Maximizing SoilArea, Water and Nitrogen-use Efficiency Key in Maize Production and Weed Management

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Abstract: A study was conducted during 2013 and 2014 growing seasons at the Research and Experimental Station, Faculty of Agriculture, Ain Shams University at Shalakan, Qualioubia Governorate, Egypt, to evaluate the effect of two irrigation systems;drip and modified surface irrigation (gated pipe) and twoplanting patterns;(i) solemaize 30 (planting maize on one side of the ridge with 30 cm-hill distance and one plant hill-1, recommended practice); (ii) sole maize 15 (planting maize on one side of the ridge with 15 cm-hill distance and one plant hill-1 with escaping a ridge between each two sown ridges, ridge maize: ridge non-sown). Under the two cropping patterns, the same maize plant density was maintained (about 47,620 plants fed-1).The maize (Zea mays L.) fertilized under three different N rates (0, 90 and 120 kg/fed).

The weed biomass differed significantly according to the irrigation system and the planting pattern. The Sole Maize 15 showed the lowest weed biomass × both of drip and gated pipe irrigation system interaction comparing to the sole maize 30 pattern being 17.55 and 69.1 g/ m2, respectively.

Data of drip irrigation showed high significant effect on measured parameter comparing to the modified surface (gated pipe) irrigation system under the two planting types. Drip irrigation system showed high significant effect on maize leaves greenness and grain yield/ fed when N applied at the rate of 90 and 120 kg/fed compared with the gated pipe irrigation system, being (50.43 and 52.26 value) or (4.88 and 4.9 t/fed), respectively.The leaves greenness, 100 grain weight and maize grain yield /fed of the sole maize-30 planting type showed no significant difference than the sole maize-15 plant being (48.88 and 47.86 value), (25.21 and 24.88 g) and (4.4 and 4.25 t/fed.), respectively.

Drip irrigation system and the N rate of 90 and 120 kg/fed showed the best significant effect on maize leaves greenness (SPAD value), 100 maize grain weigh and the grain yield/fed., comparing to the gated pipe irrigation system, while there was no significant differences between the two planting types. Sole Maize-30 planting type under the drip irrigation system recorded the highest maize leaves greenness SPAD (50.66 and 53.21 value), 100 grain weight (26.91 and 26.56 g) and the grain yield/ fed (5.06 and 5.08 t) under the N rate of 90 and 120 kg/fed, respectively. At the same time, there was no significant differences between the effect of N rate of 90 and 120 kg/fed.

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Key word: *Irrigation system, planting pattern, weed, maize yield, leaves greenness, Nitrogen fertilizer*

1. Introduction:

Globally, fertilizer nitrogen applications are approximately 80 million tons, with half being applied in developing countries **(FAO, 1990)**. It has been estimated that by the year 2025 the consumption of nitrogen fertilizer will increase from 60 to 90 %, with two-thirds of this being applied in the developing world **(Galloway *et al.*, 1995)**. Increasing nitrogen levels from zero, 90 to 120 kg N/fedsignificantly increased plant height,ear length compared with the untreated check. However, there was no. significant differences between 90 and 120 kg/fed in the first season,while a significant increase was noticed with each increment in N rate in the second season. In addition, N rate influenced significantly on ear diameter and number of rows/ear, and the grain yield by 122 and 168% in the first season and 121 and 133 in the second season, respectively compared to the control level (**Nofal *et al*., 2005)**.In addition, N improved early season corn growth, which improved the competitive ability of corn against weeds and led to significant increase in grain yield (**Najafi and Ghadiri, 2012)**.Nitrogen at the levels of 0, 110, 130, and 150 kg N/fed, had pronounced effect on grain yield and its attributes. Results indicated that 150 kg N/fed gave the highest ear length (22.97cm), number of grains/ear (340.63), 1000-grain weight (314.56g), grain yield (5.83 t/fed), biological yield (13.53 t/fed) and harvest index (42.99%), (**Khatun *et al*., 2012)**.

In agricultural practice, the sufficient and balanced application of irrigation water and nutrients are important methodology to obtain maximum yield per unit area. **Steele *et al.*, (2000)** demonstrated that irrigation water management can be used to optimize corn yield, which can decrease the amount of $N0_3$-N leached by improving N uptake by corn. On the other hand, excessive application of irrigation water and nutrients result in some serious problems **(Türkmen *et al.*, 2004)**. Maize yield varied significantly (P<0.05) under different irrigation scheduling. The irrigation Interval recorded effective practice to produce a higher fodder yield in maize and the farmers may assume this treatment to acquire high fodder production from maize **(Sultan *et al.*, 2015)**.

Minimizing nutrient leaching can be achieved by matching water and fertilizer application rates to plant uptake. Soil water potential and water content in the vicinity of active roots generally controls the rate of water and nutrient uptake by plants. Drip irrigation is an acknowledged technique for achieving high efficiencies in water use of crops by wetting only a limited part of the root zone **(Bresler *et al.*, 1982)**.

Also, Drip irrigation systems allow the delivery of N to the area of maximum crop uptake, and match the rate of application to the plants' requirements**(Coelho and Or, 1996)**. Several authors have shown that efficiencies might be improved without affecting crop yield by decreasing the amount of water leached from the root zone through more optimal drip irrigation management **(Darusman *et al.*, 1997)**.

The aim of this study was to assess the effect of different planting pattern, different irrigation system and different nitrogen dose on weeds and maize production.

2. Materials and Methods:

Experimental Site:

The experiments were conducted during 2011 and 2012 growing seasons at the Research and Experimental Station,Faculty of Agriculture, AinShamsUniversity at Shalakan, Kalubia Governorate, Egypt. The soil represents the old alluvial soil of the Nile Delta thatwas clay loam, with approximately 1.15 % organic matter, 0.14 % total nitrogen and pH of 7.52. The preceding crop was wheat in both seasons. The experiment was established with splitplots design using three replicates, where irrigation systems were arranged in the main plots andcropping patterns were allocated in the sub plots.

Experimental Procedure

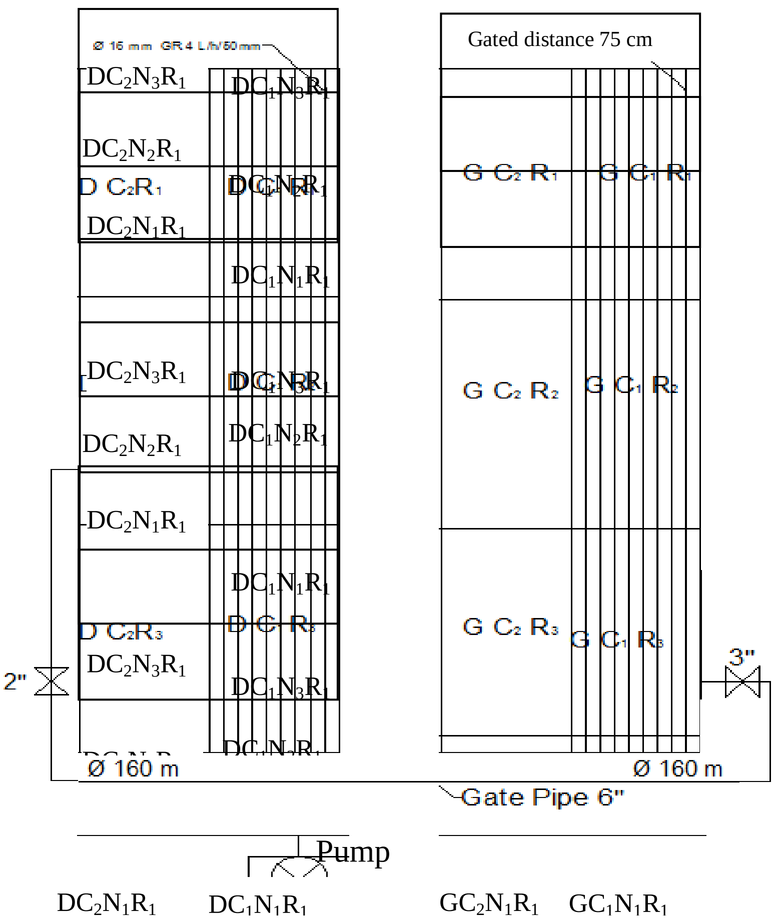
The experiment was established within split plots in a randomized complete block design, using three replicates, where irrigation systems were arranged in the main plots and cropping patterns were allocated in the sub-plots. The total experimental area was 2998.8 m2, both the drip and the modified surface irrigation (gated pipe) using plots occupied 1499.4 m2 (35.7 m width and42 m long). Each of the tested irrigation system was installed in individual five strips; each of them represented one of the cropping patterns. Each strip was divided by plastic strips into three sub-plots (experimental units). Each experimental unit area was 88.2 m2,

involving 9 furrows (14 m length and 0.7 m apart with 15 cm depth).

In gated pipe irrigation, a drip line from polyethylene was used with 16 mm diameter, and dripper discharge was 4 L fed at 1.0 bar operating pressure. Standard drippers were spaced 50 cm apart along 42 m lateral. The pipes were connected with the main line through 2" Ball valve to joint submarine line 50 mm diameter. Modified gated pipe irrigation was designed using gated pipes equipped with 6" aluminum pipes, 6 meter long with holes at 70 cm spacing. The pipes were connected with the main line, through 3" Ball valve (flow regulator) to joint flange 6" to the end for connecting the gated pipe line. Every furrow was irrigated by a single lateral line in the drip irrigation plots, and by one gate in the modified gated pipe irrigation.

Plant seeds were sownat the 1st and the 3rd of June 2011 and 2012, respectively. Maize grains *(Zea mays*, variety single hybrid 10)were drilled simultaneously at the rate of 24 kgfed^{-1}. At 17 days after sowing (DAS), plants were hoed once and thinned to secure one plant hill^{-1}. Maizeplanting pattern are illustrated as follow: (i) sole Maize-30 (planting maize on one side of the ridge with 30 cm^{-hill} distance and one plant hill^{-1}, recommended practice); (ii) sole Maize-15 (planting maize on one side of the ridge with 15 cm-hill distance and one plant hill-1 with escaping a ridge between each two sown ridges, ridge maize: ridge non-sown). Under the two cropping patterns, the same plant density of maize was maintained (about 47,620 plants fed^{-1}) (figs. 1 and 2).

Nitrogen fertilizer at therate of 0, 90, and 120 unit N fed^{-1} was applied to maize plants in the form of urea (46%), in two half portions, at 20 and 35 DAS. Irrigation of maize was ended at three weeks before harvest. All other recommended cultural practices, such as phosphorus fertilizer and insect control were adopted throughout the two seasons.



D: Drip irrigation
G: Gated pipe
C_1, C_2:Sole-maize30 cm and sole- maize 15 cm
N_1, N_2andN_3: Nitrogen concentrations
R_1, R_2, R_3: Replicates

Fig. 1. Irrigation systems, nitrogen concentrations and intercropping pattern assigned to main plots and sub-plots, respectively.

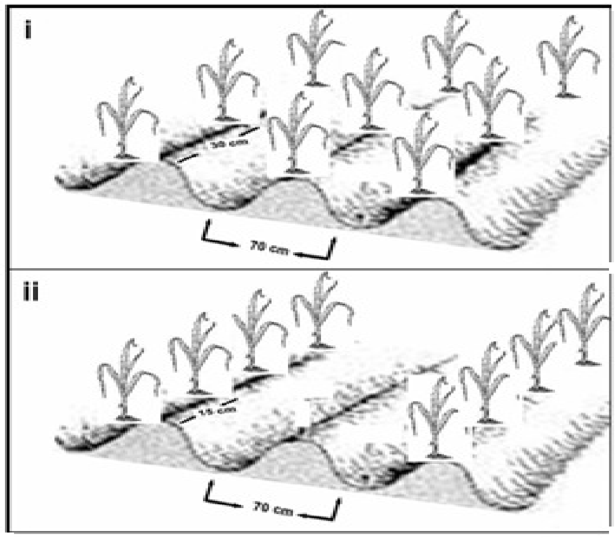


Fig. 2. Illustration of different patterns of maize (M) (i, sole maize-30 cm; ii and sole maize-15 cm).

Sampling and assessments

Weeds:During the study, the dominant annual broad leaf weeds were common purslane (Portulaca oleracea, L.) and malta jute (Chorchorus olitorius L.); while the major grasses were jungle rice (Echinochloa colonum (L.) Link.), and crowfoot grass (Dactyloctenium aegyptium (L.) P. Beauv.). From two fixed quadrates (0.5 m2) in each plot, weeds were pulled out manually at 80 DAS. Weed samples were bulked and oven-dried for 24 hours at 70 Co to a constant mass to estimate total weed biomass expressed in dry weight.

Maize:The total chlorophyll content (SPAD value) in the fourth leaf of maize was determined at 80 DAS using chlorophyll meter (SPAD–502) according to Soil Plant Analysis Department Section, Minolta Camera Co., Osaka, Japan as reported by **Minolta (1989)**. At harvest stage (115 DAS), ten plants were randomly chosen from each plot to estimate ear length, kernels number/ear row and weight of 100 kernels. Finally, maize grain yield fed-1was recorded.

RESULTS AND DISCUSSION

I- Effect of irrigation system andcropping types on weed biomass andmaize ear characteristics:

Individual effect: Data presented in Table 1revealed that maize ear length and kernels number/ ear row showed no significant effect by irrigation system and cropping pattern. The highest value of ear length and kernels number/ ear rowwas recorded when drip irrigation system was followed being (19.43 cm and 44.55 no) and Sole maize-30 planting type being 19.51 cm and 43.83 no, respectively.

As shown in Table 1, weeds biomass was significantly differed according to the irrigation system and cropping pattern. The data revealed that drip irrigation and Sole Maize 15 reduced weeds biomass significantly comparing to the other treatments being 32.27 and 43.32 g/m2, respectively.

1. Interaction effect of irrigation system × planting type:

Data presented in Table 2 revealed that interaction between irrigation system x planting type showed no significant responseon ear length. The kernels number/ear row, showed no effect by drip irrigation × the two planting pattern interaction, while gated pipe irrigation decreased it significantly in both of sole maize 30 and 15 planting pattern interaction being 42.43 and 41.53 no./ ear row, respectively.

The weed biomass differed significantly according to the irrigation system and the planting pattern. The Sole Maize 15showed the lowest weed biomass × both of drip and gated pipe irrigation interaction comparing to the sole maize 30 pattern being 17.55 and 69.1 g/ m2, respectively.

Table1. Weed biomass, and maize ear characteristics as influenced by irrigation system and planting type.

Variable	Weed biomass ($g.m^{-2}$)	Ear length (cm)	Kernels $number.Ear^{-1}row$
Irrigation system			
Drip	32.27 b	19.43 a	44.55 a
Gated pipe irrigation	68.81 a	18.87 a	42.01 a
cropping pattern			
Sole Maize-30	52.30 a	19.51 a	43.83 a
Sole Maize-15	43.32 b	18.93 a	43.08 a

Note: Means of the same category followed by different letters are significantly different from one another using LSD test at 5% level of probability

Table2. Weed biomass and maize ears characteristics as influenced by the interaction between irrigation system and planting type.

Variable		Weed biomass ($g.m^{-2}$)	Ear length (cm)	Kernels $number.Ear^{-1}row$
Drip	Sole Maize-30	22.47 c	19.98 a	45.23 a
	Sole Maize-15	17.55 d	19.33 a	44.63 a
Gated pipe irrigation	Sole Maize-30	82.12 a	19.05 a	42.43 ab
	Sole Maize-15	69.10 b	18.53 a	41.53 b

Note: Means of the same category followed by different letters are significantly different from one another using LSD test at 5% level of probability

The decreasing of growing weeds biomass may be attributed to the growing patternwhich could help to reduce the level of weed-infestation (Corre-Hellou et al., 2011). Hauggaard-Nielsen et al. (2001)who found that there was increased efficiency of cropping for utilization of environmental resources for plant growth; and better competitive ability towards weeds as compared to single crops. The apparent increased competitiveness of cropping systems makes them potentially useful for adoption into low input farming systems in which options for chemical weed control are reduced or nonexistent (Szumigalski and Van Acker, 2005).

II- Effect of irrigation system and planting type on leaves greenness maize yield

1. **<u>Individual effect:</u>**

Data (Table 3) showed that the leaf greenness of maize leaves was significantly affected by irrigation system and the N rate/fed. The N rate of 120 kg/fed and the drip irrigation treatment showed the highest SPAD value recording 49.87 and 48.37, respectively, comparing to the other treatments. Conversely, the planting type showed no significant effect on maize leaves greenness.

The weight of 100 grain was affected significantly by all treatments. The drip irrigation system, sole maize-30 planting type and N rate of 120 kg/fed showed the highest effect compared with the other treatments being; 25.05, 24.04 and 25.14 g, respectively. At the same time, there was no significant effect was observed between N rate (90 and 120 kg/fed) on 100 grain weight.

Moreover, the grain yield/fed of maize wassignificantly affected by the applied irrigation system.The highest significant effect on grain weight/fed was observed in the treatment of drip irrigation(4.33 t/fed). Although the sole maize-30 planting typeand N rate of 120 kg/fed showed the high grain quantity/fed (3.84 and 4.17 t/fed respectively).There were no significant differences were shown comparing to the planting patterns and/or the rate of 90 kg/fed.

Table 3. The effect of irrigation system, planting type and N rate on leaf greenness, 100grain weight and grain yield of corn.

Variable	Leaf greenness (SPAD value)	100 grain weight (g)	Grain yield (t. fed^{-1})
Irrigation system			
Drip	48.37a	25.05a	4.33a
Gated pipe irrigation	45.17b	22.03b	3.13b
Planting type			
Sole Maize -30	47.28a	24.04a	3.84a
Sole Maize -15	46.26a	22.67b	3.61a
N rate (kg fed)			
0	42.05c	20.86b	2.90b
90	48.40b	24.61a	4.11a
120	49.87a	25.14a	4.17a

Note: Means of the same category followed by different letters are significantly different from one another using LSD test at 5% level of probability.

2. Effect of irrigation system× planting type× N rate interaction:

Data presented in Table 4, Figs 3 and 4, revealed that drip irrigation showed high significant effect on the measured parameterscomparing to the gated pipe irrigation system under the two planting types.The leaves greenness, 100 grain weight and maize grain yield /fed of the solemaize-30 showed no significant difference than the sole maize-15 plant being 48.88 and 47.86 values, 25.21 and 24.88 g and 4.4 and 4.25 t/fed, respectively. Drip irrigation system showed high significant effect on maize leavesgreenness and grain yield/ fed when N applied at the rate of 90 and 120 kg/fed compared with the gated pipe irrigation system, (50.43 and 52.26 value) or (4.88 and 4.9 t/fed), respectively, while there were no significant differences between the two applied N rates. On the other hand, sole maize-30 planting type revealed the highest significant 100 grain weight and grain yield/fed-1 under N rate of 90 kg/fed recording 25.95g and 4.32 t/fed, respectively. Also, there were no significant differences in maize leaves greenness, and the grain yield/fed between the two planting distance when N was applied at the rate of 90 kg/fed (48.58 and 48.21 value) or (4.32 and 3.90 t/fed) and 120 kg/fed, (50.8 and 48.95 value), or (4.25 and 4.1 t/fed), respectively.

Data in Table 5illustrated that all studied traits significantly responded to the interaction between irrigation system x planting pattern. Drip irrigation system and N rate of 90 and 120 kg/fed showed the best significant effect on maize leaves greenness (SPAD value), 100 maize grain weigh and the grain yield/fed., comparing to the gated pipe irrigation system, while there was no significant differences between the two planting types. Sole Maize-30 planting type under the drip irrigation system recorded the highest maize leaves greenness SPAD (50.66 and 53.21 value), 100 grain weight (26.91 and 26.56 g) and the grain yield/ fed (5.06 and 5.08 t/fed.) under the N rate of 90 and 120 kg/fed, respectively. At the same time, there was no significant differences between the effect of N rate of 90 and 120 kg/fed.

According to the above mentioned data, it could be concluded that the drip irrigation system showed the lowest weed biomass weight and the highest maize leaves greenness, grain weight and grain yield/fed when maize was planted at the distance of 30 and/or 15 cmunder the N rate of 90 kg/fed, which led to saving the

Table 4. The effect of the first order interaction between each of irrigation system, planting type and N rate on leaf greenness, 100grain weight and grain yield of corn.

Variable		Leaf greenness	100grain weight (g)	Grain yield (t. fed^{-1})
Irrigation system x ***Planting type***				
Drip	Sole Maize -30	48.88a	25.21a	4.40a
	Sole Maize -15	47.86ab	24.88a	4.25a
Gated pipe irrigation	Sole Maize -30	45.68ab	23.60a	3.28b
	Sole Maize -15	44.67b	20.46b	2.97b
Irrigation system x N rate (kg fed^{-1})				
Drip	0	42.42c	21.95c	3.21b
	90	50.43a	26.67a	4.88a
	120	52.26a	26.51b	4.90a
Gated pipe irrigation	0	41.67c	19.78d	2.59c
	90	46.36b	22.55c	3.34b
	120	47.49b	23.76c	3.45b
Planting type x N rate (kg fed^{-1})				
Sole Maize -30	0	42.46c	21.63cd	2.96b
	90	48.58b	25.95a	4.32a
	120	50.80a	25.63a	4.25a
Sole Maize -15	0	41.63c	20.09d	2.84b
	90	48.21b	23.27bc	3.90a
	120	48.95ab	24.65ab	4.10a

Note: Means of the same category followed by different letters are significantly different from one another using LSD test at 5% level of probability.

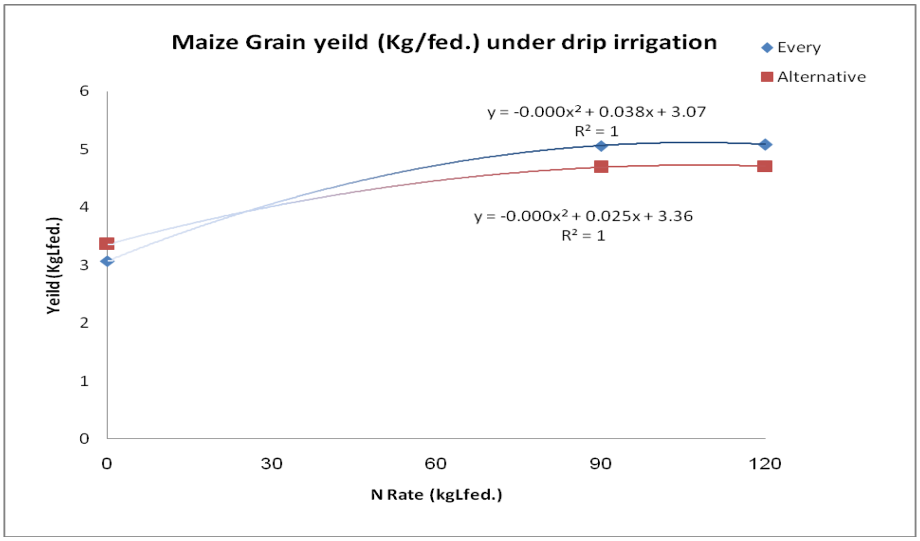


Fig. 3. Effect of drip irrigation on Maize grain yield.

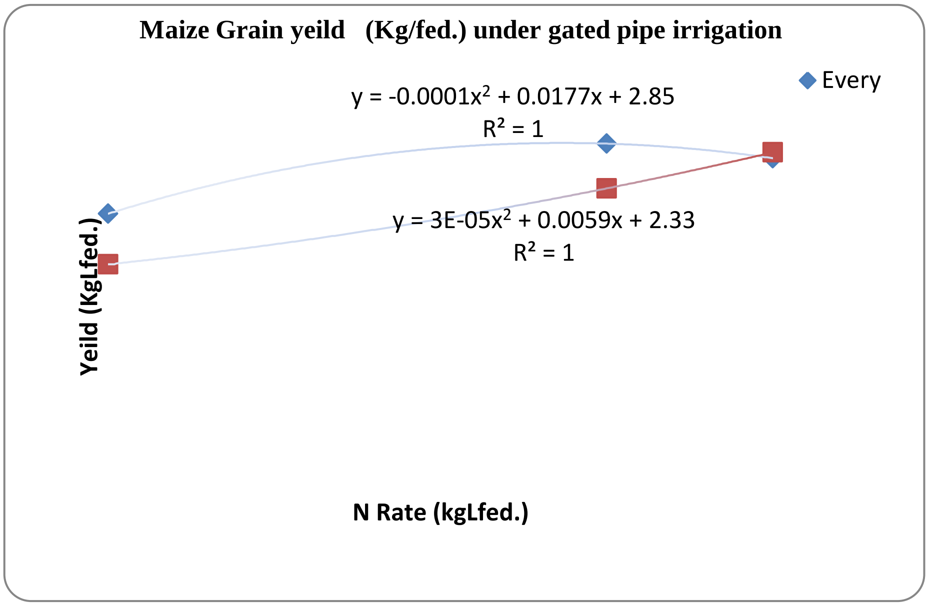


Fig. 4. Effect of gated pipe irrigation system on Maize grain yield.

Table 5. The effect of the second order interaction among irrigation system, planting type and N rate on Maize yield.

Variable		***N rate (kg fed^{-1})***		
		0	**90**	**120**
Irrigation system* x *planting type				
			Leaf greenness	
Drip	Sole Maize -30	42.78c	50.66a	53.21a
	Sole Maize -15	42.06c	50.20a	51.31a
Gated pipe irrigation	Sole Maize -30	42.15c	46.50b	48.40b
	Sole Maize -15	41.20c	46.23b	46.58b
			100-grain weight (g)	
Drip	Sole Maize -30	22.16bc	26.91a	26.56a
	Sole Maize -15	21.75bc	26.43a	26.46a
Gated pipe irrigation	Sole Maize -30	21.10cd	25.00ab	24.70ab
	Sole Maize -15	18.43d	20.11cd	22.83bc
			Grain yield (t fed^{-1})	
Drip	Sole Maize -30	3.07bc	5.06a	5.08a
	Sole Maize -15	3.36b	4.69a	4.71a
Gated pipe irrigation	Sole Maize -30	2.85bc	3.57b	3.42b
	Sole Maize -15	2.33c	3.11bc	3.48b

Note: Means of the same category followed by different letters are significantly different from one another using LSD test at 5% level of probability.

required water and the N quantity are needed for maize planting

The better maize grain characteristics with drip irrigation may be due to the fact that such system can supply limited quantities of water to an immediate area surrounding the crop root zone with balanced soil moisture in the active root zone, in addition to lowering water leaching. Moreover, This could attributed to the weeds associated with maize irrigated with gated pipe irrigation were more than those irrigated with the drip irrigation, which could remove 74.7-306.1, 90-322.2 and 100.8-317.7% of N, P and K, respectively, in weedy plots more than in weeded treatments (El-Metwally et al., 2009). Also, the presence of weeds in crops causes yield losses due to competition and allelopathic effects. In Egypt, the reduction in maize yield due to weed competition is between 34 and 90% (Abd EL-Samad et al. 2012; Saudy, 2013). Decreasing the amount of water that leaches beneath the root zone in trickle irrigated maize caused improvement in yield (Payero et al., 2008; El- Hendawy and Schmidhalter, 2010). Also, it could be attribute to the cropping effect of maize and legumes which considerably reduces the weed density compared with the monocropping maize by decreasing available light for weeds (Dimitrios et al., 2010). Also,Altier and Liebman (1986) pointed out that cropping has a potential to suppress weeds and it offers the possibility of capturing a greater share of available resources than single crop. Cropping system could increases light interception by the weakly competitive component and can, therefore, shorten the critical period for weed control and reduces growth and fecundity of late emerging weeds (Baumann et al., 2000).

Moreover, growing distance couldhelp to reduce the level of weed-infestation (Corre-Hellou et al., 2011). The apparent increased competitiveness of cropping systems makes them potentially useful for adoption into low input farming systems in which options for chemical weed control are reduced or nonexistent (Szumigalski and Van Acker, 2005). The increment in weight of 100 grains of maize recorded when maize was grown at the distance 30 or 15 cmmight be due to the less competition imposed by either plants itself or by cowpea, i.e., intra- and inter-specific competition. Moreover, several authors have shown that yield of trickle irrigated crops could be improved under limited water applications by decreasing the amount of water that leaches beneath the root zone (Viswanatha et al., 2002; Payero et al., 2008; El-Hendawy and Schmidhalter, 2010).

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الملخص العربى

تعظيم الأستفادة من وحدة مساحة الارض والمياه والتسميد النيتروجينى المستخدم لأنتاج الذرة وإدارة الحشائش

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أجريت الدراسة في محطة الأبحاث والتجارب، كلية الزراعة، جامعة عين شمس في شلقان، محافظةالقليوبية، مصر، لتقييم تأثير نظامين للري (الري بالتنقيط والري السطحى المطور (الانابيب المبوبة)، وطريقتينللزراعة لمحصول الذرة. كانت الطريقة الاولى (زراعة الذرة على مسافة ٣٠ سمبين النباتات، وهى الموصى بها)؛ والاخرى الزراعة على خط وترك آخر مع الأحتفاظ بنفس عدد النباتات المنزرعة بوحدة المساحة (حوالي ٤٧٦٢٠ نبات للفدان)، بمسافة ١٥ سمبين النبات والآخر تحت معدلات تسميد للنيتروجين (٠، ٩٠ و ١٢٠ كجم / فدان).

أظهرت النتائج اختلاف الكتلة الحيوية للحشائش أختلافاً معنوياً تبعاً لنظام الرى المستخدم وطريقة الزراعة. حيث وجد أن نظام الزراعة على مسافة ١٥سم أظهر أقل كتلة حيوية للحشائش بكلا نظامى الزراعة المستخدمان، التنقيط، و الرى السطحى المطور مقارنة بنظام الزراعة على مسافة ٣٠سم مسجلاً ١٧,٥٥، ٦٩,١ جم/م^{2}.

أظهرت نتائج الرى بالتنقيط تأثيراً معنوياً على جميع القياسات مقارنة بنظام الرى السطحى المطور بكلا نظامى الزراعة. حيث أظهر الرى بالتنقيط تأثيراً معنوياً على أخضرار أوراق الذرة، ووزن الحبوب/فدان عند التسميد النيتروجينى بمعدل ٩٠ و١٢٠ كجم/ فدان مقارنة بنظام الرى السطحى المطور مسجلاً (٥٠,٤٣ و ٥٢,٢٦ وحدة)، و (٤,٨٨ و ٤,٩ طن/ فدان)، على التوالى.

ايضاً، اختلفت درجة أخضرار الأوراق، ووزن ١٠٠ حبة ومحصول حبوب الذرة/ فدان للنباتات المنزرعة على مسافة ٣٠سم اختلافاً غير معنوى عن تلك المنزرعة على مسافة ١٥سم، مسجلاً (٤,٨٨ و ٤٧,٨٦ وحدة)، و (٢٥,٢١ و ٢٤,٨٨ جم)، و (٤,٤ و ٤,٢٥ طن/ فدان)، على التوالى.

كما أدى الرى بالتنقيط عند مستوى التسميد النيتروجينى ٩٠ و ١٢٠ كجم/ فدان إلى أفضل تأثير معنوى على أخضرار أوراق الذرة، ووزن/١٠٠ حبة ومحصول الحبوب/فدان مقارنة بنظام الرى السطحى المطور، فى حين لم يكن هناك أختلافاً معنوياً بين نظامى الزراعة المستخدمان.ففى حالة الزراعة على مسافة ٣٠سم تحت نظام الرى بالتنقيط تم تسجيل أعلى درجة أخضرار للأوراق (٥٠,٦٦ و ٥٣,٢١ وحدة)، أعلى وزن ١٠٠ حبة (٢٦,٩١ و ٢٦,٥٦ جم) و أعلى وزن محصول الحبوب (٥,٠٦ و ٥,٠٨ طن/فدان) تحت مستوى تسميد نيتروجينى ٩٠ و ١٢٠ كجم/فدان على التوالى، وفى نفس الوقت لم يكن هناك فرق معنوى بين معدلى التسميد ٩٠ و ١٢٠ كجم/فدان.