EFFECT OF PULSE DRIP IRRIGATION ON SOIL MOISTURE DISTRIBUTION AND MAIZE PRODUCTION IN CLAY SOIL

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ABSTRACT

Pulse drip irrigation is a recent concept where small frequent irrigation applications are applied to saturate the soil and meet the plant water requirements. The field experiments were carried out in clayey soil at the farm of Rice Mechanization Center (RMC), Meet El-Deepa, Kafr El-Sheikh Governorate during the successive season of 2004-2005. The experimental field was divided into three large plots. The plot was divided into 2 strips. Each strip was considered for one specified treatment. Each treatment contained eight dripper lines. The dripper lines spacing and length were designed to be 1.0 m and 50 m of both side of the manifold, respectively. The experiment was randomized complete block design (RCBD) for one variable each irrigation alone.

The purposes of this study were to determine and evaluate the effects of the traditional and the pulse drip irrigation (5 min on/ 5 min off) on the process of soil water depletion, replenishment, distribution pattern, application efficiency, emission uniformity, distribution efficiency, crop yield characteristics and water use efficiency. The crop measurements were plant height (cm), number of ears/plant, roots distribution area, kernel weight and weight of 100 kernels as an average of two samples taken at random from each plot.

The results demonstrated that the maximum crop water requirement was 6.96 mm/day during the mid season (through August). The seasonal irrigation water applied was found to be 1931.35 and 1892.48 m3/fed or 459.9 and 450.6 mm/ season for continuous and pulse drip irrigation, respectively. Pulse flow resulted in higher values of soil moisture trend for either (0-15 cm) or (15-30cm) soil depths. Moisture content showed that there was no significant difference between the two soil depths for pulse flow irrigation technique, while as the L.S.D. test was highly significant for

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continuous drip between both soil depths. The higher value for each of Ea, EU and Ed through over the growth planting season was recorded for pulse drip irrigation technique. This indicated higher water uniformity distribution along the lateral of dripper line. Pulse drip irrigation increased grain yield by 11.8% compared with continuous drip irrigation. While the total applied water was saved by 2.01% for pulse drip irrigation than that continuous drip. Water use efficiency under pulse drip irrigation was 2.34 kg/m^3 compared with 2.06 kg/m^3 for continuous drip irrigation recording an increase of 13.55%

INTRODUCTION

Maize is one of the most important crops in the world and is very sensitive to water stress. Its yield is affected by frequent drought. Because of the root corn is relatively shallow and is always mainly concentrated in raised bed. Irrigation water is possibly infiltrated to somewhere deep under crop root zone to some extent while the topsoil is still dry. The water use efficiency under this condition is very low, Yaohu et al. (2002).

Irrigation system, irrigating amount and timing are the objectives for reducing run off, decreasing percolation of water beneath the root zone and reducing water evaporation after irrigation (El-Gindy et al., 2001a and b). Using modern irrigation systems and proper irrigation management will help in saving more water which can be used to cultivate more land. The benefits of this irrigation methods, such as reducing surface soil water evaporation, decreasing fertilizers leaching, enhancing yield and so on, have been documented by different researchers. Currently, because of water shortage, farmers are encouraged to adopt drip irrigation by the Egyptian government. The advantage of water savings by drip is forfeited if crops are over irrigated. Valuable nutrients may be leached out of the root zone and become unavailable for the plants, while contaminating the groundwater. Temporary anaerobic conditions may then occur in the rooting zone, hampering growth and development of crops. Except for the uncertainty amongst producers regarding irrigation scheduling under drip irrigation system, producers also need up to date information regarding inter-row spacing, fertigation programmes and irrigation frequency.

Pulse irrigation or watering is a recent concept where small frequent irrigation applications are applied to saturate the soil and meet the plant water requirements, while reduced leaching and run-off Dole (1994). Continuous water application is associated with increased water percolation under the root zone. Intermittent irrigation strategy based on discharge pulses followed by breaks could improve water management in the field and increase irrigation efficiency (Oron, 1981). The objective of pulse irrigation is to allow no leaching by applying small amounts of water by micro tube. Intermittent water application allows reducing mean irrigation rate to a level which coincides with soil's hydraulic conductivity and minimizes percolation below the main root zone. Pulsating can be applied in any irrigation method however, is primarily applicable in drip irrigation systems. The higher the irrigation frequency, the smaller the soil wetting volume and the higher soil water content in a small range can be maintained. High irrigation frequency might provide desirable conditions for water movement in soil and for uptake by roots (Segal et al, 2000). Several experiments have shown some crops' positive responses to high frequent drip irrigation (Freeman et al, 1976; Segal et al, 2000; Sharmasarkar et al 2001). Continuous efforts are being made to improve the efficiency of drip irrigation. Several authors have shown that efficiencies might be improved without affecting crop yield through more optimal drip irrigation management (Kenig et al., 1995; Assouline et al., 2002; Dioudis et al., 2003)

Pitts et al (1991) found that the two drip irrigation frequencies (three times per day, one time per day) had not affected tomato yield, however, root length density was significantly affected by irrigation treatment at the 0 to 0.15 m depth with the more frequent irrigation treatment having less root length density. Meshkat et al (2000) went one-step further by pointing out that an irrigation regime with an excessive high irrigation frequency could cause the soil surface to remain wet and the first stage of evaporation to persist most of the time, resulted in a maximum rate of water loss. Panagiotis and Makrantonaki (2005) sated that in intermittent or pulsed application the same amount of water was applied intermittently in 1 h periods (cycles) (i.e. 1 h irrigation, followed by 1 h of no irrigation).

The role of pulse irrigation may play in improving yield and fruit quality. Pulse irrigation under stressful environments results in larger fruit which has a major impact on farm profitability. On the other hand, Evidence shows that root systems under partial soil wetting are dominated by wetting patterns under the drippers (Clothier and Green, 1994; Coelho and Or, 1996). These limited root systems might not affect crop growth when the main nutrients are applied through irrigation system.

Beeson (1992) stated that pulse-irrigated plants tended to accumulate less daily water stress. With less water stress, plants grew faster and remained healthier than plants that were stressed on a daily basis. Another benefit is that disease prevention is less difficult. Alternatively the major drawback with pulsing is the possible increase of soluble salts. To prevent this, low levels of fertilizer in solution keep soluble salts from building up rapidly in the media and reduce the need for leaching (Dole, 1993). When using the pulse strategy, salt levels must be maintained at low levels especially for crops sensitive to high soluble salts (Dole, 1993). Pulse irrigation offers one of the most economical alternatives when it comes to limiting runoff.

A good understanding of soil water distribution, crop root distribution and water uptake patterns has become increasingly important in order to develop modern and environmentally friendly practices involving drip irrigation. The purposes of this study were to determine and evaluate the effects of the continuous and pulse drip irrigation systems on soil water depletion, replenishment, distribution pattern, application efficiency, emission uniformity, distribution efficiency, crop yield characteristics and water use efficiency

MATERIALS AND METHODS

The field experiments were carried out in the farm of Rice Mechanization Center (RMC), Meet El-Deepa, Kafr El-Sheikh Governorate during the successive season of 2004-2005.

Experimental design

The experimental field was divided into three large plots. The plots were separated by ditcher 1 meter wide. The plot was divided into 2 strips. Each strip was considered for one specified treatment. Each treatment contained

eight dripper lines. The dripper lines spacing and length were designed to be 1.0 m and 50 m of both side of the manifold, respectively.
Due to the difference of the soil characteristics, weather conditions, plant conditions and age from irrigation to other through over the growth season, the statistical design used in this experiment was randomized complete block design (RCBD) for one variable for each irrigation alone. The obtained data were subjected to proper statistical analysis using (SAS) software package (1997). The mean values were compared using L.S.D. test. The treatments were continuous and pulse (5 min on/5 min off) drip irrigation systems as shown in Fig. (1).

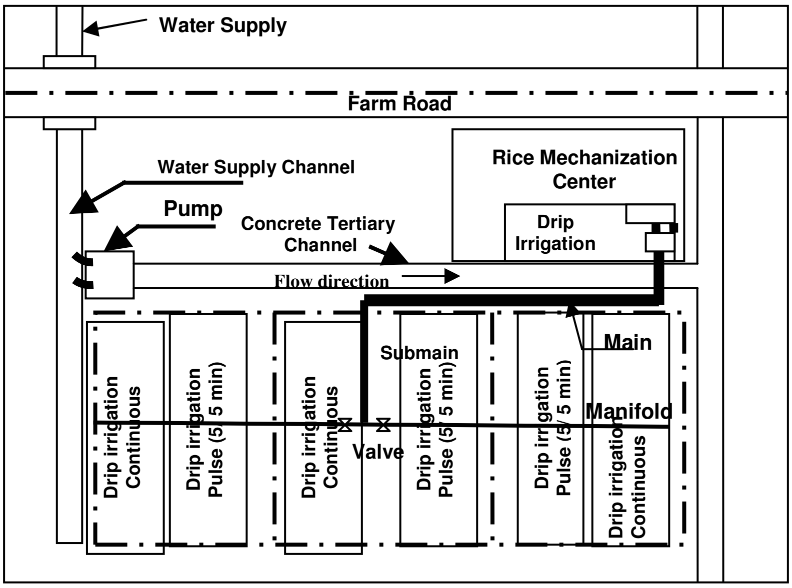


Figure (1) The experimental design layout.

Soil physical properties

The samples were taken from experimental site. A one-square meter area was selected for soil samples. This area was excavated at 60cm depth, and four soil samples were taken at 15 cm depth for each layer. The soil analysis was carried out at Soil and Water Department, Alexandria University and presented in Table (1).

Drip irrigation event measurements

Drip irrigation system at Rice Mechanization Center (RMC) consisted of control head (pump, media filter, screen filter, and pressure gage), main, submain and manifold line. All lines were buried under soil surface, except lateral lines. Type of emitters was In-line (GR).

Table(1): Soil physical analysis of experimental site.

Soil depth, cm	Particle size distribution			Soil Texture	Bulk density, gm/cm^3	Field capacity, %	P.W.P, %
	Sand, %	Silt, %	Clay, %				
0 – 15	15.68	19.35	64.97	Clay	1.09	47	21.38
15 - 30	20.4	14.3	65.3	Clay	1.15	40.5	21.58
30 - 45	17.09	17.9	65.01	Clay	1.24	39	21.19
45 - 60	18.14	15.73	66.13	Clay	1.26	38.5	20.81

Each treatment contained eight laterals. Emitter discharge was 4 ℓ/hr @ 0.5 m spacing. Each lateral was provided with a control ball valve. Also, a control valve was installed on the manifold.

Stop watch, cans and pressure gauge were used for measuring actual emitter flow rate and pressure. Pressure was measured at lateral inlet and outlet. The lateral length was 50m. The lateral lines were divided to four quarters. Flow rate was recorded at these four different quarters for each lateral. These measurements were to determine emission uniformity and application efficiency as follows,

$$EU = 100\left(\frac{q_n}{q_a}\right) \qquad (1)$$

Where EU is emission uniformity (%); q_n is average of low-quarter for emitter discharge in the block (ℓ/hr) and q_a is average of emitter discharge in the block (ℓ/hr).

$$Ea = 0.9*EU \qquad (2)$$

Where: Ea is application efficiency (%).

Applied irrigation water

Water applied was calculated as follow

$$V = q.\ n.\ t \qquad (3)$$

Where V is water volume (m^3/ lateral); q is discharge of emitter (m^3/hr); n is number of emitters / lateral and t is total irrigation time recorded by stop watch (hr);

Soil moisture content

Two laterals in the middle of each treatment were selected. Three locations on these laterals were selected near the inlet, at middle and near the end. Each location was represented by four emitters. Each emitter was surrounded by eight places for taking the soil samples and one place was just under the emitter itself. The soil moisture content was measured before irrigation around the selected emitters for each location. The total soil samples were taken from 25 positions as illustrated in Fig. (2).

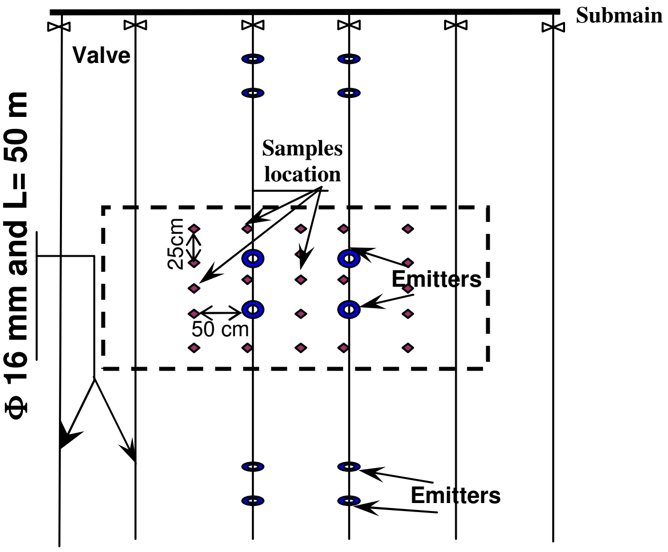


Figure (2): locations of samples taken around emitters.

Plant characteristics

The crop type used in the experiment was maize Giza Hybrid Single-10 (G.H.S.10). Data were taken on the guarded plants within row for each plot. The crop measurements were as follows: (a) Plant height (cm): the distance from the ground level to the upper most node; (b) Number of ears / plant: expressed as total no. of harvested ears per plot / no. of harvested plant per plot; (c) Roots distribution development: Plant area was determined in the tested field then, this plant was plucked out its root from the determined area and it put in water bucket to separate the suspended soil with roots after that, they were put on demonstrative draw paper to find root distribution development; (d) Kernel weight; and (e) Rows number/ear (El-Absawy, 1990; El-Sayed, 1987; El-Wakiel,1993 and Aablezah, 2001)).

Grain yield

The grain yield samples were taken from the middle of each treatment at a sample area of two furrows width (1.4m) and 10m length, Weight of harvested ears/plot at harvested moisture percent, were multiplied by shelling percent and adjusted to grain yield based upon 14 moisture percent "wet base" (El-Absawy, 1990; El-Wakiel,1993; and Aablezah, 2001).

Water use efficiency (WUE)

It was measured according to James (1988) as follows:

$$WUE = \frac{y}{Wa} \qquad (4)$$

Where WUE is water use efficiency (kg/m^3); y is total grain yield (kg/fed); and Wa is total applied water (m^3/fed.)

RESULTS AND DISCUSSION

Crop water consumptive use (Et_C)

The irrigation system at this study was managed to supply the potential evapotranspiration of Maize based on the appropriate crop coefficient and reference crop evapotranspirations. The average daily pan evaporation (Ep) was measured at Sakha Meteorological Station to obtain Etc (water consumptive use mm/day) for each month which is represented in Table (2). The results demonstrated that a maximum crop water requirement was 6.96 mm/day during the mid season. It could be noticed that, the daily crop evapotranspiration values were varied as the climatic conditions and plant growth stages were changed. Initially, the rate of crop water requirement was low, then increased till it reached its maximum value 243.6 mm at the end of flowering stage which was during 75-80 days (August month) after the planting date.

Table (2) Calculated consumptive use (mm/day) of maize using pan evaporation method.

Growth Stage*	Pan evapo. Ep, mm/day	Pan coeff., Kp	Eto, (mm/day)	Crop coeff., Kc*	Water consumptive use Etc,	
					mm/day	mm/season
Establishment 20 days	7.5 through June	0.7	5.25	0.35	1.84	36.8
Crop develop. 30 days	5.3 through July	0.7	5.81	0.7	4.07	122.1
mid season 35 days	8.8 through Aug 3 days of Sept	0.7	6.16	1.13	6.96	243.6
late season 28 days	6.81 through Sept	0.7	4.77	1.1	5.25	147.0
At harvest 12 days	6.11 through Octo	0.7	4.28	0.76	3.25	39.0

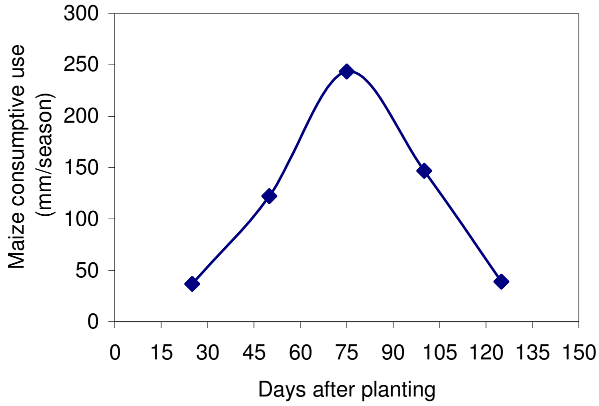


Figure (3) Estimated water consumptive use for maize

This result could be due to increase of plant growth and total leaf area, as a result transpiration consequently increased. Vice versa at the harvest stage, the rate of water consumption decreased as the crop became mature as shown in Fig. (3). The results were in agreement with Sharaf and Soliman (2000), Soliman (1999) and Khalifa et al (1988).

Irrigation water applied

The amount of water applied was calculated (m^3/ fed) according to the Fig.(3) by using the irrigation time as controlling tool of the volume of applied water. As shown in Fig. (4) and Table (3) the results revealed that the volume or depth of applied water increased with the growth of the plant then declined at the end of the growth season. The seasonal irrigation water applied was found to be 1931.35 and 1892.48 m^3/fed or 459.9 and 450.6 mm/ season for continuous and pulse drip irrigation, respectively.

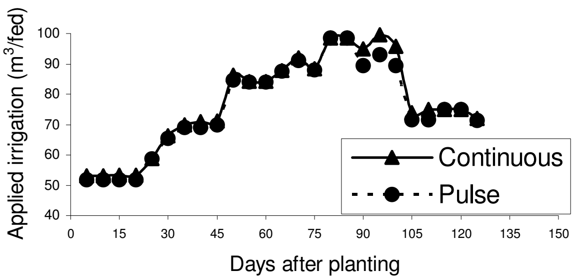


Figure (4) Values of irrigation applied water through the growing season.

Although the pulse drip irrigation save 2.05% of applied irrigation water, however, the statistical analysis of L.S.D indicated that there were no significant differences between the two irrigation techniques as shown in Table (3).

Soil moisture content

Soil moisture content was measured every 25 days for two soil depths (0-15 and 15-30 cm), just before next irrigation begain. Table (4) and Fig. (5) Showed the value of soil moisture content fluctuated according to the plant growth rate.

Table (3) Values of volume and depth of applied irrigation water.

	Day of irrigation	Irrigation time min/day	Volume Applied water m^3/fed		Depth applied water mm/Irrig.	
			Continuous	Pulse	Continuous	Pulse
	5	15	52.95	51.75	12.61	12.32
	10	15	52.95	51.75	12.61	12.32
	15	15	53.25	51.75	12.68	12.32
	20	15	53.25	51.75	12.68	12.32
	25	17	58.82	58.65	14.00	13.96
	30	19	66.31	65.55	15.79	15.61
	35	20	70.00	69.00	16.67	16.43
	40	20	71.00	69.00	16.90	16.43
	45	20	71.20	70.00	16.95	16.67
	50	20	86.40	84.72	20.57	20.17
	55	20	84.24	84.00	20.06	20.00
	60	24	84.24	84.00	20.06	20.00
	65	25	87.75	87.50	20.89	20.83
	70	26	92.04	91.26	21.91	21.73
	75	25	88.50	88.00	21.07	20.95
	80	35	98.56	98.56	23.47	23.47
	85	35	98.56	98.56	23.47	23.47
	90	25	95.00	89.50	22.62	21.31
	95	26	99.58	93.08	23.71	22.16
	100	25	95.75	89.50	22.80	21.31
	105	20	74.00	71.60	17.62	17.05
	110	20	75.00	71.60	17.86	17.05
	115	20	75.00	75.00	17.86	17.86
	120	20	75.00	75.00	17.86	17.86
	125	20	72.00	71.40	17.14	17.00
Total			1931.35	1892.48	459.85	450.59
L.S.D			NS	NS	NS	NS

NS there was no significant differences at 0.05level

Obviously, during the initial period of the growth rate, the soil moisture content recorded the higher value for depth 0-15 due to the low crop cover vegetation and root distribution development. This was for both continuous and pulse drip irrigation 44.5 and 45.3, respectively.

Table (4) Soil moisture content before irrigation time for two irrigation techniques at two soil depths

Days of irrigation	Continuous		Pulse	
	Depth 0-15	Depth 15-30	Depth 0-15	Depth 15-30
25	44.5	30.2	45.3	34.2
50	35.6	32.7	37.3	36.5
75	23.2	20.6	22.8	22.5
100	24.3	23.0	29.0	27.4
125	25.7	24.2	33.7	31.5
L.S.D	**	**	Ns	Ns
	**		**	

** there was highly significant differences at 0.05 level

Then the soil moisture content reduced with time till reached the lowest value after 75day from planting (23.2 and 22.8) as shown in Table (4). The soil moisture pattern started to increase due to the reduction of water uptake by plant during the stage of early and late season.

Similar trend for moisture content was observed at 15-30 cm soil depth, while the recorded values were lower than that at 0-15 cm soil depth. This was the general pattern for both depths (0-15 and 15-30). However fig. (5) and Table (4) illustrated that pulse irrigation resulted in higher values of soil moisture trend for either (0-15 cm) or (15-30cm) soil depths.

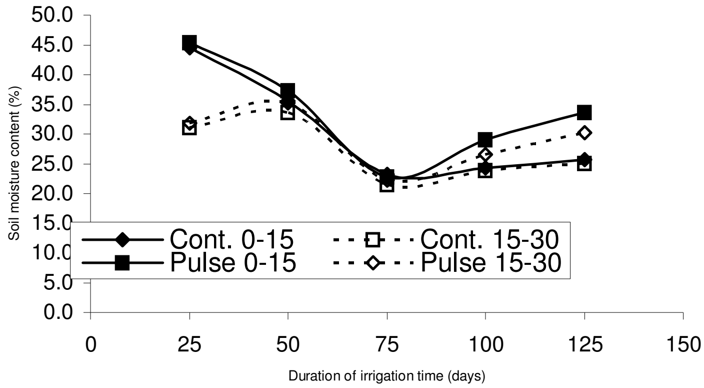
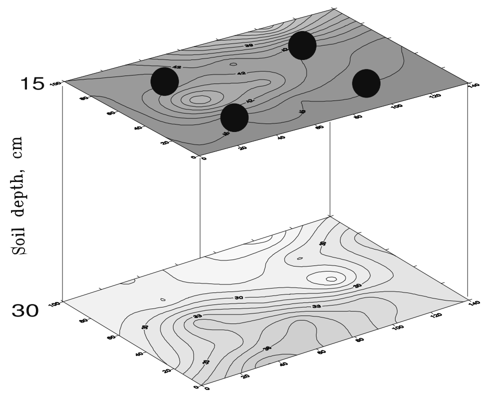


Figure (5) Soil moisture content distribution for continuous and pulse drip irrigation for two soil depths (0-15 and 15-30 cm).

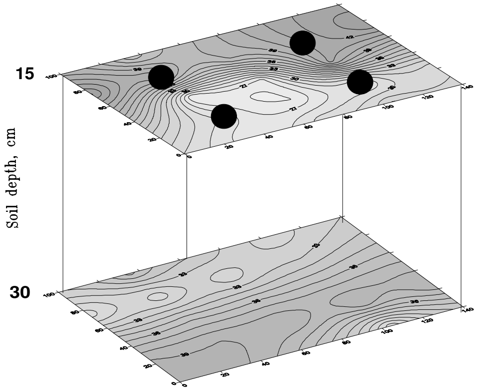
Figures (6, 7) and Table (4) illustrated that the soil water depletion ranged from 96% to 48.5% and from 84.4 to 55% at soil depths (0-15) and (15-30), respectively, for pulse drip irrigation technique. While as the value of soil moisture depletion was ranged from 94 to 49% and from 74.6 to 50.9% at soil depths (0-15) and (15-30), respectively, for continuous drip irrigation technique. Therefore, they indicated that the pulse drip irrigation resulted in higher moisture content level and better uniform moisture distribution pattern for both soil depths and through over the measurement intervals as shown in the previsions figures. The statistical analysis of L.S.D. for moisture content showed that there was no significant difference between the two soil depths for pulse flow irrigation technique, while as the L.S.D. test was highly significant for continuous drip between both soil depths. Also, the L.S.D. test was highly significant for both continuous and pulse irrigation techniques. This was in a good agreement with Pitts et al. (1991), and Mohsen (2000).

Performance of irrigation systems

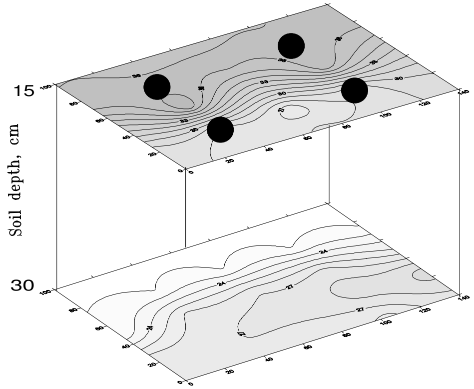
The results illustrated that each of application efficiency (Ea), emission uniformity (EU) and distribution efficiency (Ed) of the systems were maximum at the peak water requirement of plants for both drip irrigation techniques. Generally, the trend of each followed the plant growth stages. Whereas the values of Ea, Eu and Ed started slightly low and increased to the maximum values during the mid season around 75-80 days then decreased once again. This was due to adding more water than plant needed specially at the begging and at the end of plant season as shown in Fig. (8,9 and 10). These figures, also, indicated that pulse drip irrigation technique resulted in higher values through over the growth planting season for each of Ea, Eu and Ed. This indicated higher water uniformity distribution along the lateral of dripper line. The pulse technique, during the interval of the on time, allowed the water to follow through the emitters and inter the soil. While during the interval of the off time the soil moisture was allowed to be redistributed and resulted in more uniform distribution pattern. The statistical analysis indicated that the pulse drip irrigation was highly significant than that continuous drip irrigation techniqe for each of Ea, Eu and Ed. This agreed with Sharaf and Soliman (2000).



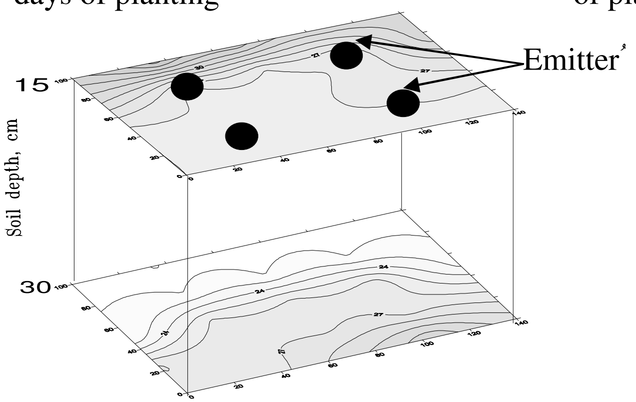
Moisture content contour after 25 days of planting



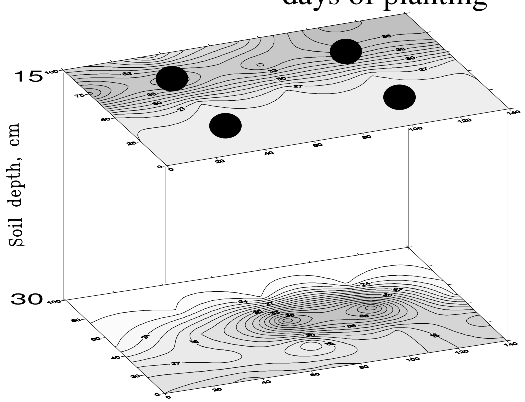
Moisture content contour after 50 days of planting



Moisture content contour after 75 days of planting

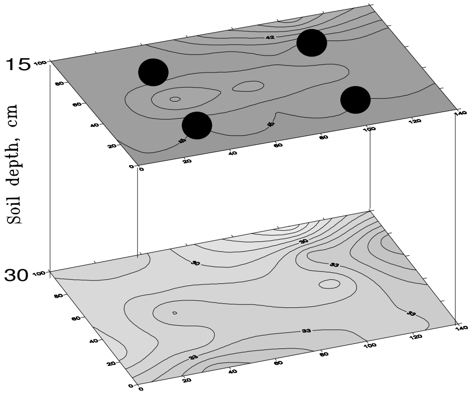


Moisture content contour after 100 days of planting

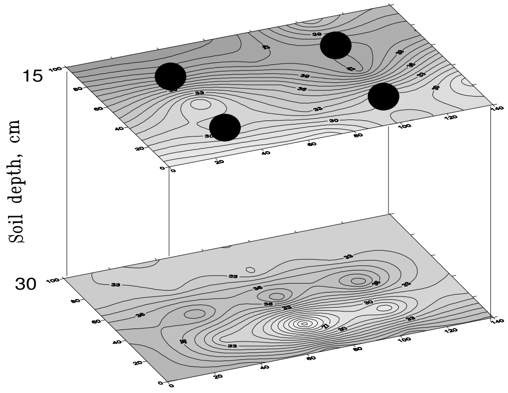


Moisture content contour after 125 days of planting

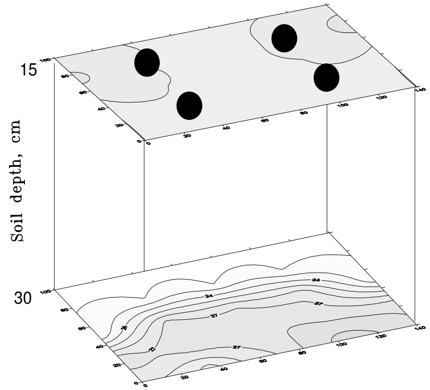
Figure (6): Contour lines representing pattern of average soil moisture distribution in tow different soil depths at(0-15 and 15-30 cm) for continuous drip irrigation during the growth season.



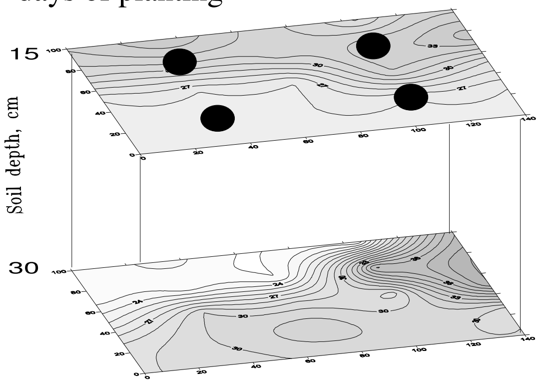
Moisture content contours after 25 days of planting



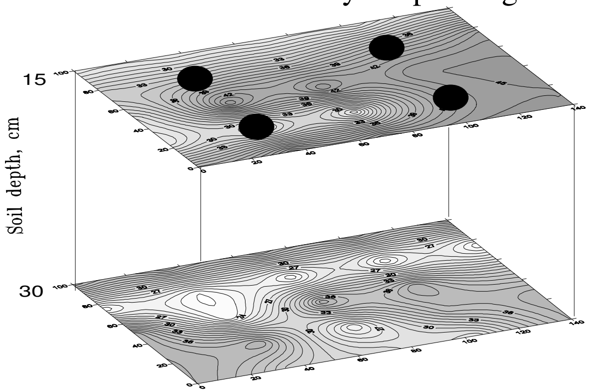
Moisture content contour after 50 days of planting



Moisture content contour after 75 days of planting



Moisture content contour after 100 days of planting



Moisture content contour after 125 days of planting

Figure (7): Contour lines representing pattern of average soil moisture distribution in tow different soil depths at (0-15 and 15-30 cm) for pulse drip irrigation during the growth season.

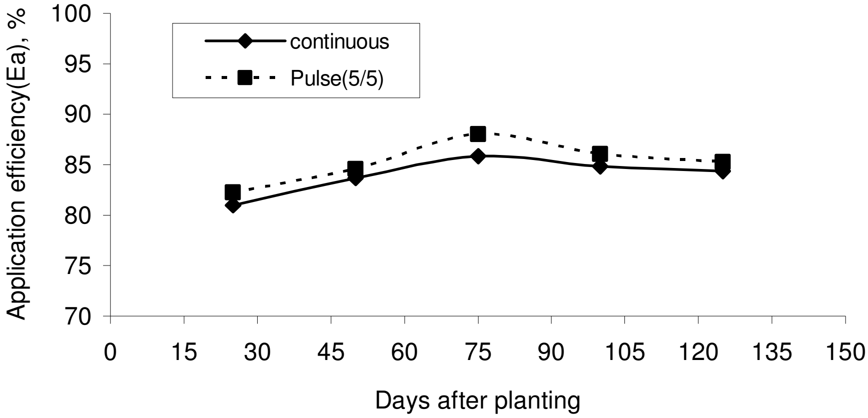


Figure.(8) Application efficiency for continuous and pulse(5/5) drip irrigation at all irrigations.

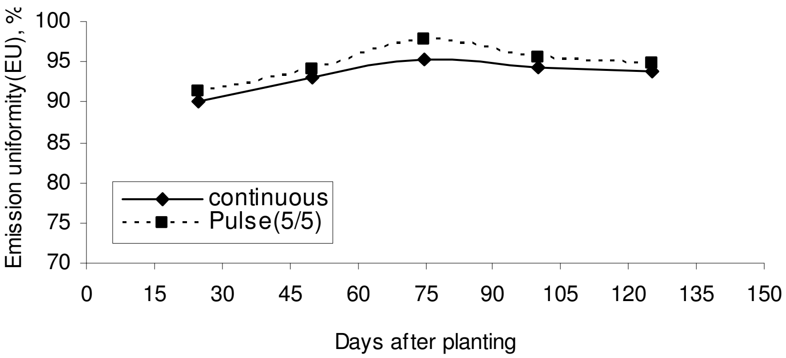


Figure.(9) Emission uniformity for continuous and pulse(5/5) drip irrigation at all irrigations.

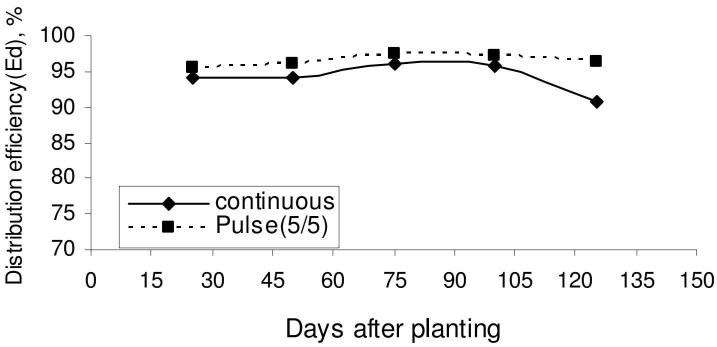


Figure.(10) Distribution efficiency for continuous and pulse(5/5) drip irrigation at all irrigations.

Effect of irrigation system on plant characteristics

The effect of pulse and continuous drip irrigation on maize yield was presented in Table (5). The obtained results indicated that pulse drip irrigation increased grain yield by 11.8% compared with continuous drip irrigation. While the total applied water was saved by 2.01% for pulse drip irrigation than that continuous drip. The advantages of pulsing are that plant growth is generally greater than with standard irrigation and lower fertilizer rates can be used (Dole, 1994).

Table (5). The Effect of irrigation systems on plant characteristics.

Irrigation System	Plant characteristics							
	Plant height cm	Leaves no/plant	Root distrib. cm^2	Ear length cm	Ear diameter cm	Grain yield kg/fed	Total Wa m^3/fed	WUE kg/m^3
Pulse	280.2	16	518.1	23.9	5.1	4443.8	1892.5	2.34
Continuous	279.4	15	501.9	21.6	4.3	3974.2	1931.4	2.06
L.S.D	NS	NS	**	**	**	**	**	**

The plant height or the number of leaves per plant was not changed significantly by drip irrigation treatments. On the other hand, the root distribution for pulse drip irrigation was higher than the continuous drip irrigation by 3.28%. The ear length was significantly changed where as the pulse drip increases the ear length by 10.65% over the ear length produced by continuous drip irrigation. This resulted in higher grain yield. Also, the results indicated that ear diameter was increased for pulse drip irrigation by 18.6% more than that was in continuous drip irrigation. Finally, table (5) illustrated that water use efficiency under pulse drip irrigation was 2.34 kg/m^3 compare with 2.06 kg/m^3 for continuous drip irrigation recording an increase of 13.59% which was highly significant as statistical analysis L.S.D. test revealed.

CONCLUSION

It can be concluded that the daily crop evapotranspiration values were varied as the climatic conditions and plant growth stages were changed. The maximum value was 243 mm at the end of flowering stage during 75-80 days after the planting date.

The volume or depth of applied water increased with the growth of the plant then declined at the end of the growth season. The seasonal irrigation water applied was found to be 1931.35 and 1892.48 m^3/fed or 459.9 and 450.6 mm/season for continuous and pulse drip irrigation, respectively.

Pulse flow recorded higher values of soil moisture trend for either (0-15 cm) or (15-30cm) soil depths. The pulse drip irrigation resulted in higher moisture content level and better uniform moisture distribution pattern for both soil depths and through over the measurement intervals.

The pulse drip irrigation was highly significant than that continuous drip irrigation techniqe for each of Ea, Eu and Ed.

The root distribution for pulse drip irrigation was higher than the continuous drip irrigation by 3.28%. The ear length was significantly changed where as the pulse drip increases the ear length by 10.65% over the ear length produced by continuous drip irrigation. Water use efficiency under pulse drip irrigation was 2.34 kg/m^3 compare with 2.06 kg/m^3 for continuous drip irrigation recording an increase of 13.55% which was highly significant as statistical analysis L.S.D. test revealed.

In the future, more pulse irrigation research is needed to develop fertilizer recommendations and to investigate media-fertilizer interactions relevant to crop production.

REFERENCES

Aablezah, A. A. (2001). Methods for comparing the breeding potentiality of new maize populations. Ph. D. Thesis. Crop Science Dept., Fac. of Ag. Alexandria Univ., Egypt.

Assouline, S.; S. Cohen; D. Meerbach; T. Harodi, and M. Rosner. 2002. Microdrip Irrigation of Field Crops: Effect on Yield, Water Uptake, and Drainage in Sweet Corn. Soil Sci. Soc. Am. J. 66:228–235.

Beeson, R.C., Jr. 1992. Restricting overhead irrigation to dawn limits growth in container-grown ornamentals. Hort. Science 27:996-999.

Clothier B. E. and Green S. R. 1994. Rootzone processes and the efficient use of irrigation water. Agricultural Water Management 25: 1-12.

Coelho E. F and D. Or. 1996. A parametric model for two-dimensional water uptake by corn roots under drip irrigation. Soil Science. American Journal 60: 1039-1049.

Dioudis, P.; M. Sakellariou-Makrandonaki; G. Terzides; N. Maslaris, and G. Nousios. 2003. Different drip irrigation arrangements in sugar beet cultivation . In Proc 9 th National Conf. of the Hellenic Hydrotechnical Association , 2-5 April , Thessaloniki, Greece, pp. 159-166, (in Greek, English abstract).

Dole, J. M. 1993. Water and fertilizer rate reduction. Greenhouse Grower 11(13):24-28.

Dole, J. M. 1994. Comparing poinsettia irrigation methods. The Poinsettia 10:4-9.

El-Absawy, E. A. (1990). Comparison between some experimental genetic designs in two populations of maize. Ph. D. Thesis. Crop Science Dept., Fac. of Ag. Moshtohor, Zagazig Univ., Egypt.

El-Gindy, A.M.; H.N. Abdel-Mageed; M.A. El-Adl and E.M.K. Mohamed. 2001a. Management of pressurize irrigated faba bean in sandy soil. Misr J. Ag. Eng., Vol.18 (1): 29-44.

El-Gindy, A.M.; H.N. Abdel-Mageed; M.A. El-Adl and E.M.K. Mohamed. 2001b. Effect of irrigation treatments and soil conditioners on maize production in sandy soil. Misr J. Ag. Eng., Vol.18 (1): 59-74.

El-Sayed, H. M. (1987). Effect of half-sib family select ion on the genetic Variance within a maize population. M. Sc. Thesis. Crop Science Dept., Fac. of Ag. Alexandria Univ., Egypt.

El-Wakiel, M. M. (1993). Genetic analysis of maize maturi characters and their association with yield. M. Sc. Thesis. Crop Science Dept., Fac. of Ag. Alexandria Univ., Egypt.

Freeman, B.M.; J. Blackwell, and K.V. Garzoli. 1976. Irrigation frequency and total water application with trickle and furrow systems. Agricultural Water Management 1: 21-31.

James, L. G. (1988). Principles of farm irrigation system design. John Willey & sons. Inc., Washington State University, pp. 73, 152-153, 350-351.

Kenig, E.; E. Mor and G. Oron. 1995. Pulsating microirrigation for optimal water use and control in the soil. In Proc. 5 th International Microirrigation Congress , 615-620. F.R. Lamm, ed. St. Joseph, Mich.: ASAE.

Khalifa, M. R.; M.A. Koriem ; S.A. Gahin and S.A. Abdl El- Hafez. 1988. Water consumptive use of Okra and salt movment in soil under plastic tunnels in north Delta J. Agric. Res. Tanta Univ. 14(3): 1744-1759.

Meshkat, M.; R. C. Warner and S. R. Workman. 2000. Evaporation reduction potential in an undisturbed soil irrigated with surface drip and sand tube irrigation. Transactions of the ASAE 43(1): 79-86.

Mohsen,A. El-Adl. 2000. Effect of irrigation and fertilization methodson pea production. Misr J. Ag. Eng., Vol.17(3): 450-468.

Oron, G. 1981. Simulation of water flow in the soil under sub-surface trickle irrigation with water uptake by roots. Agric. Water Manage . 3:179-193.

Panagiotis V. and M. S. Makrantonaki .2005. Intermittent Water Application through Surface and Subsurface Drip Irrigation. ASAE Annual Inter. Written Meeting Tampa Convention Center, Tampa, Florida. Paper No: 052216,17-20 July 2005

Pitts D. J.; Y. J. Tsai; T.A. Obreza, and D. L. Myhre. 1991. Flooding and Drip irrigation Frequency effects on Tomatoes in South Florida. Transactions of the ASAE 34(3): 865-870.

Segal E.; A Ben-Gal and U Shani. 2000. Water availability and yield response to high-frequency micro-irrigation in sunflowers. 6 th International Micro-irrigation Congress ‘Micro-irrigation Technology for developing agriculture’ , conference papers. South Africa, 22-27 October 2000.

Sharaf, G. and A. Soliman. 2000. Water requirements of tomato and pepper crops under drip irrigation. . Misr J. Ag. Eng., Vol.17 (1): 148-158.

Sharmasarkar F. C.; S. Sharmasarkar; S. D. Miller; G. F. Vance and R. Zhang. 2001. Assessment of drip irrigation and flood irrigation on water and fertilizer use efficiencies for sugarbeets. Agricultural Water Management 46: 241-251.

Soliman, A. A. 1999. Study on water requirements of two vegetable crops unpublished M.Sc. Th. Dept. Soil and Agric. Chem. Faculty of Agric (Saba Basha) , Alex. U.: 90 pp.

Yaohu K.; W. Feng-Xin and L. Shi-Ping. 2002. Effects of Drip Irrigation Frequency on Soil Wetting Pattern and Root Distribution of Potato in North China Plain. ASAE Ann. Inter. Meeting/CIGR 15th World Congress, Hyatt Regency Chicago, Chicago, Illinois, USA. Paper No: 022282.

تأثير الرى بالتنقيط النبضى على التوزيع الرطوبى وإنتاجية محصول الذرة فى الأراضى الطينية

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نظام الرى بالتنقيط النبضى أو المتقطع من احدث أساليب الرى بالتنقيط حيث تضاف المياه على فترات زمنية فى دورات متتالية (من تشغيل وايقاف) حتى يتم الوصول للاحتياجات المائية للنبات. لذا يعتبر من أهم أساليب الرى بالتنقيط فى جدولة الرى.

أجريت التجارب على تربة طينية فى مركز ميكنة الأرز بميت الديبة بمحافظة كفر الشيخ خلال الموسم ٢٠٠٤/٢٠٠٥. وقد هدفت تلك الدراسة إلى الوصول و تقييم تأثير الرى بالتنقيط النبضى (٥ دقيقه فتح/٥ دقيقة قفل) على استنفاذ و أعادة توزيع الرطوبة الأرضية ومدى تأثير ذلك على كل من كفاءة الإضافة و التوزيع و على بعض خصائص المحصول وكفاءة استخدام المياه مقارنة بالتنقيط المستمر. قسم الحقل إلى ثلاثة قطع تجربيه كل منها قسم إلى جزئيين كل جزء شمل أحدى المعاملات سواء كان رى تقليدى (مستمر) أو رى بالتنقيط النبضى حيث كل جزء أشتمل على ٨ خطوط المسافة بينها ١م وبطول ٥٠ م على جانبى خط الأنابيب التحت رئيسى. وكان التصميم الأحصائى يتبع القطع المنشقة الكاملة. أخذت العينات لتقدير خواص التربة من أربع أعماق المسافة بينها ١٥ سم. كما قيس المحتوى الرطوبى قبل الرى حول المنقطات المختارة فى ثلاث أماكن ٢٥ موضع. تم أيضا تقدير كل من طول وقطر وعدد الكيزان و توزيع الجذور .

أظهرت النتائج ان اكبر احتياج مائى كان ٦,٩٦ مم/يوم خلال موسم خلال شهر اغسطس النمو. وكانت كمية المياه الموسمية المضافة حوالى ٤٥٩,٩ و ٤٥٠,٦ مم/موسم لكل من الرى المستمر و النبضى على الترتيب. وقد تسبب الرى النبضى فى زيادة قيم المحتوى الرطوبى عند كل من الأعماق (صفر-١٥) أو (١٥-٣٠ سم). كما أن قيم المحتوى الرطوبى لم تسجل فروق معنوية بين هذان العمقان بالنسبة للرى بالتنقيط النبضى بخلاف الحال للرى المستمر. أيضا الرى النبضى أعطى قيم عالية لكل من كفاءة الإضافة Ea و كفاءة الانبعاث للمياه Eu وكفاءة التوزيع Ed والتى أوضح أن هناك انتظامية فى التوزيع على طول خط التنقيط . أيضا حدث زيادة فى المحصول بنسبة ١١,٨% عن الرى المستمر مع توفير كمية مياه حوالى ٢,٠١% بواسطة الرى النبضى عن الرى المستمر مما نتج عنه زيادة فى كفاءة استخدام المياه بنسبة ٢,٣٤% للرى النبضى مقارنة بقيمة ٢,٠٦% للرى المستمر مسجلا زيادة مقدارها ١٣,٥٩% للرى النبضى عن الرى المستمر.

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