	0.81	0.78
Na meg/L	1.79	1.84	2.21
K meg/L	0.015	0.17	0.17
Ca meg/L	2.20	1.44	1.92
Mg meg/L	0.84	0.74	0.54
H CO_3	2.16	2.44	2.93
Cl meg/L	1.74	1.50	1.59
SO_4 meg/L	0.82	0.89	0.74

The experimental plants received all the agricultural practices usually used in banana plantation except for the purpose of this study.. The plants were received organic cattle manure at the rate of 150 m^3/Fed.year which mixed with the soil root zone during the first week of December and the recommended fertilizer NPK (600,100,800 N, P_2O_5, K_2O actual g/plant) in the forms (ammonium nitrate 33.5 %N , phosphoric acid 80% and potassium sulphate 48% K_2O) were assignees to main plots in both studied seasons. The main source of water supply was well water (E.C. 0.77 m.mhos/cm. and ph 7.5).

The experiment was designed to evaluate two irrigation systems of microirrigation (drip and minisprinkler) imposed upon the levels of 7000, 8750, 10500 and 12250 m^3 /Fed./year of water regimes. The drip (trickle) system with two lines per single now and promising micro-flapper emitters was used. One dripper 100 cm. discharge 4 liter/hour were used giving a total discharge of 14.720m^3/hour (3680 dripper/fed.) to keep pressure losses low (Lahav &Kalmar,1981 and Ibrahim,1993). The minisprinkler system with two lines per single now and promising was used. On dripper 150cm. (distance) discharge 6.0 liter/hour diameter(75cm) were used giving a total discharge of 14.750m^3/hour (2453 emitters unit/ fed.). Thus experimental consisted of eight treatment each treatment was represented by ten replicates, each of ten plants.

The following parameters were used to evaluated the tested treatments

1- Vegetative growth

Morphological measurements were done at bunch shooting stage via the following parameters: Pseudostem height (cm.), pseudostem circumference (cm.) number of leaves /plant and assimilation area/plant(m^2).

2- Flowering

2-1 Time to flowering: the period from sucker emergence to bunch shooting (in days) date was calculated in the tested seasons.

2-2 Time to harvesting: the period from bunch shooting to date of harvesting (in days) was calculated.

2-3 Cropping cycle (life cycle duration): It was calculated (in days) from sucker emergence to date of harvesting .

3- Yield and bunch characteristics: at time of harvesting bunch weight in Kg., number of hands/bunch, number of finger/bunch ,finger weight, finger length and diameter were counted and recorded.

4- Water use efficiency (W.U.E.) was calculated according to the following equation:

W.U.E. = Yield (Kgs/ Fed.) / water regime (m^3 /Fed.) = kg. fruits/ one m^3. water

The method was described by Ibrahim, (1993) W.U.E. was expressed as the amount of banana fruits in Kgs. that could be produced from one cubic meter of water.

The obtained data were subjected to analysis of variance, for factorial in a srlit plot design with ten (mat) replicates in each treatments (Snedecor & Cochran, 1980). The mean were compared by using the method of new least significant differences (New L.S.D at 0.05) described by Waller&Duncan (1969).

Table 2. Scheme of water frequency by drip irrigation and minisprinkler ystem.

Treatments	Amount of water applied											
	7000 m^3 /fed./year			8750 m^3 /fed./year			10500m^3 /fed./year			12250 m^3 /fed./year		
Months	No.of discharge h	m	m^3/Fed.	No.of discharge h	m	M^3/Fed.	No.of discharge h	m	m^3/Fed.	No.of discharge h	m	m^3/Fed.
Feb.	17	0	250	21	15	312.5	25	30	375	29	45	437.5
Mar.	30	35	450	38	08	562.5	45	46	675	54	24	7875
April.	40	45	600	50	56	750	60	06	900	70	17	1050
May	44	10	650	55	13	812.5	66	15	975	77	18	1137
Jun	51	0	750	63	45	937.5	76	30	1125	89	15	1312
Jul.	61	10	900	76	25	1125	91	40	1350	106	55	1575
Aug.	61	10	900	76	25	1125	91	40	1350	106	55	1575
Sep.	51	0	750	63	45	937.5	76	30	1125	89	15	1312
Oct.	47	33	700	59	26	875	71	29	1050	83	22	1225
Nov.	34	0	500	42	30	625	51	0	750	59	30	875
Dec.	23	46	350	30	16	437.5	35	46	525	43	16	612.5
Jan.	13	35	200	17	55	250	23	15	300	27	0	350

RESULTS AND DISCUSSION

Available data listed in Table (3) show that both irrigation system and water quantity significantly affected vegetative growth of the Williams Ziv banana at bunch shooting stage in two crop cycles (first ratoon R1 and second ratoon R2). Yet the pseudostem height tented to increase with increasing water supply under any irrigation system. The highest value , 380 and 376, 373 and 370, 369 and 350, 314 and 290 cm. were obtained by using the highest amounts of water

(12250,10500,8750 and 7000 m^3/Fed./year)in drip and minisprinkler irrigation system in the first ratoon (R1) and second ratoon(R2), respectively. Pseudostem height was increased in drip system as compared with minisprinkler one (359,343.75 cm, against 346.5,328.5 cm.)in both tested seasons.

As for, the highest value of pseudostem circumferences were noticed with the largest quantity of water under any irrigation system. The narrowest pseudostem circumference was show with 7000 m^3./Fed/year under any irrigation systems. The previous available papers concerning the effect of water quantity in pseudostem height and circumferences. Results of (Lahav&Kalmar,1991, Robinson&Nel,1994, Robinson,1995 and Bisen *et al.,*1996) working on banana are in harmony and support the obtained results.

Number of green leaves sprouted on the plant and assimilation area (All the leaves blade areas/plant) at bunch shooting stage increased with increasing water quantity under any irrigation system. Higher rates of irrigation 12250 m^3./Fed/year increased the emerged green leaves (20.8&18.25 leaf/plant) and assimilation area (28.6&27.00 m^2 /plant) in comparison with the low quantity of applied water 7000 m^3./Fed/year (14.6&13.9 leaf/plant) and (18.71&17.45 m^2/plant) in Williams Ziv cultivars in tested seasons respectively. Differences in this respect between water amounts of 12250 and 10500 m^3./Fed/year were statistically insignificant in both tested seasons. The two main factors under study act dependently concerning growth parameters of Williams Ziv banana plants.

Analogical results of this respect were reported by many investigators (Behairy& Hassan,1987, Robinson & Alberts,1987, Ibrahim,1993, Ray & Chakrabarty,1998, Ibrahim et al.,2002 and Ibrahim,2003).

All previous mentioned growth parameters of banana plants tended to increase by increasing amounts of applying water among any irrigation system. Thus, it can be concluded that , the reduction of the total surface of leaf area by decreasing the amount of applying water which represented the active photosynthesis net assimilation relative growth rates and hence the dry weight were consequently decreased.

Table 3. The effect of irrigation systems and water quantity on vegetative growth of Williams Ziv banana plants (2008/2009 and 2009/2010 seasons).

1- Pseudostem height (cm).

Irr.syst Water Regime(W.R.) m3./Fed/year	First ratoon (R1)			Second ratoon (R2)		
	Drip irr.syst.	Minispirkler irr.syst.	AV.	Drip irr.syst.	Minispirkler irr.syst.	AV.
7000	314	290	302	307	294	300.5
8750	369	350	359.5	346	320	333
10500	373	370	371.5	359	344	351.5
12250	380	376	378	363	356	359.5
A.V.	359	346.5		343.75	328.5	
New L.S.D.at 0.05						
Irr.syst.	8.21			9.31		
W.R.	6.44			10.0		
interaction	9.21			11.63		

2- Pseudostem circumference (cm).

Irr.syst Water Regime(W.R.) m3./Fed/year	First ratoon (R1)			Second ratoon (R2)		
	Drip irr.syst.	Minispirkler irr.syst.	AV.	Drip irr.syst.	Minispirkler irr.syst.	AV.
7000	76	76.5	80.75	87.4	71	79.2
8750	85	93	95.45	93.6	85	89.3
10500	100	99.2	99.5	95	93.0	94.0
12250	100	100	100	99.2	95.1	97.15
A.V.	95.95	92.15		93.8	86.02	
New L.S.D.at 0.05						
Irr.syst.	3.04			4.67		
W.R.	4.12			5.90		
interaction	5.19			8.31		

3- Number of leaves/plant

Irr.syst WaterRegime (W.R.) m3./Fed/year	First ratoon (R1)			Second ratoon (R2)		
	Drip irr.syst.	Minispirkler irr.syst.	AV.	Drip irr.syst.	Minispirkler irr.syst.	AV.
7000	16.2	13	14.6	14.8	12	13.9
8750	19.0	16.6	17.8	17.3	16.8	17.05
10500	20.5	20.4	20.45	18.6	17.3	17.95
12250	20.6	20.6	20.6	18.9	17.6	18.25
A.V.	19.08	17.65		17.4	16.0	
New L.S.D.at 0.05						
Irr.syst.	1.76			1.40		
W.R.	1.94			1.62		
interaction	2.01			1.84		

4-Assimilation area(m2/plant

Irr.syst WaterRegime(W.R.) m3./Fed/year	First ratoon (R1)			Second ratoon (R2)		
	Drip irr.syst.	Minispirkler irr.syst.	AV.	Drip irr.syst.	Minispirkler irr.syst.	AV.
7000	20.42	17	18.71	18.3	16.6	17.45
8750	27.21	22.4	24.805	25	20.3	22.65
10500	29.3	27.9	28.6	27.4	26.4	26.9
12250	29.4	28.3	28.6	27	27.3	27.00
A.V.	26.58	23.9		24.43	22.4	
New L.S.D.at 0.05						
Irr.syst.	2.44			1.67		
W.R.	2.74			1.84		
interaction	2.81			1.99		

Growth cycle duration

Data in Table (4) show that the time of flowering, harvesting and life cycle of plants (cropping cycle) significantly varied due to irrigation system and/or water amount in the two experimental tested seasons. As such increasing amount of applied water significantly shortended the life cycle of plants.

Time to flowering tended to decrease with increasing water quantity. High applyied water (12250 m3./Fed/year) and the lower applied level (7000 m3./Fed/year had decreased and increased the period to flowering (357.5,361 against

405,417.5 days).in both tested seasons. Drip irrigation shortened the time to flowering than the minsprinkler system.

Time to harvesting and life cycle of plants clearly decreased by increasing water amount in each system. In this respect manner, 12250 and 10500 m3./Fed/year treatments were shortened the period to harvesting (121,122.5 and 122,118.5days) and life cycle of plants (481,488.5 and 483, 480) than 7000 m3./Fed/year(time to harvesting:134&129.5 and life cycle of plants: 480 days & 547 days) in both tested seasons respectively. The tabulated data also show that, no clear differences could be defined between the 12250 and 10500 m3./Fed/year treatments regarding time to flowering, harvesting and life cycle of plants.

Drip system decreased this period (harvesting and life cycle duration) to the minimum than minisprinkler system. The available literature in this concern were reported by Robinson & Alberts (1987) and Ibrahim (1993) working on banana plants.

Bunch weight and yield

Bunch weight/plant and yield/Fed. significantly varied according to the irrigation system and water amount. In this respect yield/Fed. or bunch weight were 20.5,30.25,31.5,27.5 and 18.75,27.20,28.5,26.0 tons/Fed. or 21.0,29.5,30.27 and 20.0,26.0,28.25,25.0,Kgs. in treatments of 7000,8750,10500 and 12250 m3/Fed./year in both tested seasons.

The heaviest bunches/plant (or yield/Fed.)were produced in plants received the 8750 m3/Fed./year treatment under drip irrigation system(34.0 and 30.0kg. or 35.5.

Micro jet emitters system increased the wetted soil volume, shortened the period stress and increase the available water for plants and, therefore improved both growth and yield than the other work systems (drip, sprinkler and flood) by increasing water utilization efficiency beside economy in water use (Ibrahim, 1993).

Table 4. The effect of irrigation systems and water quantity on flowering, maturation and cropping cycle of Williams Ziv banana plants 2008/2009 and 2009/2010.

1- Time of flowering (days)

Irr.syst WaterRegime(W.R.) m^3./Fed/year	First ratoon (R1)			Second ratoon (R2)		
	Drip irr.syst.	Minispirk. irr.syst.	AV.	Drip irr.syst.	Minispirk. irr.syst.	AV.
7000	401	409	405	419	416	417.5
8750	382	393	387.5	307	402	354.5
10500	360	372	366	334	389	361.5
12250	353	362	357.5	357	365	361
A.V.	374	384		354.25	393	
New L.S.D.at 0.05						
Irr.syst.	7.94			6.89		
W.R.	9.42			8.41		
interaction	11.25			9.64		

2-Time of harvesting (days)

Irr.syst WaterRegime(W.R.) m^3./Fed/year	First ratoon (R1)			Second ratoon (R2)		
	Drip irr.syst.	Minispirkr. irr.syst.	AV.	Drip irr.syst.	Minispirk. irr.syst.	AV.
7000	130	138	134	125	134	129.5
8750	124	129	126.5	120	127	123.5
10500	120	125	122.5	117	120	118.5
12250	120	123	121	120	124	122
A.V.	123.5	128.75		120.5	126.25	
New L.S.D.at 0.05						
Irr.syst.	4.02			5.11		
W.R.	4.31			5.34		
interaction	4.74			5.82		

3- Cropping cycle (life cycle duration)

Irr.syst WaterRegime(W.R.) m^3./Fed/year	First ratoon (R1)			Second ratoon (R2)		
	Drip irr.syst.	Minispirk. irr.syst.	AV.	Drip irr.syst.	Minispirk. irr.syst.	AV.
7000	531	547	539	544	550	547
8750	506	522	514	427	529	478
10500	480	497	488.5	451	509	480
12250	473	485	481	477	489	483
A.V.	512.75	497.5		519.25	474.75	
New L.S.D.at 0.05						
Irr.syst.	19.44			13.09		
W.R.	18.10			15.91		
interaction	20.42			17.32		

and 30.4 tons/Fed.) on both tested seasons, and the lightest bunches/plants(or yield/Fed.) were obtained from the plants irrigated with low amounts of water.

Tabulated data proved that drip system gave the highest yields (bunch weight Kgs./plant or tons/Fed) compared with minisprikler system. Interaction studies between the two main factors were statistically significantly which referred to irrigation system and water amounts act dependently in this concern.

The available reports concerning the effect of irrigation system and water quantity on banana yield are in agreement with the here in results (Srinivas & Hegde, 1990, Ibrahim, 1993, Bosu, *et. al*., 1995, Sanchez & Ojeda,1996, Metochis,1999, Salvin etal.,2000 and Ibrahim, 2003).

Table 5. The effect of irrigation systems and water quantity on bunch weight and yield of Williams Ziv banana plants (2008/2009 and 2009/2010).

1- Bunch weight (Kg)

Irr.syst WaterRegime(W.R.) m^3./Fed/year	**First ratoon (R1)**			**Second ratoon (R2)**		
	Drip irr.syst.	**Minispirk. irr.syst.**	**AV.**	**Drip irr.syst.**	**Minispirk. irr.syst.**	**AV.**
7000	22	20	21	21	19	20
8750	34	25	29.5	30	27.23	26
10500	30	30	30	28	28.5	28.25
12250	28	26	27	25	25	25
A.V.	28.5	25.25		26	24.12	
New L.S.D.at 0.05						
Irr.syst.	1.84			1.44		
W.R.	2.67			1.49		
interaction	2.82			1.53		

2- Yield/ Fed.(ton)

Irr.syst Water Regime(W.R.) m^3./Fed/year	**First ratoon (R1)**			**Second ratoon (R2)**		
	Drip irr.syst.	**Minispirk. irr.syst.**	**AV.**	**Drip irr.syst.**	**Minispirk. irr.syst.**	**AV.**
7000	22.0	19.0	20.5	20.5	17.0	18.75
8750	35.5	25.0	20.25	30.4	24.0	27.2
10500	32.0	31.0	31.5	28.0	29.0	28.5
12250	28.5	27.0	27.5	26.0	26.0	26.0
A.V.	29.37	25.5		26.22	24.0	
New L.S.D.at 0.05						
Irr.syst.	2.54			2.19		
W.R.	3.14			2.23		
interaction	3.40			2.45		

DLS. = Drip irrigation system M. I. S.

Bunch characteristics

From the obtained dare in Table (6) show that bunch characteristics(number of hands/bunch and number of fingers/bunch) significantly varied due to irrigation system and amount applied of water. Anyhow, number of hands/bunch and number of finger/bunch significantly increased with increasing the amount of water in both seasons i.e. number of hands/bunch were 6.2,11.3,12.15,12.8, and 8.2,10,12,12.5,h./b. and number of finger/bunch were 187.205.224.233.5 and 175.5,195,208.5,218.0 f./ b. in treatment of 7000,8750,10500 and 12250 m^3/Feg./year in the two tested seasons.

As for number of hands/bunch and number of finger/bunch in response to irrigation system, drip system gave the highest values as compared than minisprinkler system. Differences within two mentioned treatments were statistically significant in both seasons.

Table 6. The effect of irrigation systems and water quantity on number of hands/ bunch and number of finger/ bunch of Williams Ziv banana plants of (2008/2009 and 2009/2010).

1- Number of hands/ bunch

Irr.syst (I.S) WaterRegime(W.R.) m³./Fed/year	First ratoon (R1)			Second ratoon (R2)		
	Drip irr.syst.	Minispirk. irr.syst.	AV.	Drip irr.syst.	Minispirk. irr.syst.	AV.
7000	10.0	8.4	9.2	9.2	8	8.6
8750	12.0	10.6	11.3	11.0	10	10.5
10500	12.3	13	12.15	11.5	12	11.75
12250	12.6	13.0	12.8	11.9	12.5	12.2
A.V.	11.72	11.0		10.9	10.67	
New L.S.D.at 0.05						
Irr.syst.	N.S			N.S.		
W.R.	1.32			1.26		
interaction	1.57			1.51		

2- Number of finger/ bunch

Irr. syst (I.S) WaterRegime(W. R.) m³./Fed/year	First ratoon (R1)			Second ratoon (R2)		
	Drip irr.syst.	Minispirk. irr.syst.	AV.	Drip irr.syst.	Minispirk . irr.syst.	AV.
7000	194	180	187	183	168	175.5
8750	218	191	205	207	183	195
10500	228	220	224	217	200	208.5
12250	236	231	233.5	225	221	218.0
A.V.	220	206.5		208	190.5	
New L.S.D.at 0.05						
Irr.syst.	5.45			6.21		
W.R.	6.23			6.92		
interaction	7.44			9.32		

Finger parameters

Data in Table(7) show that finger parameters (finger weight, finger length and diameter) were significantly varied due to irrigation system and/or water amount in both tested seasons. As such the highest values of finger parameters were noticed in plants irrigated with 8750 m^3/Fed/year treatment while the lowest values of finger paramenters were noticed in plants irrigated with 7000 m^3/Fed/year. The longest finger (23.6 & 20.1cm), widest finger (4.7 &4.8 cm)and heaviest finger (141 ,134 g) were obtained from plants received 8750 m^3/Fed/year under drip irrigation whilest the shortest finger (12.0 ,10.1 cm), narrowest ones (2.8 &2.7 cm) and lightest finger (97.0, 98.0g) were obtained from planteds irrigated with 7000 m^3/Fed/year under minisprinkler system in both tested seasons, respectively.

Analogical resultus were reported by Lahav & Kalmar(1981), Bisen *et al.,* (1996), Sanchez & Ojeda (1996), Eckstein *et. al.* (1998), More *et. al.* (1999), Ibrahim(2003) and Singh *et. al.* (2011).

Table 7. The effect of irrigation systems and water quantity on finger parameters of Williams Ziv banana plants (2008/2009 and 2009/2010)

1-Finger weight (g)

Irr.syst Water Regime(W.R.) m³./Fed/year	**First ratoon (R1)**			**Second ratoon (R2)**		
	Drip irr.syst.	**Minispirk. irr.syst.**	**AV.**	**Drip irr.syst.**	**Minispirk. irr.syst.**	**AV.**
7000	103	97	100	101	98	99.5
8750	141	117	129	138	120	127.0
10500	119	125	122	118	121	119.5
12250	110	101	105.5	109	103	106
A.V.	118	110		115.5	110	
New L.S.D.at 0.05						
Irr.syst.	6.54			5.04		
W.R.	8.4			6.21		
interaction	10.11			7.34		

2- Finger length

Irr.syst Water Regime(W.R.) m³./Fed/year	**First ratoon (R1)**			**Second ratoon (R2)**		
	Drip irr.syst.	**Minispirk. irr.syst.**	**AV.**	**Drip irr.syst.**	**Minispirk. irr.syst.**	**AV.**
7000	15.0	12.0	13.5	13.5	10.1	11.8
8750	23.6	18.5	21.05	20.1	15.2	17.65
10500	21.0	20.4	21.7	20.0	20.0	20.0
12250	20.0	20.0	21.0	19.0	20.0	19.5
A.V.	19.89	17.7		18.15	16.32	
New L.S.D.at 0.05						
Irr.syst.	1.40			1.64		
W.R.	1.57			1.79		
interaction	1.74			1.83		

3-Finger diameter(cm)

Irr.syst Water Regime(W.R.) m³./Fed/year	**First ratoon (R1)**			**Second ratoon (R2)**		
	Drip irr.syst.	**Minispirk. irr.syst.**	**AV.**	**Drip irr.syst.**	**Minispirk. irr.syst.**	**AV.**
7000	3.2	2.8	3.0	3.4	2.7	3.05
8750	4.7	3.8	4.25	4.80	4.0	4.4
10500	4.4	4.3	4.35	4.1	4.4	4.25
12250	4.2	4.0	4.1	4.0	4.1	4.05
A.V.	4.13	3.73		4.08	3.8	
New L.S.D.at 0.05						
Irr.syst.	0.44			0.42		
W.R.	0.50			0.47		
interaction	0.58			0.54		

Water utilization efficiency (Kg. Fruits / one m^3 water)

Water utilization efficiency or water use efficiency (WUE), expressed as the amount of Williams Ziv banana fruits in Kgs. That could be produced from one cubic meter of water. W.U.E. clearly of faceted with irrigation system and/or the amount of applied water within each system. Therefore, drip irrigation with 8750 m^3/Fed./year gave the highest value of W.U.E.(4.05 & 3.47 Kg./m^3) while minisprinkler system with 12250 m^3/Fed/year gave the lowest ones(2.20 &2.12 Kgs. fruit/m^3 water) in both tested seasons. The obtained data show that the highest value of W.U.E. (3.95 & 3.10 Kgs.fruit/m^3 water) were obtained from plants received 8750 m^3/Fed/year followed by plants irrigated with 10500 m^3/Fed/year treatment (2.99 & 2.71 kgs fruit/ m^3 water) than plants irrigated with 7000 m^3/Fed/year (2.92 & 2.67 Kg. /m^3) whilest, the lowest value of W.U.E. (2.24 & 2.12 Kg. Fruit/m^3 water) were obtained from plants irrigated with 12250 m^3/Fed/year in both seasons, respectively.

Recorded data (Table 8) proved that drip system gave the highest values concerning W.U.E. (3.12 &2.70 Kgs. Fruit/m^3 water) compared than minisprinkler system(2.67 &2.5 kgs/m^3). In other words, improvement of W.U.E. may be attributed with available water formed in the root zone, but not the amount of applied water. Interaction studies between the two main factor concerning W.U.E. to irrigation system and water quantity act dependently in this concern.

This results agree with those reported by Srinivas & Hegde, 1990, Ibrahim, 1993, Goenage *et. al.,*1995, Eckstein *et al.,* 1998, More *et. al.,* 1999, Salvin *et. al.,* 2000, Ibrahim *et. al.,* 2002 and Ibrahim 2003) on banana . However, Kurupparachchi and Pain(1981) on banana proved that, water use efficiency was similarly affected (at soil moisture depletion 10, 40 and 75%).

Table 8. Effect of irrigation systems and water quantity on water utilization efficiency of Williams Ziv banana plants of two crop cycles seasons (2008/2009 and 2009/2010)

2- Water utilization efficiency (Kg. fruit/one m^3. water)

Irr.syst	**First ratoon (R1)**			**Second ratoon (R2)**		
Water Regime(W.R.) m^3./Fed/year	**Drip irr.syst.**	**Minispirk. irr.syst.**	**AV.**	**Drip irr.syst.**	**Minispirk. irr.syst.**	**AV.**
7000	3.14	2.71	2.92	2.92	2.42	2.67
8750	4.05	2.85	3.45	3.47	2.74	3.10
10500	3.04	2.95	2.99	2.66	2.79	2.71
12250	2.28	2.20	2.24	2.12	2.12	2.12
A.V.	3.12	2.67		2.70	2.50	
New L.S.D.at 0.05						
Irr.syst.	0.21			0.32		
W.R.	0.28			0.37		
interaction	0.34			0.41		

REFERENCES

1. Bisen, R. K., H. P. Agrawai and S. V. Jogdand. 1996. Studies on the effect of scheduling irrigation on growth and yield of banana cv. Robusta Advances on Plant Sciences 9 (2) 83-88.
2. Eckstein, K., C. Fraser, A. Botha and J. Husselmann. 1998. Evaluation of various irrigation system for highest economical yield and optimum water use for bananas. Acta Horticulture.490:147-157.
3. Goenaga, R., H. Irizarry, B. Coleman and E. Ortiz. 1995. Drip irrigation recommendations for plantain and banana growth on the semiarid southern coast of Puerto Rico. Journal of Agriculture of university Puerto Rico. 79 (1/2) :13-27.
4. Hegde, D. M. and K. Srinivas. 1991. Growth productivity and water use of banana crops under drip and basin irrigation with N and K fertilization. Tropical Agriculture 68(4) 331-334.
5. Ibrahim, E. G. 1993. Studies on irrigation of banana . Ph. D. Thesis, Fac. Agri. Zagazig Univ.Egyp.
6. Ibrahim, E. G. 2003. Productivity, water use and yield efficiency of banana under different irrigation system and water quantity in sandy soil. Egypt.j. Appl. Sci., 18(10) 334-348.
7. Metochis, C. 1999. Water requirment and yield of banana. Cyprus Technical Bulletin – Cyprus Agricultural Research Institute No.203, 8pp. (Hort. Abst. 70:7589).
8. More, M. R., R. K. Patil, D. D. Tekale and V. G. Uajshnav. 1999. Growth, productivity, water use and economics of banana cultivation under drip and basin irrigation system. J. soils and crops, 9: (1) 23-25.
9. Ray, C. C. and B. K. Chakrabarty. 1989. Effect of irrigation and mulching on growth and yield og banana cv. Dwarf Cavendish (AAA). Journal of The Agricultural science of North East India, 11 (2): 189-192.
10. Robinsons, J. C. and A. J. Alberts. 1987. The influence of under canopy sprinkler and drip irrigation systems on growth and yield of bananas (Cultivar Williams) in the subtropics. Scientia Horticultural, 32 (1/2):49-66.
11. Robinsons, J.C. and D. J. Nel. 1994. A comparison of drip and microspinner irrigation for bananas at Levubu-first ratoon cycle. Intigtinsbulletion Instituat vir Tropiese subtropiese Gewasse No. 267, 5-6.
12. Salvin, S. E., K. Baruah and Bordoloi. 2000. Drip irrigation studied in banana cv. Barjahaji (misa AAA drioup, Cavendish subgroup). Crop Resarch (Hisar) 20 (3) : 489-493.

13. Sanchez, S. and S.J. Oheda. 1996. Banana evapotranspiration. Agrarias, conseheria de Agriculutey pesca, 41:645.
14. Singh, H. P., S.Uma, R. Selvarajan and J. L. Karihaloo. 2011. Micropropagation for production of quality banana material in Asiapacific. Asia-pacific consortium on Agricultural Biotechnology New Delhi, India p. 92.
15. Snedecor, G. W. and W. G. Cochran. 1980. Statistical methods 7 th Ed. The lowa State Univ. Press. Amer., lowa, U.S.A.
16. Srinivas, K. and D. M. Hegde. 1990. Drip irrigation studies in banana. In proceedings of the 11th international congress on the use of plastics in agriculture, New Delhi, India, 26th Fe. 2th March.
17. Waller, R. A. and D. B. Duncan. 1969. A buyes rule for the symmetric multiple comparison problem. Amer. State. Assoc. J. 64:1484-1503.

الاحتياجات المائية وكفاءة استخدام مياه الري للموز صنف ويليامز Ziv تحت نظم ري وكمية مياه مختلفة في الأرض الرملية

السيد جمعة ابراهيم ، اماني مصطفي حامد ، سامية صلاح الدين حسني

قسم بحوث الفاكهة الاستوائية – معهد بحوث البساتين – مركز البحوث الزراعية – جيزة – مصر

أجري هذا البحث علي نباتات الموز صنف Williams Ziv خلال الموسمين المتتالين 2010/2009 (نباتات الخلفة الأولي) و 2011/2010 (نباتات الخلفة الثانية) نامية في ارض رملية لتحديد الاحتياجات المائية تحت نظامي الري بالتنقيط (drip irrigation) والري بالرش المحدود (minisprinkler irrigation) تحت معدلات مختلفة من كمية مياة الري 7000، 8750، 10500، 12250 متر مكعب / فدان/ سنة مع اضافة 150 م^3 سماد عضوي/ فدان كل سنة من سنوات الدراسة .

وأهم النتائج:-

1- زادت قيم المواصفات الحضرية (طول ومحيط الساق الكاذب وعدد الأوراق والمساحة الفعالة لكل نبات) زيادة معنوية بزيادة كمية المياه المضافة وقد أعطى نظام الري بالتنقيط قيماً أعلي لهذه الصفات مقارنة بنظام الرش المحدود.

2- قصرت الفترة الي التزهير والحصاد ودورة حياة النبات تقل بزيادة كمية المياه المضافة كما قلل الري بالتنقيط من هذه الفترات مقارنة بالري بالرش المحدود.

3- تحصل علي اعلي قيم وزن السوباطة والمحصول وافضل مواصفات السوباطة والأصابع من النباتات التي رويت بمعدل 8750 متر مكعب / فدان/ سنة تحت نظام الري بالتنقيط.

4- تتأثر قيم كفاءة استخدام مياه الري معنوياً بكميات الماء الصالح للامتصاص فقد تفوقت المعاملة 8750 متر مكعب تحت نظام الري بالتنقيط (4.05 و3.47 كجم ثمار/ 1 م^3 ماء) عن باقي المعاملات وقد يرتبط ذلك بمساحة منطقة البلل وإضافة السماد العضوي قد يحسن من الصفات الطبيعية والكيماوية والبيولوجية للتربة وبذلك تزيد قدرتها علي الاحتفاظ بالمياه والعناصر الغذائية مما ينعكس إيجابيا علي زيادة كفاءة الجذور المغذية .

يقترح عند زراعة صنف Williams Ziv تحت ظروف الأرض الرملية التي أجريت بها هذا البحث باستخدام معدل 8750 م^3 / فدان/ سنة تحت نظام الري بالتنقيط للحصول علي افضل نمو وإنتاجية وجودة عالية من لثمار علي ان يكون توزيع المياة بمعدل:-

شهر يناير 250 م^3 / فدان/ سنة- شهر فبراير 312.5 م^3 / فدان/ سنة – شهر مارس 562.5 م^3 / فدان/ سنة – شهر أبريل 750 م^3 / فدان/ سنة – شهر مايو 815.2 م^3 / فدان/ سنة – شهر يونيو 937.5 م^3 / فدان/ سنة – شهر يوليو 1125 م^3 / فدان/ سنة – شهر أغسطس 1125 م^3 / فدان/ سنة – شهر سبتمبر 937.5 م^3 / فدان/ سنة – شهر أكتوبر 875 م^3 / فدان/ سنة – شهر نوفمبر 625 م^3 / فدان/ سنة – شهر ديسمبر 437.5 م^3 / فدان/ سنة.