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EFFECT OF IRRIGATION RATE AND SOIL TYPE ON "CANINO" APRICOT TREES

BY

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ABSTRACT

This study was conducted on 9-years old trees of "Canino" apricot, planted at 5 x 5 m apart under drip irrigation system on both loamy sand and sandy soils. Three irrigation rates (IR) were used: 1) 18.36-18.81 m^3/tree/year (as 100% of common IR practiced in the farm), 2) 12.24-12.54m^3/tree/year (as 66.7% of IR) and 3) 6.12-6.77 m^3/tree/year (as 33.3% of IR). Vegetative growth, fruit weight, size and dimensions decreased as IR decreased, while water use efficiency, fruit firmness and juice TSS increased as IR decreased. Percentage of fruit set, number of fruits/tree, fruit yield and yield monatory value showed slight and non significant reduction with IR reduced from 100 to 66.7 as well as showed sharp and significant decrease with IR reduction from 66.7 to 33.3%. Also, all growth and yield components as well as water use efficiency and yield monatory value were better on loamy sand soil than sandy soil.

So, we can recommend apricot growers to cultivate their orchards on loamy sand soil with 12.24-12.54 m^3/tree/year to get better growth, yield and income as well as save 33.3% of irrigation rate.

INTRODUCTION

Water is fast becoming an economical scare resource in many areas of the world especially in arid and semiarid regions. In Egypt, water is considered as a limited resource because of increasing population. Moreover, water is one of the most important component in the biological systems (Salisbury and Ross, 1985). Maximizing the use of modern irrigation system is essential to satisfy the increase in irrigation water demands (Brown, 1999).

Wright and Stark (1990) revealed that, plant growth and development was retarded when water supply was restricted. But, Storchus and Kosykh (1983) and Ali (2006) on peach, Semash and Panasenko (1984), Ali *et al.*, (1998) and Hussein (1998) on apple, Salem *et al.* (1999), Fathi (1999 a & b), Hussein (2004) and Ismail *et al.* (2007) on pear as well as Kandil and El-Feky (2006) on apricot used 40, 60, 70 or 80% field capacity (F.C.) and obtained the best growth parameters and yield components with 80 % F.C. Moreover, Cathoun (1975) found that, the increase in tension from zero to 0.33 bar released more than 75% of water in light textured soil but less than 50% in heavy ones. Levin *et al.* (1979) pointed out that drip irrigation enables a restricted volume of wetted soil to be maintained with small fluctuations in water tension and with the development of a dense root system with minimum loss of water and fertilizers by leaching. Also, Levin *et al.* (1980), stated that, root distribution depended upon the volume of wetted soil, which was related to soil hydraulic conductivity, the rate and duration of water application. Therefore, using water soil potential at 100-200 mbar (12.94 m^3/tree/year) was recommended as the best level for "Canino" apricot trees in sandy soil (Kandil and El-Feky 2006). The objective of this study is to determine the effect of different irrigation rates on two soil types for "Canino" apricot trees.

MATERIALS AND METHODS

The present investigation was carried out in a private orchard at 76km Cairo-Alexandria road during 2006 and 2007 seasons. Nine years old "Canino" apricot trees were budded on local apricot seedling root-stock and planted 5 x 5 m. apart (168 tree/ feddan) on sandy and loamy sand soils. The trees were drip irrigated with two lateral lines as well as six emitters/tree (8 L/h) which spaced 0.5m apart on the lateral lines. Soil samples from three depths: 0-30, 30-60 and 60-100cm. were collected to determine physical, hydrophysical and chemical properties according to Piper (1950) and illustrated in Table (1).

Table (1): Physical and chemical properties of soil of the experimental site.

Physical:

Texture class	depth (cm.)	Particale size distribution (%)			
		Fine sand	Silt (%)	Clay (%)	Coarse sand (%)
Loamy sand	0-30	51.5	17	3.2	28.4
	30-60	16.5	13.8	3.4	66.4
	60-100	20.6	13.2	5.9	60.4
Sand	0-30	24.9	6	2.8	66.4
	30-60	25.9	5.2	2.4	66.6
	60-100	25.5	5.4	2	67.2

Chemical:

Texture class	depth (cm.)	EC	Sp	Cation (mg/100 g soil)				Anion (meg/100g soil)			
				Ca^{++}	Mg^{++}	Na+	K+	CO_3^{--}	HCO_3^-	Cl^-	$SO4^{--}$
Loamy sand	0-30	1.00	25.00	4.00	1.80	2.70	1.50	0.00	1.80	2.79	5.41
	30-60	0.80	23.00	2.00	1.20	3.68	1.12	0.00	1.24	2.79	3.97
	60-100	0.90	24.00	2.00	1.90	4.45	0.65	0.00	1.60	3.50	3.90
Sand	0-30	1.40	30.00	5.00	1.86	5.49	1.65	0.00	1.24	5.58	7.18
	30-60	1.00	37.00	3.00	1.88	3.67	1.45	0.00	1.20	3.72	5.08
	60-100	1.10	35.00	5.00	1.86	3.14	1.00	0.00	1.92	5.50	3.58

The studied irrigation rates in both soil types (sandy and loamy sand) were as follows and illustrated in Table (2).

First season (2006):

1) 3084.5 m^3/feddan/year (18.36 m^3/tree/ year) as 100% of common irrigation rate (IR) practiced in the farm.
2) 2056.3 m^3/feddan/year (12.24 m^3/tree/ year) as 66.7 % of (IR).
3) 1028.2 m^3/feddan/year (6.12 m^3/tree/ year) as 33.3 % of (IR).

Second season (2007):

1) 3160.1 m^3/feddan/year (18.81 m^3/tree/ year) as 100 % of common irrigation rate (IR) practiced in the farm.
2) 2106.7 m^3/feddan/year (12.54 m^3/tree/ year) as 66.7 % of (IR).
3) 1053.4 m^3/feddan/year (6.27 m^3/tree/ year) as 33.3 % of (IR).

The following investigation measurements were recorded:-

1) Growth parameters: shoot length, number of leaves/shoot and leaf area at mid August of both studied seasons.
2) Percentage of fruit set: the total number of flowers at full bloom and set fruitlets were counted on each tagged branch, then the fruit set % was estimated according to Westwood (1978) as follows:

$$\text{Fruit set (\%)} = \frac{\text{Number of set fruitlets}}{\text{Total no. of flowers at full bloom}} \times 100$$

Table (2): Water quantities (L/tree/month).

Season	Irrigation rate	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct	Nov	Dec	Total /year	
														M^3/tree	M^3/feddan
2006	IR_1	180	630	1800	2790	2790	2700	2160	1800	1530	1080	720	180	18.36m^3	3084.5m^3
	IR_2	120	420	1200	1860	1860	1800	1440	1200	1020	720	480	120	12.24m^3	2056.3m^3
	IR_3	60	210	600	930	930	900	720	600	510	360	240	60	6.12m^3	1028.2m^3
2007	IR_1	270	720	1800	2880	2880	2700	2160	1800	1620	1080	720	180	18.81m^3	3160.1m^3
	IR_2	180	480	1200	1920	1920	1800	1440	1200	1080	720	480	120	12.54m^3	2106.7 m^3
	IR_3	90	240	600	960	960	900	720	600	540	360	240	60	6.27m^3	1053.4m^3

3) At picking date, numbers of fruits/tree were used to calculate yield monatory value = Fruit yield (kg.)/tree x farm - gate price (LE 2.0 for kg fruits weighing > 40 g, LE 1.5 for fruits 30-40 g and LE 1.0 for kg fruits < 30 g). Also we computed water use efficiency = fruit yield (kg.)/feddan ÷ irrigation rate (m^3/feddan/year).
4) Fruit quality: at picking date, samples of 15 random matured fruits/replicate were used to assess fruit quality as fruit weight and size, fruit dimensions (length and diameter), fruit firmness (using Advance Force Gauge RHI_3, UK), juice TSS content (using a hand refractometer), juice acidity (expressed as gram of malic acid/ 100 ml. juice) and TSS/acid ratio.

The experimental treatments were arranged in a randomized complete block design with three replicates in each and three trees per replicate. The obtained data were subjected to statistical analysis according to Snedecor and Cochran (1990). Averages were compared using L.S.D. test at 5 % probability.

RESULTS

- Vegetative growth:

Concerning the effect of both soil types on some vegetative growth measurements i.e. (shoot length, number of leaves/ shoot and leaf area) of "Canino" apricot trees grown under different rates of irrigation, data tabulated in Table (3) revealed that the present growth parameters showed a clear trend to be reduced as irrigation rate was reduced where shoot length decreased from 57.7 to 42.2 to 28.5 cm., number of leaves/shoot decreased from 44.7 to 36.3 to 24.2 as well as leaf area decreased from 47.6 to 41.3 to 29.9 cm^2 as irrigation rates decreased from 100 to 66.7 to 33.3 % of common irrigation rate in that farm (IR) throughout the 2nd season respectively. On the contrary, shoot length increased on loamy sand soil 44.3 than on sandy soil 40.8 cm. Number of leaves/shoot also increased on loamy sand 39.3 than on sandy soil 32.9 as well as leaf area increased on loamy sand soil 40.7 than on sandy soil 36.7 cm^2 during the first studied season respectively. Moreover, all differences were statistically confirmed. However, the best interaction was vegetative growth on loamy sand soil under 100 % IR (57.3 and 58.0 cm shoot length, 53.3 and 51.0 No. of leaves/shoot as well as 48.8 and 52.1 cm^2 leaf area) in the two successive seasons 2006 and 2007, respectively.

- Percentage of fruit set and yield components:

Percentage of fruit set (Table 4) showed a non significant reduction (from 30.0 to 28.9 % in 2006 and from 29.9 to 29.3 % in 2007 seasons respectively) when IR reduced from 100 to 66.7 %. On the other hand, there was a significant decrease (from 28.9 to 25.8% and from 29.3 to 25.2 %) when IR decreased from 66.7 to 33.3 %. Meanwhile, this phenomenon may mean that little moisture stress (66.7 %) avoids excessive water or severe stress. Moreover, there are not significant differences between loamy sand and sandy soils with fruit set. However, we obtained better interaction with IR 100 % (30.3, 30.2, 29.7 and 29.6 %) as well as IR 66.7 % (29.1, 29.8, 28.7 and 28.9 %) through the two studied seasons.

Table (3): "Canino" apricot vegetative growth (shoot length, number of leaves/shoot and leaf area) as affected by irrigation rate (A) and soil type (B).

Irrigation rate %	Shoot length (cm.)						No. of leaves/shoot						Leaf area (cm^2)					
	Loamy sand		Sandy		Average (A.)		Loamy sand		Sandy		Average (A.)		Loamy sand		Sandy		Average (A.)	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
100	57.30	58.00	56.70	57.30	57.00	57.70	53.30	51.00	38.70	38.30	46.00	44.70	48.80	52.10	42.10	43.20	45.40	47.60
66.7	43.70	43.40	40.30	40.90	42.00	42.20	38.00	37.70	37.00	35.00	37.50	36.30	43.50	43.80	39.00	38.80	41.20	41.30
33.3	32.00	31.70	25.50	25.30	28.80	28.50	26.70	25.70	23.00	22.70	24.80	24.20	30.00	30.80	28.90	29.00	29.40	29.90
Average (B)	44.30	44.40	40.80	41.20	-	-	39.30	38.10	32.90	32.00	-	-	40.70	42.20	36.70	37.00	-	-
L.S.D. at 5 % for:																		
Irrigation rate (A) =					0.77	0.62					0.8	0.73					0.89	0.88
Soil type (B) =					0.77	0.62					0.8	0.73					0.89	0.88
Interaction (A x B):					1.09	0.87					1.14	1.03					1.26	1.25

Table (4): "Canino" apricot fruit set, no. of fruits and water use efficiency as affected by irrigation rate (A) and soil type (B).

Irrigation rate %	Fruit set (%)						No. of fruits/tree						Water use efficiencu (kg/m^3)					
	Loamy sand		Sandy		Average (A.)		Loamy sand		Sandy		Average (A.)		Loamy sand		Sandy		Average (A.)	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
100	30.30	30.20	29.70	29.60	30.00	29.90	1392	1367	1150	1133	1271	1250	3.17	3.06	2.44	2.53	2.81	2.80
66.7	29.10	29.80	28.70	28.90	28.90	29.30	1353	1350	1143	1104	1248	1227	4.55	4.44	3.52	3.50	4.03	3.97
33.3	26.40	25.80	25.20	24.70	25.80	25.20	1020	937	823	700	922	818	7.74	7.64	5.19	5.42	6.47	6.53
Average (B)	28.60	28.60	27.90	27.70	-	-	1255	1218	1039	979	-	-	5.15	5.05	3.72	3.18	-	-
L.S.D. at 5 % for:																		
Irrigation rate (A) =					1.83	1.24					32	33.7					0.19	0.18
Soil type (B) =					1.83	1.24					32	33.7					0.19	0.19
Interaction (A x B):					1.17	1.75					36.9	39.4					0.29	0.26

Yield components expressed as number of fruits/tree, fruit yield/tree and yield monatory values are shown in Tables (4 & 5). Slight and non significant reduction was observed with IR decrease from 100 to 66.7 % of No. of fruits/tree (from 1271 to 1248 and from 1250 to 1227), of fruit yield (from 51.5 to 49.4 and from 52.6 to 49.8 kg/tree) as well as of yield monatory value (from LE 91.9 to 88.1 and from LE 105.3 to 99.6) through 2006 and 2007 seasons. Otherwise, there was significant and sharp reduction of No. of fruits/tree (from 1248 to 922 and from 1227 to 818), of fruit yield (from 49.4 to 23.8 and from 49.8 to 26.4 kg/tree) as well as of yield monatory value (from LE 88.1 to 23.9 and from LE 99.6 to 39.7) as irrigation rate decreased from 66.7 to 33.3 %. Furthermore, there was better number of fruits/tree (1255 and 1218), better fruit yield (47.4 and 47.9) as well as yield monatory value (LE 85.4 and 90.7) on loamy sand soil in the two studied seasons, respectively than on sandy soil.

- Water use efficiency (WE):

The present results in (Table 4) showed a gradual and significant increase of WE (from 2.81 to 4.03 to 6.47 and from 2.80 to 3.97 to 6.53 kg/m^3) parallel to IR reduction (from 100 to 66.7 to 33.3 %) through 2006 and 2007 seasons, respectively. Also, water use efficiency was higher on loamy sand (5.15 and 5.05) than on sandy soil (3.72 and 3.18 kg/m^3) in 2006 and 2007 seasons, respectively.

- Fruit quality attributes:

Fruit characters are shown in Tables (5-7) where we can observe a gradual decrease of fruit weight (from 40.4 to 39.4 to 25.6 g.), fruit size (from 39.8 to 36.8 to 24.3 cm^3), polar diameter (from 4.53 to 4.50 to 4.06 cm.) and equatorial diameter (from 4.10 to 4.08 to 3.72 cm.) accompaniment to IR decrease in the 1st season. Contrary, fruit firmness and juice TSS increased (from 7.87 to 8.03 to 8.21 lb/inch^2 and from 11.9 to 12.2 to 12.9 %) with IR reduction. However, this phenomenon may clear the fact that, less irrigation water reflects more fruit firmness and higher juice TSS. On the other hand, juice acidity decreased (from 0.93 to 0.86 to 0.78 %) in the 2nd season while had no clear trend in the 1st season (from 1.24 to 1.31 to 1.08 %) with IR reduction (from 100 to 66.7 to 33.3 %). However, fruit quality attributes were higher on loamy sand soil than on sandy soil except with juice TSS where sandy soil get higher TSS (12.9 and 13.2 %) than loamy sand soil (11.8 and 12.1 %).

DISCUSSION AND CONCLUSION

The present results pointed out that, vegetative growth (shoot length, number of leaves/shoot and leaf area) as well as fruit quality attributes (fruit weight, size and dimensions) showed a gradual decrease parallel to irrigation rate (IR) reduction. However, these results go in line with the conclusion given by Ali *et al.* (1998), Hussein (1998) on apple, Salem *et al.* (1999), Fathi (1999 a & b), Hussein (2004) and Ismail et «/., (2007) on pear trees; Ali (2006) on peach; Kandil and El-Feky (2006) on apricot, who revealed that vegetative growth and yield were markedly reduced at lower irrigation rates. On the other hand, water use efficiency (WE), fruit firmness and juice TSS increased as IR decreased. Meanwhile, this phenomenon may be as a result of the fact of WE increase with less water consumption. Also, smaller fruits have higher firmness and juice TSS. Moreover, Chalmers (1990), Fathi (1999 a & b), Hussein (2004) and Ismail *et al.* (2007) on pear trees have disclosed the same trend. Furthermore, percentage of fruit set, number of fruits/tree, fruit yield and yield monatory value showed slight and non significant reduction with IR reduction from 100 to 66.7 % as well as showed sharp and significant decline with IR reduction from 66.7 to 33.3 %. Generally, Ali *et al.* (1998), Salem *et al.* (1999), on apple concluded that, for maximizing irrigation water benefit, IR should be practiced at moderate soil moisture stress, i.e., 40% depletion in available water. Also, Ritchie (1974) pointed out that, some water conservation benefits can be obtained from allowing plants to experience moderate water stress.

Table (5): "Canino" apricot fruit weight, fruit yield and yield monatory value as affected by irrigation rate (A) and soil type (B).

Irrigation rate %	Fruit weight (g.)						Fruit yield/tree (kg)						Yield monatory value (LE)					
	Loamy sand		Sandy		Average (A.)		Loamy sand		Sandy		Average (A.)		Loamy sand		Sandy		Average (A.)	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
100	41.90	42.10	38.90	42.10	40.40	42.10	58.30	57.60	44.80	47.70	51.50	52.60	116.60	115.20	67.20	95.40	91.90	105.3
66.7	41.10	41.30	37.70	39.80	39.40	40.60	55.70	55.70	43.10	43.90	49.40	49.80	111.40	111.40	64.70	87.80	88.10	99.60
33.3	27.60	32.50	23.60	31.80	25.60	32.20	28.20	30.40	19.50	22.50	23.80	26.40	28.20	45.60	19.50	33.80	23.90	39.70
Average (B)	36.90	38.60	33.40	37.90	-	-	47.40	47.90	35.80	38.00	-	-	85.40	90.70	50.50	72.30	-	-

L.S.D. at 5 % for:

Irrigation rate (A) =	1.64	1.54	2.81	3.02	4.92	6.11
Soil type (B) =	0.64	0.54	4.81	4.02	2.95	5.07
Interaction (A x B):	0.91	0.76	7.15	6.45	3.16	3.82

Table (6): "Canino" apricot fruit size, polar diameter and equatorial diameter as affected by irrigation rate (A) and soil type (B).

Irrigation rate %	Fruit size (cm^3)						Polar diameter (cm.)						Equatorial diameter (cm.)					
	Loamy sand		Sandy		Average (A.)		Loamy sand		Sandy		Average (A.)		Loamy sand		Sandy		Average (A.)	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
100	41.70	40.00	38.00	39.00	39.80	39.50	4.52	4.51	4.53	4.51	4.53	4.51	4.11	4.10	4.09	4.10	4.10	4.10
66.7	38.30	38.30	35.30	37.30	36.80	37.80	4.50	4.49	4.49	4.48	4.50	4.49	4.10	4.08	5.06	4.07	4.08	4.08
33.3	26.70	31.70	22.00	31.30	24.30	31.50	4.08	4.08	4.03	4.02	4.06	4.05	3.74	3.73	3.70	3.69	3.72	3.71
Average (B)	35.60	36.70	31.80	35.90	-	-	4.37	4.36	4.35	4.34	-	-	3.98	3.97	3.95	3.59	-	-

L.S.D. at 5 % for:

Irrigation rate (A) =	0.62	1.04	0.037	0.100	0.147	0.135
Soil type (B) =	0.62	1.04	0.037	0.100	0.147	0.135
Interaction (A x B):	0.88	1.47	0.163	0.141	0.207	0.191

Table (7): "Canino" apricot fruit firmness, juice TSS and acidity as affected by irrigation rate (A) and soil type (B).

Irrigation rate %	Fruit firmness (lb/inch^2)						TSS (%)						Acidity (%)					
	Loamy sand		Sandy		Average (A.)		Loamy sand		Sandy		Average (A.)		Loamy sand		Sandy		Average (A.)	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
100	8.12	7.33	7.61	6.53	7.87	6.93	11.10	11.20	12.70	12.70	11.90	11.90	1.30	0.96	1.17	0.89	1.24	0.93
66.7	8.17	7.75	7.90	6.57	8.03	7.16	11.50	11.90	13.00	13.00	12.20	12.50	1.34	0.85	1.29	0.87	1.31	0.86
33.3	8.51	9.00	7.91	6.57	8.21	7.78	12.80	13.20	13.10	14.00	12.90	13.60	1.08	0.78	1.08	0.78	1.08	0.78
Average (B)	8.27	7.80	7.80	6.56	-	-	11.80	12.10	12.90	13.20	-	-	1.24	0.86	1.18	0.85	-	-
L.S.D. at 5 % for:																		
Irrigation rate (A) =					0.79	0.85					0.11	0.51					0.04	0.06
Soil type (B) =					0.79	0.85					0.11	0.51					0.04	0.06
Interaction (A x B):					1.11	1.20					0.15	0.72					0.06	0.08

Furthermore, availability of soil moisture is not a property of the soil alone, but indeed a combined function of the plant, the soil and the climate (Hillel, 1987). The present results clearly showed that all growth and yield components as well as yield monatory value and water use efficiency were better on loamy sand soil than on sandy soil.

So, we can recommend "Canino" apricot growers to cultivate their orchards on loamy sand soil and irrigate their trees with 12.24-12.54 m^3/ tree/year to get better growth, yield and income as well as to save 33.3 % of irrigation water.

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تأثير معدل الرى ونوع التربة على أشجار المشمش صنف "كانينو"

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أجريت هذه التجربة فى مزرعة خاصه بالكيلو ٧٦ طريق مصر الإسكندرية الصحراوى على أشجار مشمش صنف كانينو بعمر ٩ سنوات مزروعه على مسافة ٥ × ٥ متر تحت نظام الرى بالتنقيط فى تربة رملية وأخرى رملية طفلية. كانت الأشجار مطعومة على أصل مشمش بذرى محلى وأعطيت معدلات الرى الآتية:ــ

- معدل عالى = (١٨,٣٦ – ١٨,٨١ م٣ / الشجرة فى السنة)، معدل متوسط = ٦٦,٧% من المعدل العالى (١٢,٢٤ – ١٢,٥٤ م٣/شجرة فى السنه)، معدل منخفض = ٣٣,٣% من المعدل العالى (٦,١٢ – ٦,٢٧ م٣/شجره فى السنة).
- أظهرت النتائج أن النمو الخضرى ووزن الثمرة وحجمها وأبعادها زادت بزيادة معدل الرى، بينما كانت كفاءة استخدام ماء الرى وصلابة الثمار ونسبة المواد الصلبة الذائبة فى عصير الثمار تزيد نتيجة نقص معدل الرى.
- كما أوضحت النتائج أن النسبة المئوية لعقد الثمار وعدد الثمار/ الشجرة ومحصول الشجرة (الكجم) والقيمة النقدية للمحصول نقصت قليلا وبصورة غير معنوية مع معدل الرى المتوسط، بينما نقصت بصورة حادة ومعنوية مع معدل الرى المنخفض. كما كانت كل مواصفات النمو والمحصول والعائد المادى للمحصول وكفاءة استخدام ماء الرى أفضل فى حالة الأرض الرملية الطفلية عنها فى حالة الأرض الرملية.
- لذلك نوصى المزارعين بزراعة المشمش صنف كانينو فى أراضى رملية طفلية واستخدام معدل الرى المتوسط للحصول على معدل نمو عالى ومحصول أفضل وعائد نقدى أعلى وأيضا توفير ٣٣,٣% من معدل الرى تحت نفس ظروف التجربة.