European Journal of Academic Essays 2(6): 14-19, 2015
ISSN (online): 2183-1904
ISSN (print): 2183-3818
www.euroessays.org

Effect of Drip Irrigation Circuits Design and Lateral Lines Length on: VI-Cost Analysis of Corn Crop Production

Tayel, M. Y[1], Mansour, Hani A.[1] and Lightfoot, D. A[2].

[1] National Research Centre (NRC), Agricultural Division, Water Relations and Field Irrigation Dept., El-Buhouth St., El-Dokki, Giza, Cairo, Egypt.
mansourhani2011@gmail.com
tayelmynrc@gmail.com

[2] PSAS Dept., Southern Illinois University, Carbondale, Illinois, USA.
ga4082@siu.edu

Abstract: Irrigation system design and automation controller used like other factors have their impact on production amount, energy used in processing, exportation and importation of fertilizers. Field experiments were conducted in clay loam soil at the Experimental Farm, Faculty of Agricultural Science, Southern Illinois University at Carbondale, Illinois, USA to study the effect of drip irrigation circuit design (DIC) and Lateral lines lengths (LLL) on cost analysis (CA) of corn crop production. Two circuits were used: closed circuits with one manifold for lateral lines (CM1DIS), closed circuits with two manifolds for lateral lines (CM2DIS), and traditional drip irrigation system as a control (TDIS). The lateral lines lengths were: LLL1, LLL2, LLL3 (40, 60; 80m, respectively). N, P2O5 and K2O were applied via irrigation water (Fertigation) at the rate of 60.71 and 69 kg fed-1 in doses according to growth stage. Based on Class A pan evaporation reading, the growth irrigation requirement was applied every 4 days. Crop growing season lasted 158 days, but the irrigation season was ended 10 days before. After harvesting the yield of both grains (g) and Stover (S), WUE, FUE and CA were calculated. Data obtained were subjected to statistical analysis. The results could be outlined in the following: Concerning the values of total cost (EL fed-1 season-1), total revenue(EL fed-1 season-1), physical income (kg m-3) and money income (EL m-3), the DIC and LLL treatments could be arranged in the following orders: (CM2DIS > CM1DIS > TDIS), (CM2DIS > CM1DIS > TDIS), (CM2DIS > CM1DIS > TDIS), and (CM2DIS > CM1DIS > TDIS), respectively and LLL3<LLL2<LLL1. Differences in parameters mentioned under item 7 between DIC and LLL were significant at 1% level except that between CM1DIS and CM2DIS in the 1st and 3rd orders and that between LLL1 and LLL2 in the physical income, the maximum and the minimum values of the total cost, total revenue, the physical income, and the money income from unit of irrigation water could be seen in the following interactions: (CM2DIS X LLL1; TDIS X LLL2), (CM2DIS X LLL1; TDIS X LLL3), (CM2DIS X LLL1; TDIS X LLL2) and (CM2DIS X LLL1; TDIS X LLL3), respectively, and finally, one can deduce that both DIC and LLL in addition to other factors affect WUE, FUE, CA and subsequently energy used in processing, exportation and importation of fertilizers.

Keywords: ***DIC, LLL, Cost Analysis of Corn Production.***

1. Introduction

Drip irrigation offers many unique features of agricultural technologies and economic development (Nakayama and Bucks, 1986). Many authors studied the effect of irrigation method, irrigation levels, fertilizer treatment and plant species on the net income i.e. [1], [2], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12], and [13], The net income had been over estimated in some of the previous studies, This can be attributed to missing one or more of the fixed costs i.e interest on the capital costs, land rent, and water is offered free to the farmers.
[7] found that the maximum and the minimum net profit obtained from grape crop were 3335 and 1414 LE fed -1 under trickle and gated pipe irrigation system, respectively. [6] indicated that depending on irrigation method, irrigation level and bean varieties, the maximum net income and the minimum one were 5751 and 2045 LE fed-1, respectively. [13] stated that the maximum and minimum net income obtained from garlic crop were 4521 and 709 LE fed-1, respectively depending on irrigation treatment, phosphorous treatment and fertilizer injector used.
The physical net income from the unit of irrigation water was in the range of 1.22-2.14 kg dry bean seeds m-3 of irrigation water [9] and [10]. They mentioned that the maximum and the minimum water price varied from 11.6 – 13.0 and from 2.5 – 3.5 LE m-3 of irrigation water used. They added that this price of irrigation under trickle

Corresponding Author: Hani A. Mansour, WRFI Dept, NRC, mansourhani2011@gmail.com, Tel +201068989517

irrigation was affected by irrigation regime, phosphorous level and faba bean (ViciaFaba) varieties. In western Kansas, USA, surface trickle irrigation system had lower returns than in-canopy center pivot sprinkler systems for corn production. Initial investment, system longevity, and corn yield are affecting on economic returns rather than pumping costs and application efficiencies, [14]. Good irrigation managements, scheduling decisions and the appropriate evaluation of the economic impacts at farm level are the main constraints of the adoption of deficit irrigation strategies [15]. In comparison studies between different irrigation systems Mansour, (2006) found that the increases in both water use efficiency and water utilization efficiency at the 2nd season relative to the 1st one were the maximum under drip irrigation system (42; 43%, respectively), followed by the low head bubbler irrigation system (40.7; 37%), while the minimum ones were (30.6; 32%, respectively) under gated pipe irrigation system. Also he found that the increases in fertilizers use efficiency of N, P_2O_5, and K_2O at 2nd season relative to the 1st one were (24, 23; 28 %), (22%, 21%; 27%) and (9%, 8%; 14%) under drip irrigation system, low head bubbler irrigation system and gated pipe irrigation system, respectively. [16], stated that the primary determinant of the cost of the irrigation system is the source of power or energy, while revenue in the amount of capital investment based on: dimension to be of use (target) to be achieved, differences in elevations of field, and the availability of water sources, type of crop and soil, the number of hectares to be irrigated and agricultural equipment required.

The aim of the work presented in this paper was to study the effect of drip irrigation circuits (DIC) used: 1- closed irrigation circuit with one manifold for lateral lines (CM1DIS) 2- closed irrigation circuit with two manifolds for lateral lines (CM2DIS), 3- traditional drip irrigation system (TDIS) as a control and lateral lines length (LLL): (LLL1 = 40m, LLL2 = 60m; LLL3 = 80m) on Cost analysis of Corn production.

2. Materials and Methods

Field experiment was conducted at the experimental farm, Faculty of Agricultural Sciense, Southern Illinois University, Carbondale, Illinois, USA using transgenic corn crop (Zea mays, L. GDH – LL3 – 272 x B73 genotype) grown in Silty clay loam soil through the growing season (2009/2010) to study the effect of drip irrigation circuits design (DIC) and lateral lines length (LLL) on cost analysis of corn production.

Drip irrigation system used included the following treatments:

Closed drip irrigation circuits with one manifold (CM1DIS),closed drip irrigation circuits with two manifolds (CM2DIS), and traditional drip irrigation system as a control (TDIS) Lateral lines length (LLL) were 40, 60; 80 m (LLL1, LLL2; LLL3). Fig. (1) Showed that the total experimental area was 4536 m^2 under each of the tested trickle irrigation circuits, plot areas were 168, 252 and 336 m^2 under LLL1=40 m, LLL2=60m and LLL3=80m, respectively.

The complete description of irrigation system was given by [17], [18], [19], [20] and [21].

The experiment design was split plot with three replicates. Corn grains were sown in rows 0.7 m apart and hills were 0.25 m apart along the rows on the 9th of April. Planting density was 24000 plant fed-1. Each row was drip irrigated by single straight lateral line according to the daily reading of Class A pan evaporation. Irrigation frequency was 4 days. The amount of irrigation water required per irrigation was calculated according to the following equation:

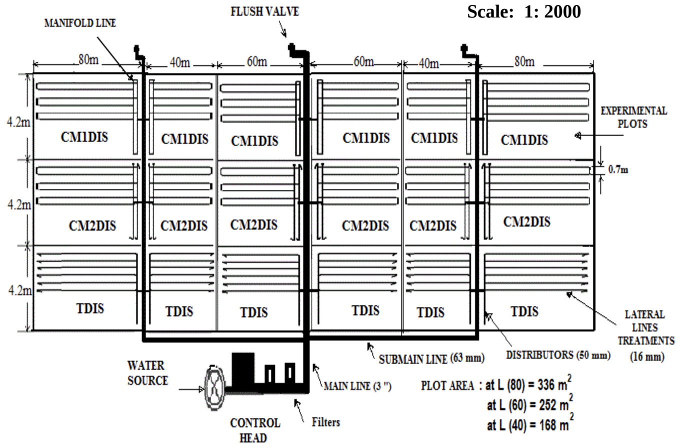

Figure 1: Layout of the field experimental plots: using DIC, (CM2DIS, CM1DIS and TDIS); and (LLL1=40m; LLL2=60m and LLL3=80m) treatments.

1-Fixed costs

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

F.C = D + I + T……………………… (4)

Where:

F.C. = annual fixed cost (LE $year^{-1}$), D = depreciation rate, (LE $year^{-1}$) = (2.678 % from initial cost), I = interest (LE $year^{-1}$) = (4 % initial cost), and T = taxes and overhead ratio (LE $year^{-1}$).

Depreciation can be calculated from the following equation:

D = (I.C. – Sv) /E…………………… (5)

Where:

I.C. = initial cost of irrigation system (LE), Sv = salvage value after depreciation (LE) and E = expectancy life, year.

The current interest is calculated as follows:

I = (I.C. + Sv) * I.R. / 2 ………..….… (6)

Where

I.R. = interest rate per year, 4% from initial cost.

Taxes and overhead ratios were taken as (1.5 - 2.0%) from the initial costs.

2-Operating costs

Operating costs were calculated from the following formula:

O.C. = L.C + E.C + (R&M)…………… (7)

Where:

O.C. = annual operating costs (LE $year^{-1}$ $feddan^{-1}$), L.C = labor costs ($LE^{-1}year^{-1}$fed), E.C = energy costs (LE $year^{-1}$ $feddan^{-1}$), and R&M = repair and maintenance costs (LE $year^{-1}$ $feddan^{-1}$).

Labor to operate the system and to check the system components depend 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 .N . P ……………..... (8)

Where:

L.C = annual Labor cost (LE $year^{-1}$), T = annual irrigation time (hr $year^{-1}$), N = number of labors per feddan, and P = labor cost (LE hr^{-1}).

[22] stated that energy costs were calculated by using the following formula:

E.C = Bp.T.Pr……………… (9)

Where:

E.C. = energy costs, LE $year^{-1}$, Bp = the brake power, kWh^{-1},

T = annual operating time, h. and Pr = cost of electrical power, LE $(kWh)^{-1}$.

Repair and maintenance costs were taken as 3 % of the initial costs for trickle irrigation system.

Total annual irrigation costs = fixed costs + operating costs.

MSTATC program (Michigan State University) was used to carry out statistical analysis. Treatments mean were compared using the technique of analysis of variance (ANOVA) and the least significant difference (L.S.D) between systems at 1%, [23].

3. Results and Discussion

Total costs of agricultural operations are major capital inputs for most farms. The capital and annual costs (fixed and operating ons) of different DIC: CM2DIS (with two manifolds), CM1DIS (with one manifold) and traditional trickle irrigation (TDIS) and LLL: (LLL1 = 40m, LLL2 = 60m; LLL3 = 80m) on costs analysis of corn production (total cost, total revenue and both physical and money income per unit used of irrigation water were given in Tables (1 and 2).

Data on hand indicated that the studied parameters differed according to DIC and LLL used. Table (1) showed that the capital costs (LE fed-1) ranged from (5008-5658), (5032-5632) and from (4962-5562) according to LLL under CM2DIS, CM1DIS and TDIS, respectively. It was obvious that the capital costs increased with decreasing LLL. This may due to the extra length of tubes used as manifolds and valves. Relative to the total costs, the fixed ones accounted to (40.35, 39.03; 37.46 %), (40.12, 38.83; 37.45 %) and (39.7, 35.69; 37.0 %) under (CM2DIS, CM1DIS; TDIS) and (LLL1, LLL2 ; LLL3), respectively. On the other hand, the operation costs reached: (10.04, 10.26; 10.53 %), (10.27, 10.5; 10.73 %) and (10.58, 11.29; 11.06 %) of the total ones in the same sequence mentioned before.

Table (1) illustrated grain yield, Stover yield, the net profit and both the physical and money income from the unit of irrigation water used. The obtained values of these parameters were: (5412, 5139; 5049 kg fed^{-1}), (5302, 5046; 4986 kg fed^{-1}), (5052, 4634; 4381 kg fed^{-1}), (3247, 3083; 3029 kg fed^{-1}), (3181, 3027; 2992 kg fed^{-1}) and (3031, 2780; 2629 kg fed^{-1}), (2.20, 2.12; 2.08 kg m-3), (2.17, 2.09; 2.06 kg m^{-3}), (2.10, 1.98; 1.90 kg m^{-3}), (0.43, 0.41; 0.40 LE m^{-3}), (0.42, 0.40; 0.39 LE m^{-3}) and (0.21, 0.19; 0.18 LE m^{-3}) in the same sequence under (CM2DIS, CM1DIS; TDIS) and (LLL1, LLL2; LLL3), respectively.

Table (2) stated the effect of both DIC and LLL used on the total costs (LE fed^{-1} $season^{-1}$), total revenue (LE fed^{-1} $season^{-1}$), physical income (kg m^{-3}) and the money income (LE m^{-3}). Concerning the effect of DIC on the parameters under consideration, the DIC used could put in the following descending orders: (CM2DIS = CM1DIS > TDIS), (CM2DIS > CM1DIS > TDIS), (CM2DIS = CM1DIS > TDIS), (CM2DIS > CM1DIS > TDIS), in the same sequence, respectively. In other hand, differences in total costs and physical income between CM2DIS and CM1DIS from one side and TDIS system from the other side were significant at the 1 % level, whereas, the differences in both the total revenue and money income from unit of irrigation water used among DIC were significant at the 1% level.

In the case of the effect of LLL on all the studied parameters LLL could be ranked in the following ascending order: LLL3< LLL2< LLL1. Differences in data on hand among LLL were significant at the 1% level except that between LLL2 and LLL3 in the case of the physical income, net profit and net income from unit of irrigation

The effects of the interaction DIC x LLL were given in Table (2). The maximum values and the minimum ones of the total costs, total revenue, the physical income and the money income from irrigation water unit used were achieved in the following interactions: (CM2DIS X LLL1; TDIS X LLL2), (CM2DIS X LLL1; TDIS X LLL3), (CM2DIS X LLL1; TDIS X LLL3) and (CM2DIS X LLL1; TDIS X LLL3), respectively.

The data obtained could be explained on the basis that DIC and LLL effects on the investigated parameters were through their effect on some hydraulic characteristics i.e. emitter discharge, lateral discharge, pressure head, friction loss, flow velocity, velocity head, uniformity coefficient and coefficient of variation [7], [8], [9], [10], [11], [17], [18], [19], [20], [21], [23], [24], [25], [26] and [27], The positive effect of CM2DIS and CM1DIS and the short LLL on these parameter led to better distribution of both water and fertilizers along the lateral lines. This was positively reflected on corn yield per feddan and subsequently on the physical and the money income from the unit used of both irrigation water and fertilizers. In the same time, the effect of DIC and LLL on the parameters under consideration through the fixed and operating costs was quite nil.

Table 1: Agricultural Cost analysis of corn production under different DIC and LLL (LE fed-1 season-1)

Cost items		CM_2DIS			CM_1DIS			TDIS		
		40	60	80	40	60	80	40	60	80
Capital cost (LE fed $^{-1}$)		**5658**	**5358**	**5008**	**5632**	**5332**	**5032**	**5562**	**5262**	**4962**
Fixed costs (LE fed^{-1} season^{-1})										
1- Depreciation		396	375	351	394	373	352	389	368	347
2- Interest		226	214	200	225	213	201	222	138	198
3- Taxes and insurance		85	80	75	84	80	75	83	79	74
Sub-total		**707**	**669**	**626**	**703**	**666**	**628**	**694**	**585**	**619**
Operating costs (LE fed^{-1}season^{-1})										
1- Electricity for pump motor		76			80			85		
2- Maintenance and Repairing		100			100			100		
Sub-total		**176**			**180**			**185**		
Total annual irrigation cost (LE fed^{-1} season^{-1})		**883**	**845**	**802**	**883**	**846**	**808**	**879**	**770**	**804**
Total agricultural Costs		**869**			**869**			**869**		
Total costs (LE fed^{-1}season^{-1})		**1752**	**1714**	**1671**	**1752**	**1715**	**1677**	**1748**	**1639**	**1673**
Yield	**Grain, (kg fed^{-1})**	**5412**	**5139**	**5049**	**5302**	**5046**	**4986**	**5052**	**4634**	**4381**
	Stover,(kg fed^{-1})	**3523**	**3467**	**3417**	**3497**	**3443**	**3400**	**3475**	**3404**	**3394**
Price, (LE fed^{-1})	**Grain**	**3247**	**3083**	**3029**	**3181**	**3027**	**2992**	**3031**	**2780**	**2629**
	Stover	**234**	**222**	**218**	**229**	**218**	**216**	**218**	**200**	**189**
Total revenue, (LE fed^{-1}season^{-1})		**3481**	**3305**	**3247**	**3410**	**3245**	**3208**	**3249**	**2980**	**2818**
Hysical net income (kg m^{-3})		**2.20**	**2.12**	**2.08**	**2.17**	**2.09**	**2.06**	**2.10**	**1.98**	**1.90**
Net profit, (LE fed^{-1}season^{-1})		**1740**	**1653**	**1624**	**1703**	**1621**	**1602**	**843**	**774**	**732**
Net income LE m^{-3}		**0.43**	**0.41**	**0.40**	**0.42**	**0.40**	**0.39**	**0.21**	**0.19**	**0.18**

Water requirements of DIC = 4060 m3fed-1season-1 & fed = 4200 m2, CM2DIS: Closed circuits with tow manifolds separated, CM1DIS: Closed circuits with one manifold; TDIS: Traditional trickle irrigation system.

Table 2: Effect of DIC and LLL on cost parameters of corn production.

DIC	LLL	Total costs (LE fed^{-1} season^{-1})	Yield (kg fed^{-1})		Price, (LE fed^{-1})		Total revenue, (LE^{-1}fed^{-1} season)	Physical net income (kg m^{-3})	Net profit, (LEfed^{-1} season^{-1})	Net income LE m^{-3}
			Grain	Stover	Grain	Stover				
CM_2DIS	**40**	1752a	5412a	3523a	3247a	234a	3481a	2.20a	1740a	0.43a
	60	1714ed	5139c	3467d	3083c	222c	3305c	2.12c	1653c	0.41c
	80	1671hf	5049ed	3417f	3029ec	218dc	3247ec	2.08fc	1624dc	0.40dc
CM_1DIS	**40**	1752ba	5302b	3497a	3181b	229ba	3410b	2.17ba	1703b	0.42ba
	60	1715d	5046fe	3443e	3027fc	218ec	3245fc	2.09ec	1621ed	0.40e
	80	1677f	4986g	3400h	2992g	216g	3208g	2.06gf	1602fd	0.39fe
TDIS	**40**	1748ca	5052d	3475c	3031dc	218fc	3249dc	2.10dc	843g	0.21g
	60	1639i	4634h	3404g	2780h	200h	2980h	1.98h	774h	0.19hg
	80	1673gf	4381i	3394i	2629i	189i	2818i	1.90i	732i	0.18ih
1X2	**$LSD_{0.01}$**	**5**	**79**	**18**	**60**	**5**	**64**	**0.05**	**30**	**0.01**
Means(1)	**CM_2DIS**	1712a	5200a	3469a	3120a	225a	3344a	2.13a	1672a	0.41a
	CM_1DIS	1715ba	5111b	3447b	3067ba	221ba	3288b	2.11ba	1642b	0.40ba
	TDIS	1687c	4689c	3424c	2813c	202c	3016c	1.99c	783c	0.19c
$LSD_{0.01}$		**4**	**64**	**10**	**62**	**6**	**62**	**0.03**	**29**	**0.01**
Means(2)	**40**	1751a	5255a	3498a	3153a	227a	3380a	2.16a	1429a	0.35a
	60	1689b	4940b	3438b	2963b	213b	3177b	2.06b	1349b	0.33b
	80	1674c	4805c	3404c	2883c	208cb	3091c	2.01cb	1319cb	0.32cb
$LSD_{0.01}$		**6**	**89**	**25**	**65**	**8**	**67**	**0.06**	**34**	**0.01**

DIC; Trickle irrigation circuits, LLL: Lateral line lengths,CM2DIS: Closed circuits with tow manifolds separated, CM1DIS: Closed circuits with one manifold; TDIS: Traditional trickle irrigation system.

4. Conclusion

The world today is facing ever-growing challenges of widespread food insecurity and malnutrition due to limited water resources, increasing population, negative impact of climate changes, environmental degradation, and dependence on fossil fuel energy. Drought is the number one limitation to crop productivity.

As climate changes, the incidence and duration of drought and heat stress on our major crops will increase in many regions, negatively affecting crop yield and food security. Agriculture must produce more crop per unit used of both irrigation water and fertilizers.

Data obtained indicated that the drip irrigation circuits and lateral line length selection can positively affect some hydraulic characteristic of the irrigation system and subsequently water use efficiency and fertilize use efficiency, physical and money income from unit of irrigation water and fertilizers used and cost analysis of corn crop. Therefore, solution to the challenges mentioned before will be found in part through more researches on using this technique under our local conditions.

5. References

[1] Younis, S. M. 1986. Study on different irrigation methods in Western Nobaria to produce tomato. Alex. J. Agric. Res.,31 (3):11-19.

[2] Zhang.H and T. Oweis, 1999. Water-yield relations and optimal irrigation scheduling of wheat in the Mediterranean region**.**Agricultural Water Management, 38 (3): 195-211.

[3] Metwally, M. F. 2001. Fertigation management in sandy soil. M. Sc. Thesis, Agric. Eng., Fac. of Agric. El Mansoura Univ.

[4] Cetin, B., S. Yozgan and T. Tipia, 2004. Economics of drip irrigation of olives in Turkey. Agricultural Water Management, 66:145-151.

[5] Maisiri, N.; A. Senzanje; J. Rockstrom and S. J. Twomlow, 2005. On farm evaluation of the effect of low cost drip irrigation on water and crop productivity compared to conventional surface irrigation. Physics and Chemistry of the Earth, 30: 783-791.

[6] Mansour, H. A., (2013). Evaluation of Closed Circuits Drip Irrigation by Using Simulation Program Under Automation Controller. 2(3): 128-136. www.seipub.org/ijace.

[7] Mansour, H. A., (2006). The response of grape fruits to application of water and fertilizers under different localized irrigation systems. M.Sc: Thesis, Faculty of Agriculture, Agric., Ain Shams University, Egypt.

[8] Mansour, H. A., Hany M. Mehanna, Mohamed E. El-Hagarey, Ahmehd S. Hassan (2013). Using Automation Controller System and Simulation Program for Testing Closed Circuits of Mini-Sprinkler Irrigation System. Open Journal of Modelling and Simulation, 1(2): 14-23. (http://www.scirp.org/journal/ojmsi).

[9] Mansour, H. A., E.F. Abdallah, M.S. Gaballah and Cs. Gyuricza (2015)a. Impact of bubbler discharge and irrigation water quantity on 1- hydraulic performance evaluation and maize biomass yield. Int. J. of GEOMATE, Vol. 9, No. 2 (Sl. No. 18), pp. 1538-1544.

[10] Mansour, H. A., M. Abdel-Hady and Ebtisam I. El-dardiry, V. F, Bralts (2015)b. Performance of automatic control different localized irrigation systems and lateral lengths for: 1- emitters clogging and maize (zea mays l.) Growth and yield. Int. J. of GEOMATE, Vol. 9, No. 2 (Sl. No. 18), pp.pp. 1545-1552.

[11] Tayel, M. Y; EL-Gindy, A. M. and A. A. Abdel-Aziz, 2008. Effect of irrigation systems on: III- productivity and quality of grape crop. J. APP. Sci. Res, 4(12):1722-1729.

[12] Dagdelen, N.; H. Bas, al, Eyilmaz, T. Gurbu, Z.And S. Akcay, 2009. Different drip irrigation regimes affect cotton yield, water use efficiency and fiber quality in Western Turkey. Agricultural Water Management, 96: 111-120.

[13] Tayel, M. Y.; Ebtisam I.; Eldardiry and M. Abd El-Hady, 2006. Water and fertilizer use efficiency as affected by irrigation methods. American-Eurasian J. Agric. &Environ. Sci., 1(3):294-300.

[14] Dhuyvetter, K. C.; F. R. Lamm and D. H. Rogers, 1995. Subsurface Drip Irrigation (SDI) for Field Corn - An Economic Analysis. Proceedings of the 5th International Micro-irrigation Congress, Orlando, Florida, April 2-6, 1995, pp: 395 - 401.

[15] El Amami, H.; A. Zairi; L. S. Pereira; T. Machado; A. Slatni and P. Rodrigues, 2001. Deficit irrigation of cereals and horticultural crops: economic analysis.Agricultural Engineering International: the CIGR Journal of Scientific Research and Development.Manuscript LW 00 007b. Vol. III. pp 1-11.

[16] Yazgan, S.; Degirmenci, H.; Byukcangaz, H. and C. Demirtas, 2000. Irrigation problems olive production in Bursa region. In: National First Olive Symposium. Bursa, Turkey, pp. 275–281.

[17] Mansour, H. A. 2012. Design considerations for closed circuits of drip irrigation system. PhD.Thesis, Faculty of Agriculture, Agric., Ain Shams University, Egypt. Pp. 74-82.

[18] Mansour, H. A., M. Abd El-Hady (2014). Performance of Irrigation Systems under Water Salinity in Wheat Production. (IOSR-JAVS)-Journal of Agriculture and Veterinary Science 7 (7), 19-24.

[19] Mansour, H. A., M. S. Gaballah, M. Abd El-Hady and Ebtisam I. Eldardiry (2014) Influence Of Different Localized Irrigation Systems Andtreated Agricultural Wastewater On Distribution Uniformities, Potato Growth Tuber Yield And Water Use Efficiency. International Journal of Advanced Research, Volume 2, Issue 2, 143 - 150. Journal homepage: http://www.journalijar.com.

[20] Mansour, H. A., M. Y. Tayel, M. A. Abd El-Hady, David A. Lightfoot, A. M. El- Gindy, (2010)a. Modification of water application uniformity among closed circuit trickle irrigation systems. (Agriculture Science journal, Vol. 1, No. 1, pp. 1-9.), http://www.scirp.org/journal/as/.

[21] Mansour, H. A., M. Y. Tayel, David A. Lightfoot, A. M. El-Gindy, (2010)b. Energy and water saving by using closed circuits of drip irrigation systems. (Agriculture Science journal, Vol. 1, No. 3, pp. 154-177.), http://www.scirp.org/journal/as/.

[22]Abdel-Aziz, A. A. 2003. Possibility of applying modern irrigation systems in the old citrus farm and economic return, J. Agric. Sci. Mansoura Univ., 28 (7): 5621-5635.

[23]Steel, R. G. D and J. H. Torrie, 1980. Principles and Procedures of Statistics.A biometrical approach.2nd Ed., McGraw Hill Inter. Book Co. Tokyo, Japan.

[24] Tayel, M. Y., H.A. Mansour, and A.M. El-Gindy (2012). Effect of drip irrigation circuit design and lateral line lengths iii- on dripper and lateral discharge. Journal of Applied Sciences Research, 8(5): 2725-2731.

[25] Tayel, M. Y., H.A. Mansour, and A.M. El-Gindy (2012). Effect of drip irrigation circuit design and lateral line lengths iv- on uniformity coefficient and coefficient of variation. Journal of Applied Sciences Research, 8(5): 2741-2748.

[26] Tayel, M. Y., H.A. Mansour, and David A. Lightfoot (2012). Effect of drip irrigation circuit design and lateral line lengths i- on Pressure head and friction loss.(Agric. Sci., 3(3): 392-399). http://www.scirp.org/journal/as.

[27] Tayel, M. Y., H.A. Mansour, and David A. Lightfoot (2012). Effect of drip irrigation circuit design and lateral line lengths ii- on flow velocity and velocity head. Agric. Sci., 3(4): 531-537). http://www.scirp.org/journal/as.

Hani A. Mansour, PhD received the B.Sc., M.Sc. and PhD. degrees in Agricultural Engineering from Minufia and Ain Shams University, Faculty of Agriculture, 2000, 2006 and 2012, respectively. During 2009-2011, he stayed in SIUC, Carbondale, Illinois, USA to study complete the field experiments of PhD. Thesis, in 2013 and 2014 he obtained to postdoctoral scholarships in agricultural engineering at SZIU, Hungary and Purdue University, USA, respectively. He now works as a Researcher at National Research Centre, Egypt.