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POSSIBILITY OF APPLYING MODERN IRRIGATION SYSTEMS IN THE OLD CITRUS FARMS AND ECONOMIC RETURN

Abdel-Aziz, A. A.
Agric. Eng. Dept., Fac. of Agric., Ain Shams Univ., Cairo, Egypt.

ABSTRACT

The irrigation and production costs of irrigated citrus farms by four different irrigation systems (drip, low head bubbler, gated pipes and traditional surface irrigation) were evaluated. The results indicated that the capital and total annual costs of traditional surface irrigation (280 and 142.1LE/Fed respectively)are considerably cheaper than that of the other irrigation systems, while drip irrigation has the highest capital and total annual costs (2230 and 533.4 LE/Fed) for citrus. Irrigation water requirements for citrus irrigating were reduced by 44.4%, 37.5% and 23.1% when using drip, bubbler and gated pipes irrigation systems respectively compared to the traditional surface irrigation. On the other hand, the citrus yield reduced by 13.8%, 8.2% and 3.7% under drip, bubbler and gated pipes irrigation systems respectively compared to traditional surface irrigation in the first season, while, the yield increased by 37%, 20.5% and 6.8% under drip, bubbler and gated pipes irrigation systems respectively in the third season. This increase in yield under drip and low head bubbler irrigation systems helped in covering the initial cost of these systems. The highest net profit (2746.6 LE/Fed) for citrus was obtained by using drip system, followed by low head bubbler (2375.6 LE/Fed), while the lowest net profit was (1902.9LE/fed) by using traditional surface irrigation.

INTRODUCTION

Citrus is one of the major fruit crops in Egypt and it has a great potentiality for export to European markets. The total citrus area in Egypt reached 311061 feddans, yielded about 2.25 million tons concentrated in Sharkia, Giza, Kalubia, Menofia, Ismallia, Fayuom and Gharbia Governorates (Ministry of Agriculture, 1998).

Holder and Marshall (1987) reported that the total cost by using the drip irrigation system was 499$/acre compared with fixed sprinkler irrigation system 681.12$/acre for vegetable crops (140 days). El-Gindy(1988)said that the furrows and sprinkler irrigation methods increase the cost of production unit by 12% and 74.6% over the drip irrigation method for tomatoes crop, but for cucumber, furrow and sprinkler methods increase the cost by 46.8% and 239.6% over the drip irrigation method. Badr (1992) found that the cost of one cubic meter of applied water for potato crop was 0.2 LE under both drip and sprinkler irrigation systems. Moll(1996)found that the flood irrigation system is considerably cheaper to install than the drip irrigation system, but the drip system's low annual operating costs outweigh its initial expense and make it the most financially and environmentally attractive system. Wichelns *et al.*(1996)said that water saving methods include sprinkler and gated pipe. These methods involve higher labor and energy costs, which may exceed the value of water, saved when switching from surface irrigation methods such as

furrow irrigation with siphon tubes.Public policies that reduce the capital cost of investing in sprinkler systems and research to develop better surface irrigation methods, will assist farmers in continuing their efforts to improve irrigation water management while, maintaining economic viability. Wichelns *et al.*(1997) examined the fixed and variable costs of using sprinkler and siphon tubes and found that the potential improve in crop yield that may be achieved when using sprinklers to determine the economic rotational for these decisions. Results suggest that agencies wishing to encourage improvements in water management practices should implement policies that reduce the initial cost of sprinkler systems, while permitting farmers to choose the best combination of irrigation methods.

This paper aims to study the possibility of applying modern irrigation systems in the old citrus farms and economic return.

MATERIALS AND METHODS

The economic analysis of irrigation system may be very complex. A comparison of the cost of each irrigation system regarding with its return for the farmers is considered in order to install the appropriate irrigation method under arid-ecosystem conditions.

1- Experimental site:

Field experiments were carried out for three seasons (1999, 2000 and 2001) at Imam Farm, Giza Governorate to evaluate the citrus production feasibility under different irrigation systems (drip, low head bubbler, gated pipes and traditional irrigation). The experimental area of 56x70m was cultivated with citrus trees (Mandarin variety, 7years age)at distance of 3.5x3.5m. This area divided into four plots (35x28m) for each. Some physical and chemical properties of the soil are presented in Tables (1 and 2).

Table (1): Mechanical analysis and some physical properties of the soil.

Sample depth, cm	Particle Size Distribution, %				F.C. %	W.P. %	D.B.D. g/cm^3	Hydraulic conduct., cm/s
	Sand	Silt	Clay	Soil texture				
0-30	87	8	5	Sandy	19.7	8.5	1.25	$6x10^{-3}$
30-60	95	3	2	Sandy	16.5	7.1	1.22	$6x10^{-3}$
60-100	96	2	2	Sandy	13.8	6.2	1.30	$6x10^{-3}$

Table (2): Chemical analysis of the experimental soil.

Sample Depth, cm	pH	EC dS/m	Soluble Cations, meq/L				Soluble Anions, meq/L			
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO^{=}_3$	HCO^{-}_3	$SO^{=}4$	CL^{-}
0-30	7.4	1.2	3.3	1.2	3.9	0.4	-	1.0	7.2	0.6
30-60	7.4	0.9	3.1	1.4	2.1	0.6	-	0.7	6.1	0.4
60-100	7.6	0.5	2.6	1.1	1.7	0.1	-	1.6	3.3	0.6

2- Irrigation systems:

Irrigation networks include the following:

1- Control head which consists of centrifugal pump 4/3″ drived by electrical motor 5.5 HP, screen filter (120mesh), flow meter, pressure gauges and venturi for fertilization.

2- 110 mm diameter PVC, main line.
3- 90mm diameter PVC, sub main line
4- 75/63mm diameter PVC, manifold line for low head bubbler irrigation and 63/50 mm in diameter for drip irrigation.
5- Distributors:
a- Emitters with discharge of 35 lph for each at 1.0 bar built on PE tube of 25 mm in diameter with length of 35m. Two emitters for each tree.
b- Low head bubbler (PE tube of 16 mm in diameter with discharge of 160 lph for each at 1.5m head). These tubes connected with PVC pipes of 32 mm in diameter with length of 35m. The head adjusted by stand steel with height of 2m.
c- PE gates fixed on aluminum pipes of 160mm diameter. Gate discharge is $4.0 m^3/h$.

The layout of different irrigation systems is shown in Fig. (1).

3- Water requirements:

Irrigation water requirements for citrus trees were estimated according to El-Kantar Weather Station data available (ET_0) at the Central Laboratory for Agricultural Climate (CLAC), Ministry of Agriculture and Land Reclamation. Quantity of the water applied was calculated from the following equation, (FAO, 1991):

$$IR = ((Et_0 \times k_c \times K_r \times A / Ei) + L.R)\, I \quad \ldots\ldots\ldots\ldots (1)$$

Where:

IR = Irrigation water requirements, l/tree/interval,
Et_0 = Reference evapotranspiration, mm/day, and equals $E_p \times K_p$ (Doorenbos and Pruit, 1977),
E_p= Pan evaporation, mm/day,
K_p= Pan coefficient (equals 0.7)
K_c= Crop coefficient, dimensionless (0.7 for citrus, Doorenbos and Pruit, 1977),
K_r= Reduction factor due to ground cover and equals P_s/ 85 (Keller and Karmeli, 1975),
P_s= The area shaded by the plant cover as a percentage of the total area, % (70% for citrus, Doorenbos and Pruit, 1977),
A = Area for tree, m^2,
Ei = Irrigation system efficiency, %,
L.R= Leaching requirements, 10% of IR, and
I = Time interval, days.

Irrigation system efficiency (Ei) was calculated from the following formula according to Wu and Gtilin, 1975.

$$Ei = Ea \times Du \quad \ldots\ldots\ldots\ldots (2)$$

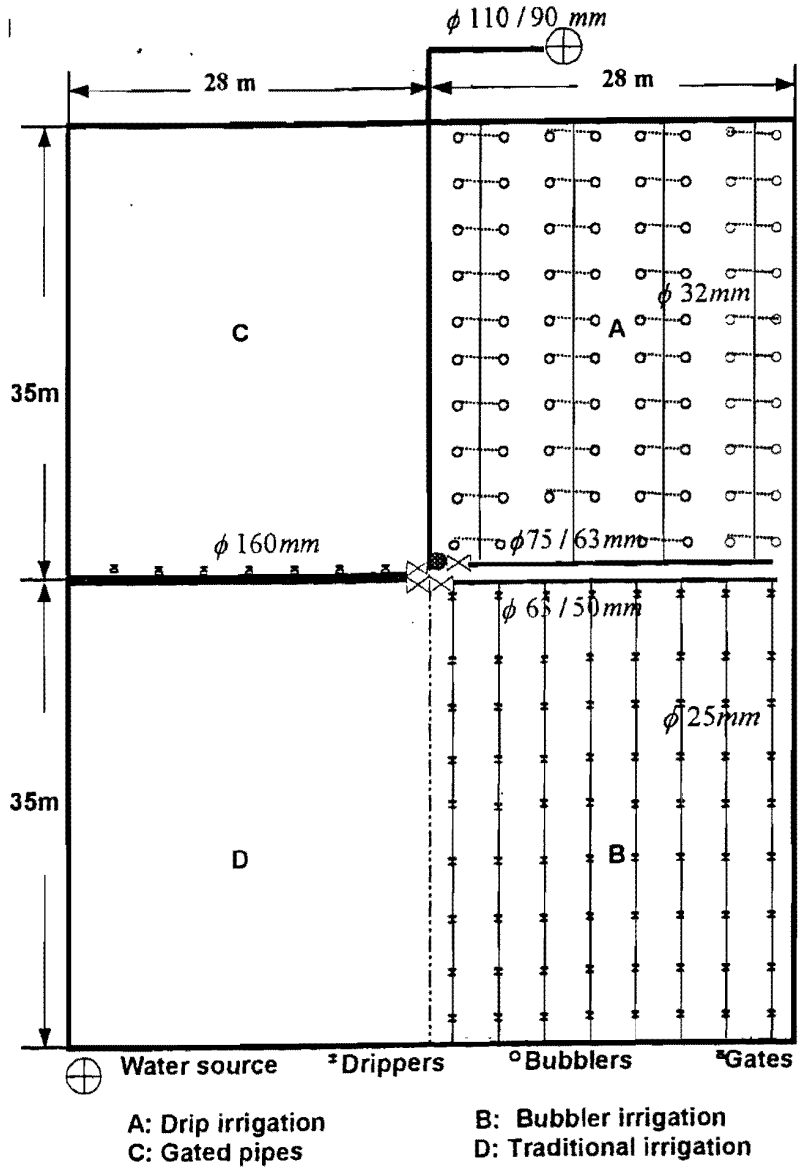

Fig.(1): Layout of different irrigation systems

Where:

Ea = Application efficiency, %

Eu = Distribution efficiency, %

$$Ea = \frac{W_{DZ}}{D_T} x100 \quad \text{..... (3)}$$

Where:

W_{DZ} = Depth of water stored in the root zone, cm

D_T = Gross depth of applied water, cm

$$Du = \frac{D_{Lq}}{D_{av}} x100 \quad \text{..... (4)}$$

Where:

D_{Lq}= The depth infiltrated on the quarter of the area which received the lowest amount of the irrigation water, cm

D_{av}= The average depth of infiltrated of total area, cm.

4- Total production costs:

Total production costs of citrus included irrigation cost, fertilization cost, weed control cost, and pest control cost.

A- Irrigation cost:

Capital costs for different irrigation systems were computed according to the market price of 2002 for equipment and installation as shown in Table (3).

Table (3): Capital costs of different irrigation systems for citrus, LE/Fed.

Items	Life, year	Irrigation systems			
		Drip	L.H. Bubbler	Gated pipe	Traditional
Land leveling	1	-	-	120	120
Electrical pump and control head	15	800	500	200	100
Irrigation ditches	15	-	-	-	60
Main and sub-main lines (PVC pipes)	25	550	450	-	-
Stand steel for low head	10	-	100	-	-
Laterals (PE)	5	400	350	-	-
Drippers	5	180	-		-
Gated pipes	10	-	-	650	-
PE- tubes (bubblers)	5	-	100	-	-
Fertigation unit	10	100	100	60	-
Valves and Controllers	10	200	120	30	-
Total costs, LE/Fed.	-	2230	1720	1060	280

The annual costs (fixed and operating) of different irrigation systems for citrus farms were computed according to (Worth and Xin, 1983).

1- Fixed costs:

The annual fixed costs invested in the irrigation systems were calculated using the following formula:

$$F.C = D + I + T \quad \text{..... (5)}$$

Where:

F.C. = Annual fixed cost, LE/year,
D = Depreciation rate, LE/year,
I = Interest, LE/year, and
T = Taxes and overhead ratio, LE/year.

* Depreciation cost differs from one system to another, according to the life span of the different components of each system. Depreciation can be calculated from the following equation:

$$D = (I.C. - SV) / E \quad \ldots\ldots\ldots\ldots (6)$$

Where:
I.C. = Initial cost of irrigation system, LE,
SV = Salvage value after depreciation, LE, and
E = Expectancy life, year.

* The current interest rate of 10%, on the money market, has been used as the value of opportunity cost for capital used in leveling and the cost for the supply and installation of the irrigation network. Interest is calculated as follows:

$$I = (I.C. + S_V) \times I.R / 2 \quad \ldots\ldots\ldots\ldots (7)$$

Where:
I.R. = Interest rate per year, %.

* Taxes and overhead ratios were taken as 2.0% from the initial costs.

2- Operating Costs:

The operating costs were calculated from the following formula:

$$O.C. = L.C + E.C + (R\&M) \quad \ldots\ldots\ldots\ldots (8)$$

Where:
O.C. = Annual operating costs, LE/year,
L.C = Labor costs, LE/year,
E.C = Energy costs, LE/year, and
R&M = Repair and maintenance costs, LE/year.

* Labor to operate the system and to check the system components depends on irrigation operating time. This time would change from system to another according to irrigation water application rate. Labor cost was estimated as follows:

$$L.C = T \times N \times P \quad \ldots\ldots\ldots\ldots (9)$$

Where:
L.C = Annual labor cost, LE/year,
T = Annual irrigation time, h/ year
N = Number of labors per feddan, and
P = Labor cost, LE/h

* Energy costs were calculated by using the following formula:

$$E.C = Bp \times T \times Pr \quad \ldots\ldots\ldots\ldots (10)$$

Where:
E.C. = Energy costs, LE/year,
Bp = The brake power, kW,
T = Annual operating time, h. and
Pr = Cost of electrical power, LE/kW. h.

The brake power required (Bp) in kW for water pumping was calculated by using the following formula (Longenbaugh and Duke, 1981).

$$Bp = \frac{Q \times TDH_W}{K \times E_{Overall}} \quad \ldots\ldots\ldots\ldots (11)$$

Where:
Q = Total discharge, lps,
TDH = Total dynamic head, m,
K = Coefficient to convert to energy unit, 102 and
$E_{overall}$ =The overall efficiency (67.5%for pump drived by electric motor).

* Repair and maintenance costs were taken as 2% of the initial costs for bubbler system, 3% for drip irrigation system and 5% for both gated pipe and traditional irrigation.

* Total annual irrigation costs = fixed costs + operating costs.

B- Fertilization cost:

Fertilization of citrus trees carried out by fertigation system under drip, bubbler and gated pipes irrigation systems, while the manually method of fertilization (broadcasting) was used with traditional surface irrigation. Fertilization cost was calculated as follows:

$$Fr = (Wf \times Pr) + Ac \quad \ldots\ldots\ldots\ldots (12)$$

Where:
Fr = Fertilization cost, LE/Fed.
Wf = Amount of fertilizers, kg/Fed.
Pr = Fertilizers price, LE/kg
Ac = Application cost of fertilizers, LE/Fed.

C- Pest control cost:

Pest control carried out by using the sprayer and pest control cost was calculated as follows:

$$Pc = (Wp \times P) + Ac \quad \ldots\ldots\ldots\ldots (13)$$

Where:
Pc = Pest control cost, LE/Fed.
Wp = Amount of pesticide used, kg/Fed.
P = Pesticide price, LE/kg
Ac=Application cost of pesticides, LE/Fed.(sprayer rent and labor cost).

D- Weed control cost:

Weed control carried out manually by using labors and weed control cost was calculated as follows:

$$Wc = N \times L \times T \quad \ldots\ldots\ldots\ldots (14)$$

Where:
Wc = Weed control cost, LE/Fed.
N = Number of labors per feddan
L = Labor cost, LE/h
T = Time used, h/Fed.

5- Net profit:

The economical profit of different irrigation methods for citrus trees was calculated by using the following formula, (Younis *et al.*, 1991).

$$P = (Y_t \times d) - C_t \quad \text{..... (15)}$$

Where:
P = Net profit, LE/fed
Y_t = Total yield, ton/fed
d =Yield price, LE/ ton (400 LE for citrus), and
C_t = Total production costs, LE/fed.

6- Cost of production unit:

It was calculated as follows:

$$Cost\ of\ production\ unit\ (LE/kg) = \frac{Total\ costs, (LE/Fed)}{Total\ yield\ (kg/Fed)} \quad \text{.....(16)}$$

RESULTS AND DISCUSION

1- Irrigation systems evaluation and efficiencies:

Data presented in Table(4)indicated that the average application efficiency of drip irrigation system was 96% increasing by 5.6%, 18% and 41% more than the application efficiency of bubbler irrigation system (91.4%), gated pipes irrigation (78% and traditional method of irrigation (55%) respectively. This is due to the least percentage of water loss occurred under drip irrigation system, less water is lost resulting from direct evaporation and deep percolation. On the other hand, the distribution uniformity values were 87%, 83.3%, and 75% for bubbler, gated pipes and traditional method of irrigation respectively, decreased by 3.0%, 6.70% and 15.0% than value of distribution uniformity of the drip irrigation system (90%). The distribution uniformity of traditional method of irrigation was less than the other irrigation systems due to the effect of deep percolation and runoff water losses. The highest value of total irrigation efficiency was 86.4% under drip irrigation, followed by bubbler irrigation (79.5%), and then gated pipes irrigation (65.5%), while the lowest value of irrigation efficiency was 42.0% under traditional irrigation.

Table (4): Irrigation efficiencies of different irrigation systems.

Irrigation systems	Application efficiency,%	Distribution efficiency,%	Total irrigation efficiency, %
Surface drip	96.0	90.0	86.4
Low head bubbler	91.4	87.0	79.5
Gated pipes	78.0	83.3	65.0
Traditional	55.0	75.0	42.0

2- Irrigation water requirements:

Water requirements for citrus and water saving under different irrigation systems are shown in Table (5).

Table (5): Water requirements for citrus trees under irrigation systems.

Irrigation systems	Irrigation water (m^3/fed)	Amount of water saving (m^3/fed)	Amount of water saving (%)
Surface drip	2657	2123	44.4
Low head bubbler	2990	1790	37.5
Gated pipes	3678	1102	23.1
Traditional	4780	-	-

Data indicated that irrigation water applied for citrus was reduced by 44.4%, 37.5% and 23.1% when using drip, bubbler and gated pipes irrigation respectively of that applied to the traditional irrigation. The difference in water requirements is primarily due to the relatively greater efficiency of drip irrigation (86.4%) compared to the other irrigation systems which ranged between 79.5% - 42%. In addition, water use saving can also result to the less water losses which is due to evaporation from limited surface area and deep percolation and run off deep percolation and run off for drip irrigation system.

Amounts of water saving from citrus irrigated by using drip, bubbler and gated pipes irrigation were 2123, 1790 and 1102 m^3/Fed respectively compared to the traditional surface irrigation. In Egypt, total citrus acreage about 311061 feddans according to Ministry of Agriculture, (1998). This area would save about 660 or 556 or 342 million cubic meters per year if used the drip or bubbler or gated pipes irrigation system for irrigating this area instead of the traditional surface irrigation. Assuming that each feddan needs to about 6000m^3 of water annually for crops irrigating. So that, these amount of water saving can be used to irrigate and reclaim about 57-110 thousand feddans of a newly land in the Egyptian desert.

3- Citrus yield:

Fig.(2) shows that the citrus yield decreased by 13.8%, 8.2% and 3.7%when using drip, bubbler and gated pipes irrigation systems respectively compared to the traditional irrigation system in the first season. This due to die percentage of the surface roots resulted in the water was not available. Meanwhile, the yield increased by 8.0%, 5.8% and 1.5% under drip, bubbler and gated pipes irrigation systems respectively in the second season compared to the traditional irrigation system , then the increase in the yield reached 37%, 20.5% and 6.8% under drip, bubbler and gated pipes irrigation systems respectively in the third season. This increase in the yield due to adept of the tree root system with the water distribution in the soil profile under these systems , in addition to high the application efficiency of drip, bubbler and gated pipes irrigation systems compared to the traditional irrigation system.

4- Water use efficiency:

Data illustrated in Fig.(3) indicates that the water use efficiency was affected by different irrigation systems.

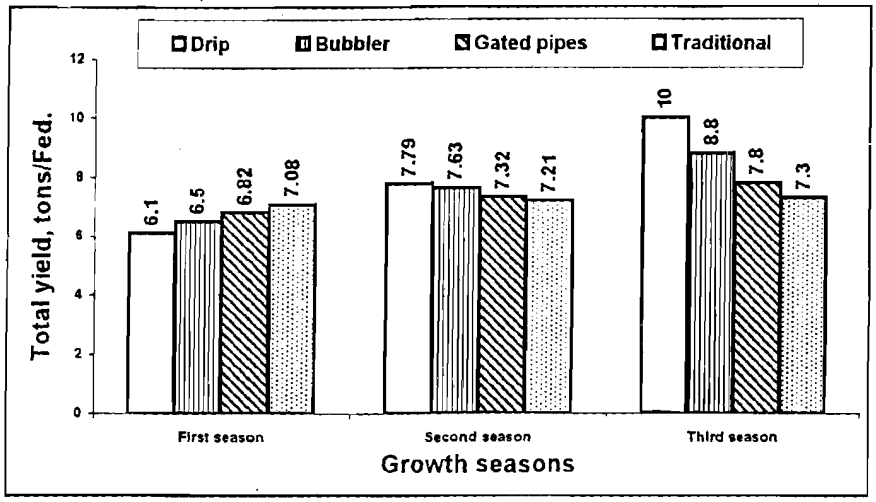

Fig. (2): Total yield of citrus under different irrigation systems.

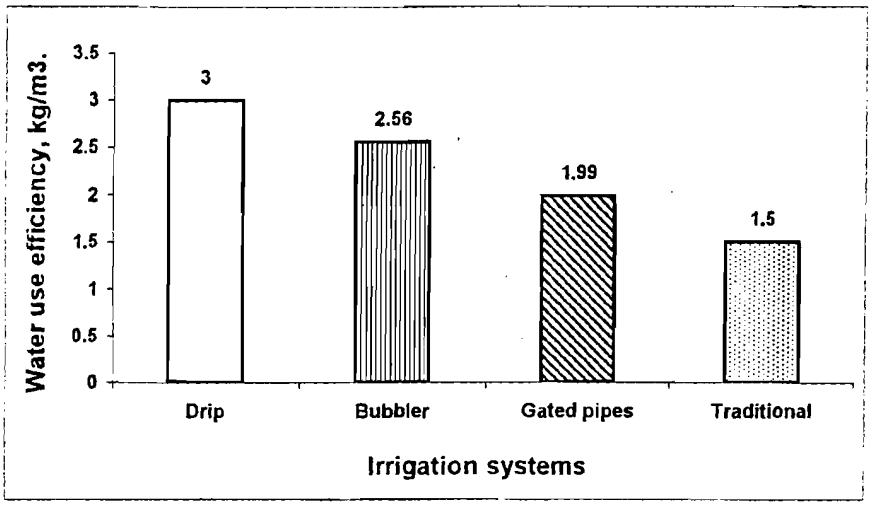

Fig.(3):Water use efficiency of citrus under different irrigation systems.

The obtained data showed that the greatest value of water use efficiency was 3.00kg/m^3 under drip irrigation system, followed by bubbler irrigation (2.56kg/m^3), then gated pipes irrigation (1.99kg/m^3), while the lowest value was1.50kg/m^3 when using the traditional surface irrigation. This is due to the increase in citrus yield and the few water losses during the irrigation operation under drip irrigation system compared with the other irrigation systems.

5- Irrigation cost:

The economical analysis of citrus production indicated that the yield of citrus differs according to the irrigation system. Total irrigation costs are a major capital impute for most farms. The capital and annual costs (fixed and operating) of different irrigation systems are presented in Table (6).

Table (6): The annual costs of different irrigation systems, LE/Fed.

Items	Irrigation systems			
	Drip	Bubbler	Gated pipes	Traditional
Capital cost, LE/ Fed.	2230	1720	1060	280
Fixed cost				
- Depreciation	199.2	156.0	78.6	9.6
- Interest	122.6	94.6	58.3	15.4
- Taxes, etc.	44.6	34.4	21.2	5.6
Subtotal	366.4	285.0	158.1	30.6
Operating cost				
- Labor	40.0	40.0	60.0	75.0
- Power	60.0	30.0	15.0	22.5
- Repair	67.0	34.4	53.0	14.0
Subtotal	167.0	104.4	128.0	111.5
Total costs, LE/ Fed.	533.4	389.4	286.1	142.1

Data showed that the traditional irrigation is considerably low capital and annual costs (280 and 142.1LE/Fed respectively) for citrus irrigated, followed by gated pipes irrigation (1060 and 286.1LE/Fed), then the low head bubbler irrigation (1720 and 289.4 LE/Fed), while the highest value of capital and annual irrigation costs was (2230 and 533.4 LE/Fed respectively) when using drip irrigation system.

6- Fertilization and pest control costs:

Fig. (4)shows that the fertilization cost under drip, bubbler and gated pipes irrigation systems (375LE/Fed) was lower than that under traditional surface irrigation(405LE/Fed) by 8.0%.This due to save the labors cost required for fertilizers application. Meanwhile, pest control cost was the same

under different irrigation systems (220LE/Fed), because the pest control was carried out by using sprayer under all systems.

7- Weed control cost:

Data illustrated in Fig.(4) indicates that the lowest cost of weed control was 125LE/Fed under drip irrigation system compared to the other irrigation systems, while the highest cost of weed control was 250LE/Fed under traditional surface irrigation. This may be due to decrease in the total biomass of weeds produced per unit area under drip irrigation system compared to the other irrigation systems because, the wetted area of the top soil surface under drip irrigation system was less than that under bubbler or gated pipes or traditional surface irrigation.

8- Total production costs and net profit:

Table (7) illustrates that the minimum value of total production costs was 1017.1 LE/Fed for citrus by using traditional irrigation system, while the maximum value of total production costs was 1253.4 LE/Fed when using the drip irrigation system. On the other hand, the highest value of net profit was 2746.6 LE/Fed for citrus under drip irrigation system, followed by low head bubbler irrigation (2375.6LE/Fed), then the gated pipes irrigation (2038.9LE/fed), while the lowest value of net profit was 1902.9 LE/Fed for both citrus by using traditional irrigation system.

Table (7) :Total production costs for citrus trees under different irrigation systems.

Production costs	Irrigation systems			
	Drip	Bubbler	Gated pipes	Traditional
Total costs, LE/Fed.	1253.4	1144.4	1081.1	1017.1
Citrus yield, tons/Fed	10.0	8.8	7.8	7.3
Yield price, LE/Fed.	4000	3520	3120	2920
Net profit, LE/Fed.	2746.6	2375.6	2038.9	1902.9

7- Cost of production unit:

Data illustrated in Fig. (5) indicates that the lowest value of cost production unit was (0.125LE/kg) for citrus under drip irrigation, followed by bubbler irrigation (0.130LE/kg), while the highest value was (0.139LE/kg) under traditional surface irrigation, followed by gated pipes irrigation (0.138LE/kg).

From the previous results, it is clear that the capital cost of irrigation and total production costs of the drip irrigation were higher than that of the other irrigation systems but, it also produced higher yield of citrus. This increase in the yield under drip irrigation system (2.7tons/Fed) covered the increase in the capital cost of irrigation during two years, in addition to rotational application of water which can be used to irrigate and reclaim areas of lands.

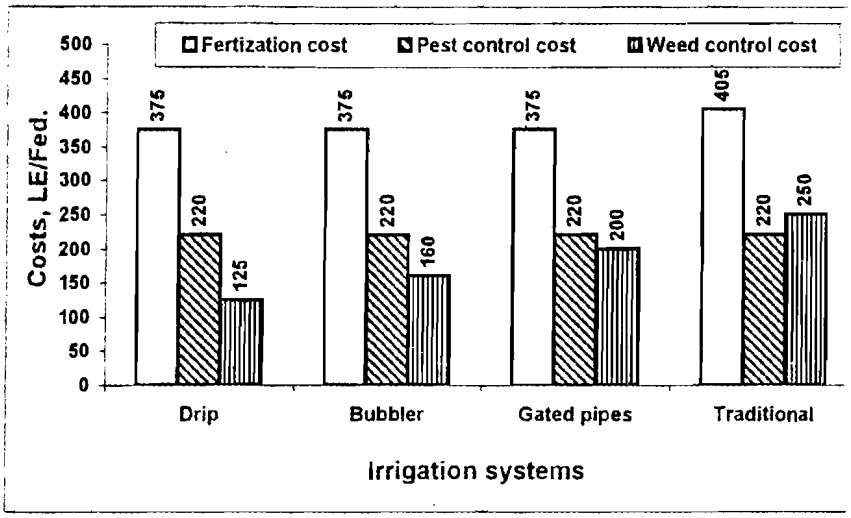

Fig. (4): Production costs of citrus under different irrigation systems.

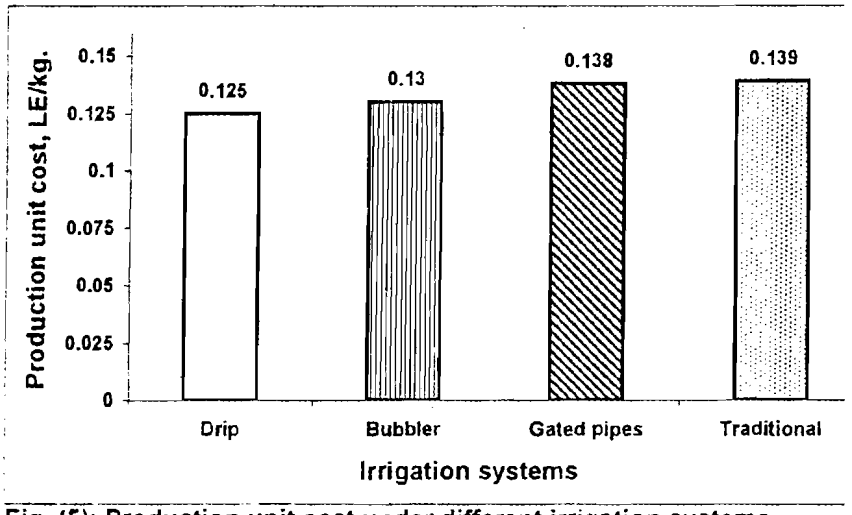

Fig. (5): Production unit cost under different irrigation systems.

CONCLUSIONS

From the above-mentioned presentation and discussion, it can be concluded that:

1- Irrigation water used for citrus irrigation was reduced by 44.4%, 37.5% and 23.1% when using drip, bubbler and gated pipes irrigation systems respectively compared to the traditional surface irrigation.
2- In the first season, the citrus yield reduced by 13.8%, 8.2% and 3.7% under drip, bubbler and gated pipes irrigation systems respectively compared to traditional surface irrigation, while in the third season, drip irrigation produced higher citrus yield (10ton/Fed) followed by bubbler irrigation (8.8tons/Fed), then gated pipes irrigation (7.8tons/Fed), while the traditional surface irrigation produced the lowest yield (7.3tons/Fed).
3- Drip irrigation has the highest capital and total annual costs (2230 and 533.4 LE/Fed respectively) compared to bubbler irrigation (1720 and 389.4LE/Fed), gated pipes irrigation (1060 and 286.1LE/Fed), and traditional surface irrigation (280 and 142.1LE/Fed)..
4- Highest value of net profit was (2746.6LE/Fed) under drip irrigation, while the lowest value was obtained under traditional surface irrigation (1902.9 LE/Fed) for citrus.
5- The lowest value of citrus production unit was (0.125LE/kg) under drip irrigation, while the highest value was (0.139LE/kg) under traditional surface irrigation.

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امكانية تطبيق نظم الرى الحديثة فى مزارع الموالح القديمة والعائد الاقتصادى

أحمد ابو الحسن عبد العزيز

قسم الهندسة الزراعية – كلية الزراعة – جامعة عين شمس– القاهرة– مصر

أجريت هذه التجارب لتحديد مدى امكانية تطبيق نظم الرى الحديثة فى مزارع الموالح القديمة وكذلك تقدير التكاليف الإنشائية وتكاليف التشغيل السنوية لنظم الرى المختلفة، بالإضافة الى التكاليف الكلية لانتاج الموالح والعائد الاقتصادى. استخدمت أربعة نظم لرى اشجار الموالح التى عمرها ٧ سنوات وهى(الرى بالتنقيط – الرى النافورى ذو الضاغط المنخفض– الرى السطحى المطور باستخدام الانابيب المبوبة–الرى السطحى التقليدى).وكانت أهم النتائج المتحصل عليها كالتالى:

١- توفير كمية كبيرة من مياه الرى تقدر بحوالى ٤٤,٤% ، ٣٧,٥% ، ٢٣,١% باستخدام نظم الرى بالتنقيط ، الرى النافورى ، الرى السطحى باستخدام الانابيب المبوبة لرى اشجار الموالح على الترتيب مقارنة باستخدام الرى السطحى التقليدى.

٢- انخفضت انتاجية اشجار الموالح فى الموسم الاول بنسبة ١٣,٨%، ٨,٢%، ٣,٧% باستخدام نظم الرى بالتنقيط ، والرى النافورى ، والرى السطحى المطور على الترتيب. بينما فى الموسم الثالث حقق استخدام الرى بالتنقيط لرى أشجار الموالح أعلى إنتاجية(١٠طن/فدان) بالمقارنة بنظم الرى الاخرى والتى تراوحت انتاجيتها بين(٧,٣– ٨,٨ طن/فدان) .

٣- كانت تكاليف الإنشاء للرى السطحى التقليدى(٢٨٠جنيه/فدان) بالمقارنة بنظم الرى الحديثة والمطورة التى تتراوح تكاليف انشائها ما بين (١٠٦٠– ٢٢٣٠جنيه لفدان الموالح) .

٤- كانت أقل تكاليف سنوية للرى بالطريقة التقليدية(١٤٢,١جنيه/فدان) مقارنة بنظام الرى بالتنقيط (٥٣٣,٤ جنيه/فدان) ، ونظام الرى النافورى (٣٨٩,٤جنيه/ فدان) والرى السطحى المطور باستخدام الانابيب المبوبة (٢٨٦,١جنيه/فدان) للموالح على الترتيب.

٥- تحقق اكبر صافى ربح من فدان الموالح باستخدام نظام الرى بالتنقيط (٢٧٤٦,٦جنيه)، يليه الرى النافورى ذو الطاقة المنخفضة(٢٣٧٥,٦ جنيه) ،ثم نظام الرى السطحى المطور(٢٠٣٨,٩جنيه)، بينما استخدام الرى السطحى التقليدى حقق اقل صافى ربح يقدر بحوالى (١٩٠٢,٩جنيه).

بناءاً على النتائج السابقة يمكن التوصية باستخدام نظامى الرى بالتنقيط والرى النافورى ذو الطاقة المنخفضة لرى أشجار الموالح فى المزارع القديمة بدلا من الرى السطحى التقليدى (الغمر) ، وذلك لزيادة الإنتاجية وتوفير كميات كبيرة من المياه يمكن الاستفادة منها فى رى واستصلاح مساحات كبيرة من الأراضي .