INFLUENCE OF IRRIGATION METHOD AND FERTILIZATION TYPE ON AVOCADO YIELD AND QUALITY

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ABSTRACT

This research study investigated the impact of watering method and fertilization on avocado yield and quality in newly reclaimed areas. The research attempted to choose the optimum irrigation system and fertilization type to improve avocado yield and quality. Different irrigation systems (micro-sprinkler, drip irrigation and combined approach of micro-sprinkler and drip) with different fertilization types (mineral fertilization, fertilization using fallen avocado leaves+mineral fertilization and fertilization using plant compost +mineral fertilization) were evaluated for enhancing avocado yield and quality. The results showed that using fallen avocado leaves and plant compost, with mineral fertilization and the use of combined irrigation (micro-sprinkler + drip irrigation together) increased total yield, growth rates, water use efficiency compared with the use of mineral fertilization only with micro-sprinkler irrigation or drip irrigation only. Drip irrigation led to higher water use efficiency as a result of less water applied. The highest avocado yields of 21.08 and 14.63 Mg ha^{-1} for Hass and Ettinger cultivar respectively were obtained from the combination combined irrigation with fallen leaves + mineral in 2016-17 growing season. The same combination produced the highest yield in the second season but with fewer records.

INTRODUCTION

Avocado (*Persea americana Mill*.) is a perennial evergreen plant indigenous to the humid subtropical/tropical areas in central and Northern South America. It is distributed throughout many countries from the tropics to Mediterranean climates (**Wolstenholme and Whiley, 1999 and Lahav et al., 2013**). Its value as a fruit crop is demonstrated by the fact that world's avocado production has continued to increase from 2.7 million tons in 2000 to 3.6 million tons in 2009 (**Wolstenholme, 2013**).

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Avocado orchards are commonly irrigated in regions which are characterized by dry-summer climate, such as California, Australia and Chile (**Carr, 2013**). Since water availability is one of the key factors controlling fruit quality and productivity of avocado, understanding plant-water relations and following the right irrigation strategy are very necessary to optimize crop productivity and avoid yield reductions. The choice of appropriate irrigation strategy is the key factor for irrigation water-saving and increase productivity in arid areas. In case of water scarcity, effective irrigation techniques have become more important. In avocado orchards, drip and micro-sprinkler irrigation systems are commonly used for irrigation that are different in distribution water around avocado tree trunks and thus fundamentally affect root size and distribution. Greater root size and distribution could enhance fertilization use efficiency (**Purbopuspito and Van Rees, 2002**). Drip irrigation mainly apply water to the soil in wet bulbs which roots concentrate within them (**Cantuarias et al., 1995**) while micro-sprinkler disseminates water in a larger area mainly between tree lines and thus wider roots pattern (**Meyer et al., 1992**). Soil holding capacity is a function of irrigation method and management (**Watson and Kelsey, 2006**).

Avocados trees should also, be fertilized with the goal of maintaining optimum concentrations of nutrients in the leaf tissue. Consideration of the fruit load in the tree is also important. Applying the same level of nutrients when a tree has no fruit, only leads to a bigger tree that will need to be pruned more heavily. Bio-fertilizers are important for plant production as they play a vital role in increasing vegetative growth, yield and fruit quality of avocado (**Abd-Rabou, 2006**).

Development of irrigated agriculture mainly depends not only on the suitable irrigation system selection, but also on the optimum fertilization type. Choosing an appropriate irrigation method has an effect on economic return through maximizing crop productivity while minimizing the irrigation water used. To accomplish the main goal of this research it is necessary to assess the effects of different irrigation methods and fertilization type on avocado yield and quality. Therefore, the overall aim of this research was to identify the optimum irrigation system and fertilization type to increase avocado yield and quality.

MATERIALS AND METHODS

The experiments of this research study were carried out over two successive growing seasons of 2016-17 and 2017-18 on eight years old Hass and Ettinger avocado (*Persea Americana Mill.*) cultivars. The experiments were conducted at Elfatteh Experimental Farm, South Altahrir, Bohaira Governorate, Egypt (30º 34' 37" N, 30º 42' 57"E). Avocado trees were planted at a rate of 310 tree ha^{-1}. Three techniques of irrigation systems were utilized for avocado irrigation. A split plot design with three replicates was used. Irrigation treatments were assigned as main plots including the three used methods (drip, micro-sprinkler, and combined approach of drip and micro-sprinkler). Fertilization treatments were assigned for sub plots which included: mineral fertilization, fallen leaves + mineral fertilization, and plant compost + mineral). Table 1 details the amounts of mineral fertilization added to avocado trees (Hass and Ettinger) over 2016-17 and 2017-18.

Table 1: Mineral fertilization amounts added to both avocado cultivars (Hass and Ettinger) in 2016-17 and 2017-18 growing seasons

Total amount, kg ha^{-1}	Nutrient									
	N^+	P^+	K^+	Ca^{++}	Mg^{++}	Fe	Mn	Zn	B	Cu
	132	39	176	72	36	1.2	1.5	3	3.9	0.7

The experimental soil was classified as sandy soil with 1.26 g cm^{-3} soil bulk density. The chemical analysis of the experimental soil including anions and cations is detailed in Table 2. The organic matter of the experimental soil was very low of 0.38%. The volumetric water content values were measured using pressure membrane as 22, 19, and11% at saturation, field capacity, and wilting points, respectively.

Table 2: Chemical analysis of the experimental soil

EC, dS/m	pH	Soluble cations, meq L^{-1}				Soluble anions, meq L^{-1}				SAR
		Ca^{++}	Mg^{++}	Na^+	K^+	Co_3^{--}	$H\ Co_3^-$	Cl^-	So_4^{--}	
2.8	7.9	10.8	7.2	9	1	0.8	6.8	18.8	1.6	3

A total area of approximately 2 ha was used for the experiment which was divided into three equal plots. The first plot was irrigated by micro sprinkler irrigation, the second irrigated by drip irrigation and the third was irrigated by a combined approach of drip and micro sprinkler irrigation. Fig. 1 illustrates the layout and distribution of micro-sprinklers and drippers for the three different cases. Each plot was divided into three subplots representing fertilization treatments (mineral fertilization, fallen leaves + mineral fertilization, and plant compost + mineral fertilization). For the plots irrigated by micro sprinklers, micro-sprinklers lateral lines was installed on the trees line and two micro sprinkles of 35 L h^{-1} with 5 m wetted diameter were allocated for each tree which installed at 2.5 m from the tree trunk. The micro sprinklers produced a full circle to maximize the wetted area around the tree. For orchards irrigated by drip irrigation, each tree was served by three lateral lines with 0.5m spacing (24 drippers of 4 L h^{-1} discharge rate for each tree). Two lateral lines were installed 0.5 m from the tree line on both sides and one just on the tree line as depicted in Fig. 1. Canal water having 0.37 dS m^{-1} and 7.6 electrical conductivity and pH respectively was used for watering different orchards.

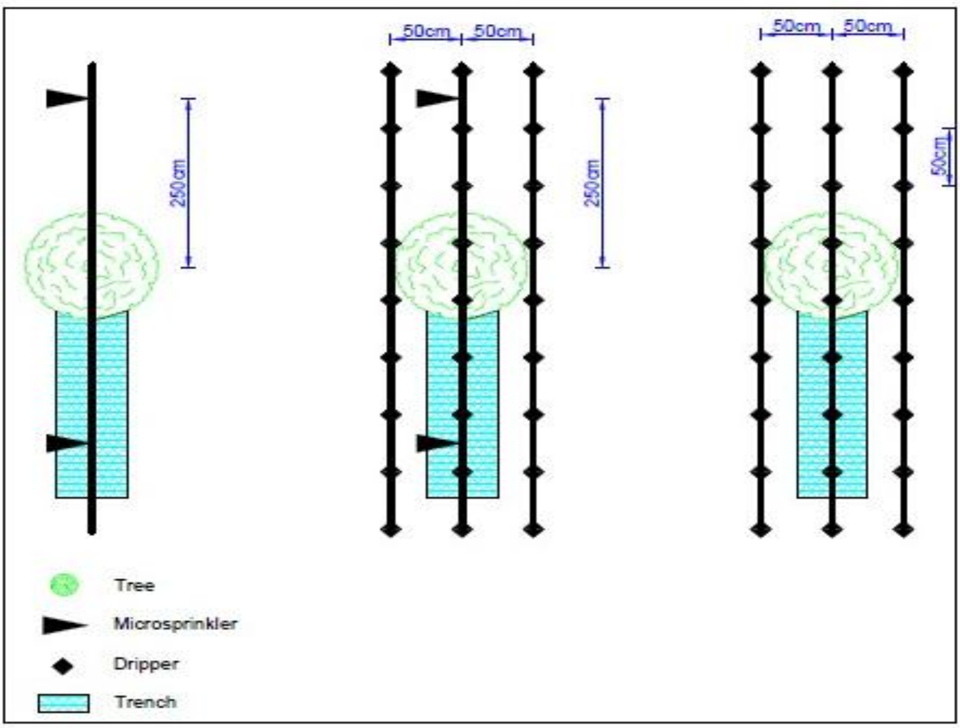

Fig. 1: Layout of drip, micro sprinkler, and combination of drip and micro sprinkler irrigation systems.

Before the addition of compost to the trees, sand and compost were mixed properly. A terrace was constructed along the tree line to apply compost. Compost and sand were applied at rates of 50 tonnes ha^{-1} and 310 m^3ha^{-1} respectively. For the addition of the fallen leaves, a terrace was constructed along the tree line and fallen leaves were applied at a rate of 3.5 Mg ha^{-1} of falling leaves, in addition to 130 m^3sand ha^{-1}. Tables 3 and 4 detail the chemical properties of avocado fallen leaves and plant compost used in this study. The procedures of **Page et al., (1992)** were followed for the chemical analysis of avocado fallen leaves and plant compost.

Table 3: Some chemical analyses of avocado fallen leaves used in this research

Macronutrients (%)					Micronutrients (mq kg^{-1})				
N^+	P^+	K^+	Ca^{++}	Mg^{++}	F	Zn	Mn	B	Cu
2.2	0.28	0.84	1.35	0.37	170	45	48	32	9

Table 4: Some chemical analyses of plant compost utilized in this research

EC,d S m^{-1}	p H	N, %	O.M, %	O.C, %	C/N	P, %	K, %	M.C, %	Ash, %
2.1	6. 8	0.4 8	20.7	12	1:2 5	0.2	0.72	8	42

O.M: Organic matter O.C: Organic carbon M.C: moisture content

Irrigation water requirements

Crop water requirements were calculated according to **Abdrabbo et al., 2013** employing the following equation

$$IR = \frac{ETo * kc * LF * R * A}{IE * 1000}$$

Where:

IR = Irrigation requirement (m^3ha^{-1}),

Kc = Crop coefficient, which was 0.5, 0.5, 0.8, 0.8, 0.65, 0.65, 0.65, 0.65, 0.65, 0.65, 0.5, 0.5 starting from January through to December

ETo = Reference crop evapotranspiration (mm day^{-1}).

LF = Leaching fraction (assumed 20% of irrigation water).

IE = Irrigation efficiency (assumed 80%),
R = Reduction factor (80% coverage percent) A= area , ha

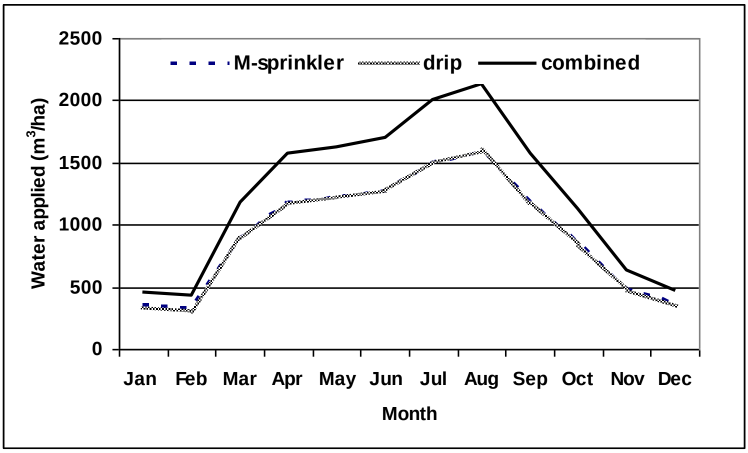

Fig. 2 Average monthly water applied to combination of drip and micro-sprinkler, micro-sprinkler, and drip irrigation systems during investigated seasons

Water Use Efficiency (WUE)

Water use efficiency (kg mm^{-1}) was calculated as the ratio between total fresh avocado yield and total water applied (mm ha^{-1}) according to **Lovelli et al., 2007** as follows:

$$WUE = Y/ W,$$

Where: WUE is water use efficiency in Mg mm^{-1}, Y is the total avocado yield in Mg ha^{-1} and W is the total water applied in mm ha^{-1}

Some physical and chemical measurements of avocado

All fruits were harvested from the experimental plots in November and February for Ettinger and Hass respectively for both seasons. Samples of 20 randomly mature fruits from each experimental unit were collected for measuring some various fruit physical properties including fruit weight, volume, length, width, and diameter.

Quality considerations

Following the harvesting, it is very important for avocado fruits of different cultivars to be the preference of customers, so they should have the minimum requirements to be marketed. Fruits should be free from various things including visible foreign material, pests and damage caused by heat stress or other stresses. Thereafter, avocado fruits are classified into categories. A locally-made sorting machine was employed to classify avocado fruits samples into three different classes (one for exportation, the second and third for local consumption) according to fruit size.

Statistical analysis:

Data were statistically analyzed using SAS software package (SAS Institute, 2003). The means were compared with least significant difference (LSD) at 5% significance level. The coefficient of correlation was also calculated using the same software package.

RESULTS AND DISCUSSION

Effects of irrigation method on avocado properties

The statistical analysis of the effect of irrigation method showed remarkable effects on avocado properties including average weight of fruits, total weight of fruits per tree, export and local ratios. It is obvious that for both investigated seasons the combined approach of micro-sprinkler + drip irrigation enhanced various avocado properties as detailed in Table 5. The combined approach produced the highest values of average weight of fruits, total weight of fruits per tree, export and local ratios (177.9, 63.9, 70.88, and 24.1 for Hass; 332.3, 36.8, 46.33 and 44.91 for Ettinger respectively). Broadly, the data detailed in table 5 demonstrated that Ettinger cultivar produced higher values in all investigated properties compared with Hass. Additionally, drip irrigation produced comparable records when compared with micro-sprinkler irrigation. The optimum combination of irrigation method and cultivar for higher average weight of fruits is the combined with Ettinger (332.3 g); higher total weight of fruits is the combined with Hass (63.9 kg); for higher export ratio is the combined with Hass (70.88%). The results further showed that irrigation systems did not significantly affected export and local ratios for Ettinger in both 2016-17 and 2017-18 seasons while for Hass significant differences were noticed. The advantage of the combined approach of micro-sprinkler + drip irrigation may have been a result of better and greater root size and distribution since drip irrigation enhance roots to grow nearby drippers and micro-sprinkler distribute water to distances away from those accessible by drippers.

Effects of fertilization type on avocado properties

The data detailed in Table 6 clearly demonstrated that Ettinger cultivar produced higher values of average weight of fruits per tree in both seasons compared with Hass cultivar. The highest values of 314.56 and 316.55 g were recorded with fallen leaves + mineral and plant compost + mineral in 2016-17 and 2017-18, respectively. The average weight of fruits per tree for Hass was around 40% less than Ettinger for all combinations in both seasons.

Regarding the weight of fruits per tree, data in 2016-17 had the opposite trend of average weight of fruits per tree since the weight of fruits per tree values were greater for Hass cultivar than Ettinger with the highest value of 59.15 recorded with the fallen leaves+mineral type. Hass produced higher weights of fruits per tree by at least 40% more than Ettinger in 2016-17.

The export ratio values of Hass in 2016-17 are strongly affected by the fertilization type and fallen leaves + mineral fertilization produced the highest export ratio among different treatments for Hass in 2016-17 and for Ettinger in 2017-18. It is obvious that different types of fertilization did not significantly affect Ettinger most properties in 2016-17 season except the average weight of fruits per tree as fallen leaves + mineral protocol produced the highest value (314.56 g). For export and local ratios of Ettinger, there were no significant differences. This may have been a result of similar fruits size as the classification of fruits into categories depends mainly on the size of random fruits sample.

Effects of combination between irrigation and fertilization on avocado properties

Regarding the average weight of fruits per tree, the combination combined irrigation and fallen leaves +mineral recorded the greatest value of 355.3 g for Ettinger in both seasons. It is also noticed that the average weight of fruits per tree values in 2016-17 were higher than those recorded in 2017-18 for most cases.

Table 5: Separate effects of irrigation system, cultivar on avocado properties

Variety	Irrigation	2016-17				2017-18			
		W_1	W_2	EXR	LR	W_1	W_2	EXR	LR
Hass	Micro-sprinkler	164.6 d	41.7 b	68.00 b	22.50 c	175.6 d	23.2 c	53.66 a	29.93 b
	Drip	167.3 e	57.9 a	69.11 b	23.82 b	171.6 d	23.9 c	53.22 ab	29.82 b
	Combined	177.9 e	63.9 a	70.88 a	24.10 b	173.6	25.9	54.11 a	31.32 b
Ettinger	Micro-sprinkler	292.7 b	29.6 d	44.55 c	43.92 a	304.3	23.7	46.77 b	44.86 a
	Drip	280.6 c	31.8 d	46.22 c	44.82 a	280.6 c	28.9 b	47.61 b	45.06 a
	Combined	332.3 a	36.8 b	46.33 c	44.91 a	352.9 a	32.8	48.00 ab	43.67 a
LSD		5.39	6.08	1.76	1.33	17.28	2.96	6.80	3.24

W_1, average weight of fruit (g); W_2, weight of fruits/tree (kg); EXR, Export Ratio (%) and LR, Local ratio1 (%)

Table 6: Separate effects of fertilization type, cultivar on avocado properties

Variety	Fertilization	2016-17				2017-18			
		W_1	W_2	EXR	LR	W_1	W_2	EXR	LR
Hass	Plant compost +	170.11	55.49	69.2 a	23.7 b	172.66	23.89	44.5 c	34.0 b
	Fallen leaves +	168.55	59.15	70.6 a	23.9 b	175.55	27.02	45.7 c	34.3 b
	Mineral	171.11	48.80	68.1 b	22.7 b	172.44	22.17 e	44.6 c	22.7 c
Ettinger	Plant compost +	295.22	30.69	47.4 c	44.9 a	316.55	29.63	47.4 a	44.1 a
	Fallen leaves +	314.56	36.18	46.3 c	44.1 a	314.55	30.05 a	48.05 a	44.4 a
	Mineral	295.78	31.29	46.3 c	44.6 a	306.66	25.70	47.8 a	45.01 a
LSD		5.39	6.08	1.74	1.33	17.28	2.96	1.51	1.52

Broadly, the total weight of fruits per tree was greater in 2016-17 than 2017-18 in all combinations with the highest value of 73.8 kg obtained from the combination fallen leaves + mineral with combined irrigation for Hass cultivar. The total weight of fruits increased by at least 30% in 2016-17 more than 2017-18 in most combinations. For the export ratio, it is obvious that its values were greater in 2016-17 than 2017-18 in most cases with the highest value of 71.3% produced from the combination fallen leaves +mineral and combined irrigation. The results illustrated in Fig. 5 further demonstrated that the combined approach of irrigation produced the highest export ratio regardless the fertilization type in 2016-17 while in 2017-18 fallen leaves + mineral with the combined approach produced the highest values. For the local ratio, the combined irrigation showed the superiority among various combinations in both investigated seasons with the highest values of 46.6% and 36% in 2017-18 for Ettinger and Hass respectively. No remarkable differences of local ratio between 2016-17 and 2017-18. In general, data showed that the combination of combined approach of irrigation with fallen leaves + mineral is the optimum since it produced the highest values of different avocado properties as depicted in Figures 3 and 4. This can be attributed to the uniform distribution of roots throughout the allocated area for each tree. Drip irrigation possibly produced larger root size around the tree trunk while micro sprinkler enhance the root distribution and size at further points that are away from the wetted bulb of drip lines. Again, greater root size and efficient distribution encouraged the uptake of various nutrients and thus more activities that enhance yield, growth rates, photosynthesis and other fundamental processes.

Effects of irrigation method on avocado yield

Broadly, plots irrigated by the combined irrigation method (micro sprinkler + drip) produced higher yields in comparison to separate systems. The highest avocado yield for Hass and Ettinger cultivars were 21.08 and 8.4 Mg ha^{-1}; 14.63 and 12.76 Mg ha^{-1} in 2016-17 and 2017-18 respectively. The results further showed that drip irrigation is more advantageous than micro sprinkler system for enhancing yield as in most treatments drip irrigation produced higher yields.

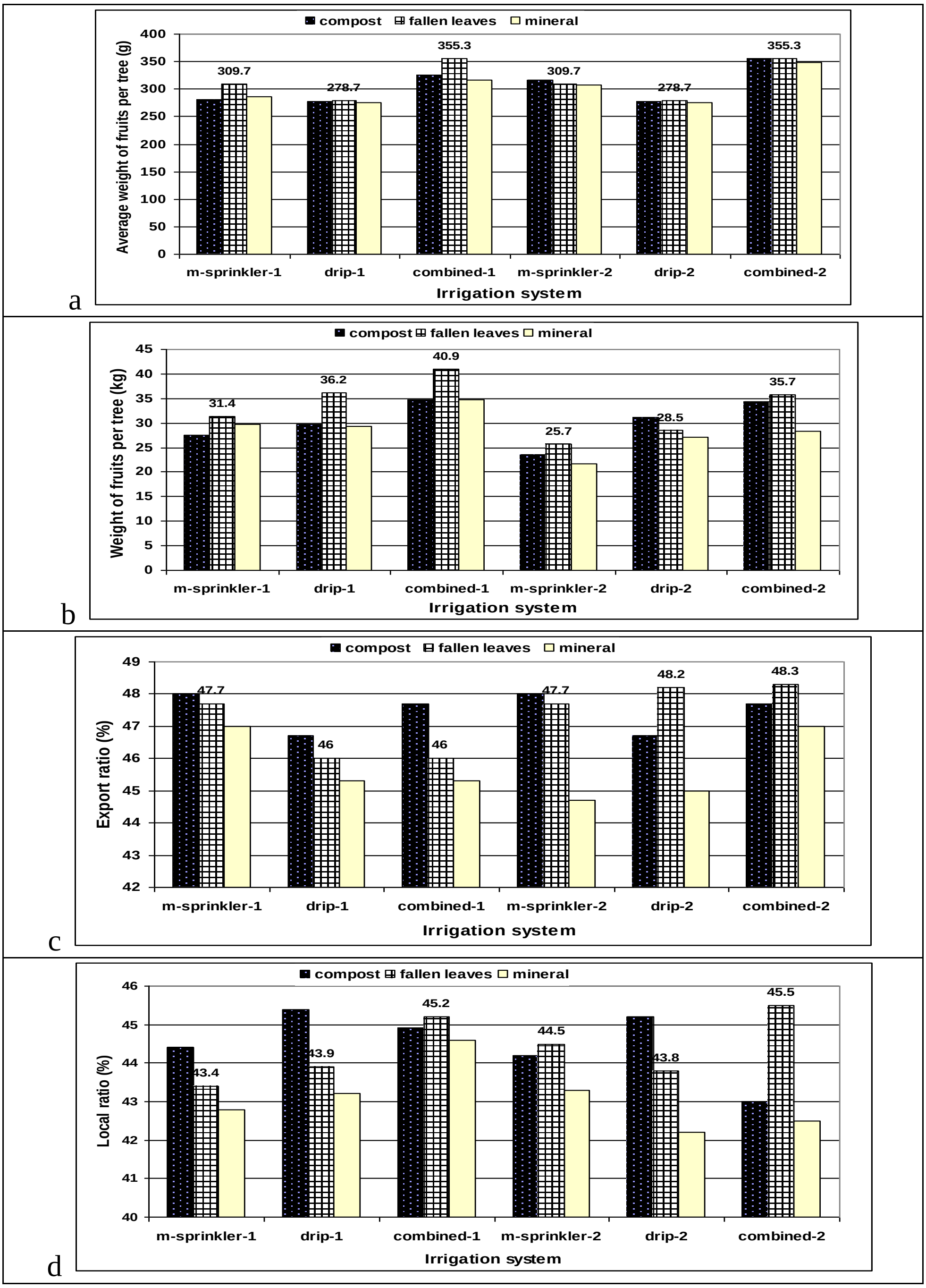

Fig. 3: Effects of irrigation system and fertilization type on a) average weight of fruits per tree, b) weight of fruits per tree (kg), c) export ratio (%) and d) local ratio (%) of Ettinger cultivar in 2016-17 and 2017-18 seasons.

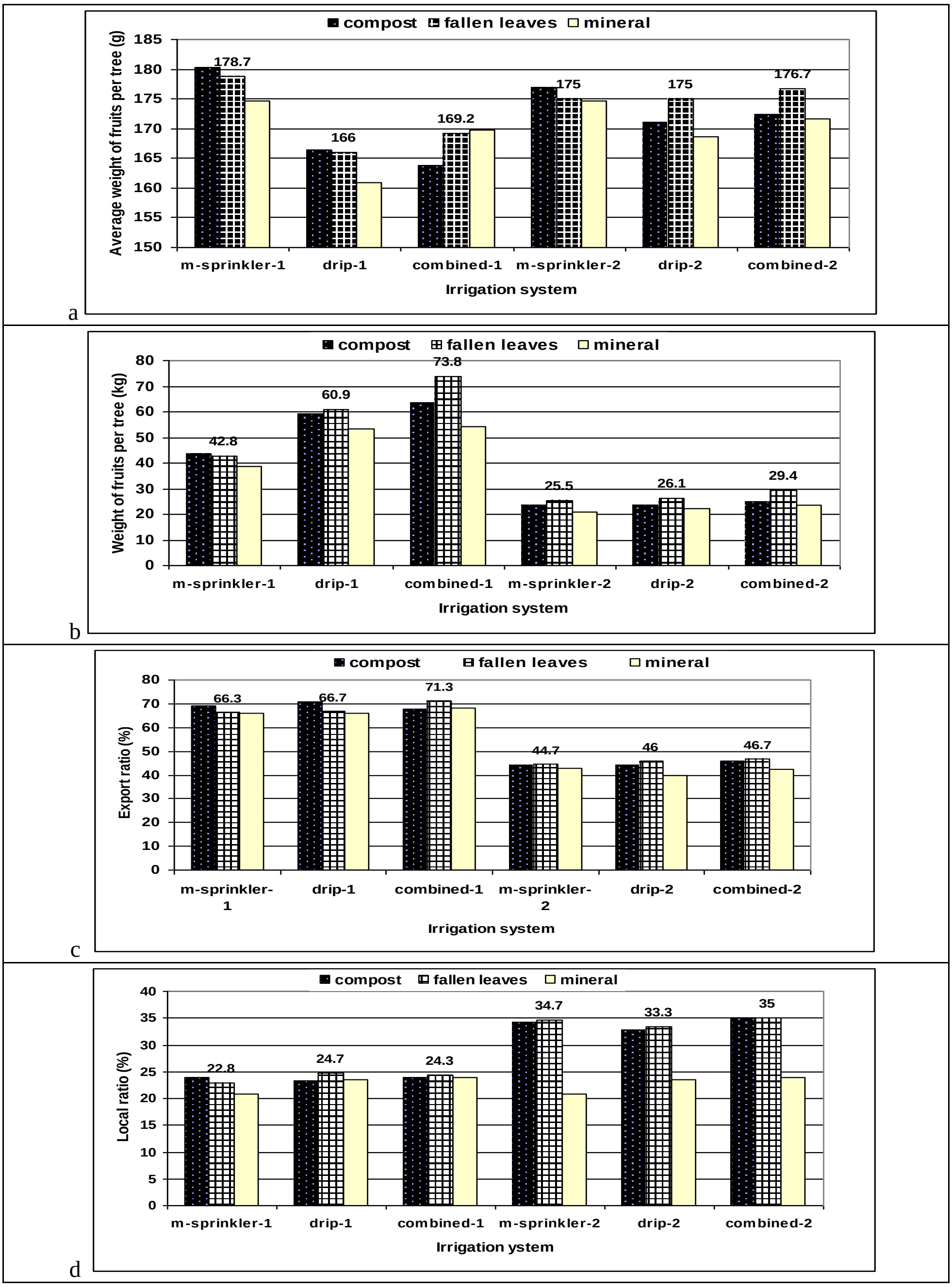

Fig. 4: Effects of irrigation system and fertilization type on: a) average weight of fruits per tree, b) weight of fruits per tree (kg), c) export ratio (%) and d) local ratio (%) of Hass cultivar in 2016-17 and 2017-18 seasons.

The application of plant compost and fallen leaves plus mineral fertilization enhanced avocado fruit yield for Hass and Ettinger cultivars in both investigated seasons. The plots treated by the combined approach of irrigation (micro-sprinkler + drip) and fallen leaves + mineral fertilization produced the highest yield of 21.08 Mg ha^{-1} in 2016-17 which may have been a result of larger root size that enhance avocado growth traits for both cultivars. The results further demonstrated that among various treatments, avocado yield was less with the combination of micro-sprinkler and mineral fertilization. From the above mentioned results it can be noted that the combination of micro-sprinkler and drip irrigation motivated avocado yield though larger root distribution that maximize the root size and therefore great root activities including for sure uptake of macro and micro nutrients.

Table 7: Effect of irrigation method and fertilization type on yield (Mg ha^{-1}) of Ettinger and Hass avocado cultivars.

Irrigation method	fertilization	Hass 2016-	Hass 2017-	Ettinger 2016-	Ettinger 2017-
Micro-sprinkler	Plant compost +	12.46	6.68	9.85	8.37
	Fallen leaves +	12.21	7.29	11.20	9.23
	Mineral	11.04	5.91	10.64	7.70
Drip	Plant compost +	16.90	6.70	10.62	11.09
	Fallen leaves +	17.39	7.46	12.93	10.19
	Mineral	15.29	6.40	10.49	9.72
Combined	Plant compost +	18.19	7.09	12.40	12.26
	Fallen leaves +	21.08	8.40	14.63	12.76
	Mineral	15.48	6.69	12.39	10.12

Water use efficiency

Water use efficiency (WUE) calculated as the ratio between avocado yield and water applied was remarkably affected by irrigation method and fertilization type. The results obviously revealed that drip irrigation produced higher WUE compared with micro-sprinkler and the combined method with all investigated fertilization types. This finding can be attributed to less water applied to the combinations included drip irrigation. The combination drip irrigation + (fallen leaves + mineral) produced WUE of 15.69 kg mm^{-1} which is the highest among the whole set of the treatments. The results further showed that WUE values obtained for both Hass and Ettinger were less in 2017-18 growing season as a result of lower yields in the same year which may have been a result of what is called alternate bearing. Regardless the irrigation method used, fallen leaves + mineral led to higher yields and thus greater WUE with just one exception under micro-sprinkler irrigation.

Table 8 Effect of irrigation method and fertilization type on WUE (kg mm^{-1}) of both Ettinger and Hass avocado cultivars

Irrigation technique	Fertilization	Hass		Ettinger	
		2016-17	2017-18	2016-17	2017-18
Micro-sprinkler	Plant compost +	11.09	5.95	8.77	7.45
	Fallen leaves + mineral	10.87	6.49	9.97	8.22
	Mineral	9.83	5.26	9.47	6.86
Drip	Plant compost +	15.25	6.05	9.58	10.0
	Fallen leaves + mineral	15.69	6.73	11.67	9.19
	Mineral	13.79	5.78	9.47	8.77
Combined	Plant compost +	12.18	4.75	8.31	8.21
	Fallen leaves + mineral	14.12	5.63	9.80	8.55
	Mineral	10.37	4.48	8.30	6.78

CONCLUSION

This research aimed to choose the optimum irrigation method and fertilization type for the production of two avocado cultivars (Hass and Ettinger). The research hypothesized that the combination of micro-sprinkler and drip irrigation system besides the optimum fertilization protocol can maximize avocado fruit yield and quality. The results clearly demonstrated that the combined approach of micro-sprinkler and drip irrigation encouraged avocado yield and quality including fruit yield, number of fruits per tree, export ratio and water use efficiency. The novel idea presented here is the combination between micro-sprinkler and drip irrigation to have greater root size and distribution that enhance various nutrients uptake and other root activities. Moreover, the application of fallen leaves plus normal mineral fertilization type remarkably increased avocado yield and quality and thus higher net income.

REFERENCES

Abdrabbo M. A. A.; S. Ouda and T. Noreldin (2013). Modeling the irrigation schedule on wheat under climate change conditions. Nature and Science,11 :10-18.

Abd-Rabou, F.A. (2006). Effect of microbien, phosphorine and effective microorganisms (EM) as bio-stimulants on growth of avocado and mango seedlings. Egypt. J. Appl. Sci., 21 (6B): 673-693.

Cantuarias, T.; Cohen, Y.; and Tomer, E. (1995). Improving avocado tree water status under severe climatic conditions by increasing wetted soil volume. In: Proceedings of The World Avocado Congress III. pp.196-204.

Carr, M.K.V. (2013). The water relations and irrigation requirements of avocado (Perseaamericana Mill.): a review. Exp. Agric. 49, 256–278.

Lahav, E., A.W.Whiley and D.W. Turner (2013). Irrigation and mineral nutrition: Chapter11. In Whiley AW, Schaffer B, Wolstenholme BN eds. The Avocado:Botany, Production and Uses: 2nd edition. Wallingford, UK: CABIPublishing. pp. 301-341.

Lovelli, S., M. Perniola, A. Ferrara, and T. D. Tommaso (2007). Yield response factor to water (Ky) and water use efficiency of Carthamustinctorius L. and Solanum melongena L. Agric. Water Manage., 92: 73–80.

Meyer, J.L.; Yates, M.V.; Stottlemyer, D.E.; Takele, E.; Arpaia, M.L.; Bender, G.S.; and Witney, G.W. (1992). Irrigation and fertilization management of avocados. In: Proceedings of the Second World Avocado Congress. pp. 281-288.

Page, A.L.; R.H. Miller, and D.R. Keeney (1992). Methods of Soil Analysis. Part 2. Chemical and Microbiological Properties. American Society of Agronomy. In Soil Science Society of America, Vol. 1159.

Purbopuspito, J. and Van Rees, K.C.J. (2002). Root distribution at various distances from clove trees growing in Indonesia. Plant Soil, 239: 313-320.

SAS Institute (2003). SAS User’s Guide: Version 9.1. SAS Institute Inc., Cary, NC.

Watson, G.W. and Kelsey, P. (2006). The impact of soil compaction on soil aeration and fine root density of *Quercus Patustris*. Urban For. Urban Green 4, 69-74.

Wolstenholme, B.N. (2013). Developments in the world avocado industry, and their relevance to the South African and African industries. Acta Horticulturae1007: 865-871.

Wolstenholme, B.N. and A.W. Whiley (1999). Ecophysiology of the avocado (Perseaamericana Mill.) tree as a basis for pre-harvest management. Revista Chapingo Serie Horticultura 5:77-88.

الملخص العربى

تأثير نظام الرى ونوع التسميد على انتاجية وجودة الأفوكادو

وليد محمد بسيونى درويش* و عادل هلال المتولى**

يعتبر الأفوكادو من الثمار عالية العائد الاقتصادى والمطلوبة للتصدير لما لها من فوائد غذائية عديدة وبما انها من الفواكه التى تحتاج إلى مناطق دافئة لانتاجها فإن زراعتها فى مصر يمكن ان يكون له مردود اقتصادى عالى. واختيار نظام الرى ونوع التسميد الملائم من اهم الاشياء التى يجب أخذها فى الاعتبار عند زراعة الافوكادو لذلك تهدف الدراسة الحالية إلى اختيار الانسب من هذين العامليين لتعظيم انتاج وجودة الأفوكادو تحت الظروف المصرية.

أجريت هذه الدراسة فى منطقة جنوب التحرير بمحافظة البحيرة لدراسة تأثير كل من طرق رى مختلفة وانواع تسميد مختلفة على انتاج وجودة صنفين من الافوكادو وهما الهاس والاتنجر وكانت عوامل الدرسة كالتالى:

نظم الرى : الرى بالتنقيط –الرى بالرش قليل التصرف – استخدام كلا النظامين (النظام التكاملى)

نوع التسميد : تسميد معدنى – تسميد معدنى + اوراق شجر الأفوكادو المتساقطة - تسميد معدنى + كمبوست نباتى

وكانت أهم النتائج مايلى:

- أعلى انتاجية للأفوكادو سجلت مع المعاملة ذات الرى التكاملى (التنقيط + الرش) مع التسميد بالاوراق المتساقطة + التسميد المعدنى بقيمة مقدارها ٢١,٠٨ ميجاجرام / هكتار.
- نظام الرى التكاملى (التنقيط + الرش) ادى إلى زيادة ملحوظة فى كل الصفات المدروسة ومنها متوسط وزن الثمرة للشجرة ، الوزن الكلى للثمار للشجرة ، النسبة التصديرية وكذلك النسبة المحلية.
- أظهرت النتائج ايضا أن ظاهرة تبادل الحمل الثمرى فى صنف الهاس اكبر منها فى صنف الاتنجر حيث سجلت بعض المعاملات ما يقرب من ٢٥٠% للموسم الاخر كما فى الرى التكاملى مع الاوراق المتساقطة.
- أوضحت الدراسة ايضا ان كفاءة استخدام المياه لنظام الرى بالتنقيط كانت اعلى من الرى التكاملى والرى بالرش قليل التصرف كنتيجة لقلة كمية المياه المضافة.

يتضح من هذه الدراسة ان اختيار طريقة الرى الملائمة ونوع التسميد يمكن أن يساعد بشكل كبير فى تعظيم انتاجية الأفوكادو وايضا سوف يزيد كفاءة استخدام المياه والمواصفات التصديرية الخاصة بجودة ثمار الأفوكادو ونتيجة لذلك زيادة العائد الكلى. كذلك يتضح من الدراسة ان استخدام مخلفات الاشجار من الاوراق المتساقطة كتسميد طريقة جيدة وذات عائد عند النظر للتوفير فى كميات الاسمدة المستخدمة.

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