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EFFECT OF SOME IRRIGATION SYSTEMS ON DRAINGE PROCESS

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ABSTRACT: A field experiment was conducted at Ismailia Agricultural Research station to study the effect of irrigation systems on the farm of wheat Yield, water applied, soil moisture distribution, salt distribution and the drainage process. There methods of irrigation are used namely flood irrigation, sprinkler irrigation and drip irrigation. The results showed that be the yield components were highly significant affected with different irrigation systems under study. From the results, it is clearly observed that, under the investigated soil the drainage system needed only under flood irrigation system. For soil salinity distribution, under surface irrigation there was no significant different between the EC during the growth stages. The salt concentration increased under drip irrigation during the growth and stages there was no significant different in soil depth. Under sprinkler irrigation the value of EC did not affected during the growth stages while but increased slightly in soil depth. The highest value of field water use efficiency was obtained with drip irrigation systems under seedling in two direction.

Key words: Irrigation systems, soil moisture, soil salinity, water use efficiency and drainage operation.

INTRODUCTION

Water is fast becoming an economically scarce resource in many areas of the world especially in arid and semi-arid regions. Irrigation is the artificial application of water to soil for the purpose of crop production. Irrigation water is supplied to soil moisture from ground water. In many areas of the world the amount and timing of rain fall are no adequate to meet the moisture requirement of crops and irrigation is essential to raise crops necessary to meet the needs of food and fiber.

A proper choice of irrigation method greatly Facilitates reduction in drainage volume,

uniform leaching and use of poor quality water Excess water through different methods of irrigation may be applied because of improper design of the system, improper choice of the method of water application, lack of control on water application depths during the process of irrigation and non uniform application resulting from non-uniformity in soil infiltration rate or irrigation system or both.

Helmy *et al.,* (2000) reported that, increasing the applied water volume tends to increase soil moisture content in both direction of vertical and horizontal under drip irrigation system and in vertical direction only under furrow irrigation system. Also they stated that furrow irrigation because the irrigation was used daily under drip irrigation system.

Also, they stated that, the soil salinity increased by increasing soil depth after irrigation but before the next irrigation, the soil salinity decreased by increasing depth under furrow irrigation system. Under drip irrigation system the soil salinity increased by increasing the distance form emitter in both vertical and horizontal direction.

Kassem (2000) found in a comparative study for the effect of subsurface drip, surface drip and furrow irrigation on the growth of sunflower crop. The resulted revealed that the maximum crop yield was 1.23 Mg/fed. For subsurface drip laid at 30 cm depth while the minimum value was 0.98 Mg/fed. For subsurface drip laid at 40 cm depth.

In Egypt the total amount of drainage water discharge annually varied between 14 billion m^3 in 1984 to 12 billion m^3/in 1986. the EC value of the drainage water around the year is on the average 300 mg/l. the amount of drainage water used in irrigation in 1991 was 7.2 billion m^3 annually which was expected to be increased gradually and reach 7.0 billion m3 by the year 2000 (Abu-Zeid, 2002).

El-Nemr (2000) concluded that, increasing operating pressure head at drip irrigation system increased corn crop yield and water use efficiency. The highest crop yield and water use efficiency values were 10.08 Mg/fed and 0.00545 kg/m^3 respectively under long path emitter at 12 m operating pressure and two days intervals, while the some values for surface irrigation were 7.883 Mg/fed, and 0.000292 Mg/ m^3 respectively.

MATERIALS AND METHODS

To study the effect of some irrigation systems on the drainage processes. The experiment was carroed out at farm, Agricultural Research Station in Ismailia Governorate during the winter growing season (2003/2004). The experiment was conducted on sandy soil (97% sand with a low organic matter content 0.2%. The field trial was performed during in sandy soil and cultivated by wheat crop (Giza 168 variety) under three irrigation system, namely flood, sprinkler and drip irrigation under three planting methods manul and seedling in two directions and one direction) were sown with wheat verity (Giza 168 variety).The soil samples were Taden ranilamely to investigate some mechanical and chemical sl properties as shown in table 1-2

The main objective of this work is to invertigate water applied, soli moisture distribution, salt distribution and the drainage.

Table 1. Soil mechanical analysis in some soil properties of the experimental site.

Particle Size distribution %				Texture class	Calcium class	Soil moisture by weight			Bulk density gm/cm^3	Organic matter%
Coarse sand	Fine sand	Silt	Clay			Field capacity %	Wilting Point %	Available water %		
60.325	35.878	3.00	0.796	Sandy	1.6625	7.5	1.125	1.53	1.6	0.3675

Table 2. Soil chemical analysis of the experimental site.

SAR melq/1	pH 1:2.5 soil water susp	EC x 10^3 at 25° c mmohs/cm	C.E.C melq/100 gm soil	DTPA-extractable mg/kg anions melq/1			Aions meq/l			Cations melq/l			
				N	P	K	HCO_3^-	Cl^-	SO_4^{--}	Ca^{++}	Mg^{++}	Na^+	K^+
3.3	7.5	0.39	2.236	31.5	6.09	4.62	2.50	1.36	2.91	2.46	2.31	19.95	55.62

Table 3.The chemical analysis of Irrigation water .

pH	EC mm hos/	Anions melq/1				Cations melq/1			
		HCO_3	CO_3	Cl^-	$SO4^{--}$	Ca^{++}	Mg^{++}	Na^+	K^+
5.01	0.325	1.6	--	1.5	0.15	1.6	1 .00	0.59	0.06

The irrigation water source is Ismalia canal. Some representative water samples were collected in summer and winter seasons and analysed for its chemical properties. The obtained data are shown in Table 3.

Materials

For soil bed preparation, land rotary and levelling cultivator were used and wheat planting, mechanical seed-drill was used.

Sandy soil auger cylindrical auger was used to take soil samples. For measuring the time, stopwatch was used with resolution of 0.1 sec, to measure the moisture content, electrical oven was used to dry the soil samples at 105°c for 24 hours. electric conductivity ECmeter was used to measure the salinity with resolution of 0.01 dS/m.

Sprinkler Irrigation System

The sprinkler irrigation system consists of the following components:

Irrigation unit: consists of an electrical motor 40 hp, connected to centrifugal pump 4/3 inch for delivering flow rate of 50 m^3/h under operating pressure of 6 bar.

The control: head connected to main line, to regulated the pressure manometers and water filters included:

a- 3 sand filter with pipe 3 inch

b- screen filter with pipe 6 inch

Main pipe line: 6 inch diameter and 800m length of PVC provided with gated valve.

Sub main pipe line: 3 inch of pvc from the main riser, this line divided into four lines of pvc of 63 mm provided with sprinkler with space of 12 m between low sprinkler, on the line distance.

The sprinkler: of 19 mm in diameter with tow nozzles 2.5 and 4.5 mm in diameter sprinkler discharge was 1.2 m^3/h at 2.5 bar operating pressure. The riser of sprinkler has 1.2 high 40 cm below ground and 80 cm above ground shown in Plate 1.

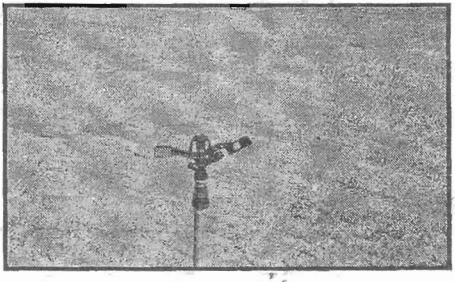

Plate 1. Sprinkler type used for sprinkler system.

Drip Irrigation System

As shown in plate 2 it was consists of the following components:

The unit: consists of an electric motor 40 hp, connected with the centrifugal pump ¾ inch to deliver flow rate of 50 m^3/h under operating pressure of 6 bar.

The control head: connected to main pipe line, to regulate the pressure and the delivered waste, pressure manometers, water filter includes.

a- sand filter with pipe 3 inches

b- Screen filter with pipe 6 inches

Main pipe line: of 6 inch diameters and 800 m length of PVC provided with gated valve.

Sub main line: of 4 of PVC provided.

Lateral line: of 3 of PVC for the main riser form this line four lines of PVC of 1.5 to four plots, the plot connected to pipe GR of 16 mm, dripper with space of 50 cm between two dripper, on the line distance between tow lines of 60c m. dripper discharge was 4 L/h.

Fertilizer injector: to feeding four plot with different pressure.

Plate 2. The lay out of drip irrigation system.

Experimental Design

The experiment was conducted on an area of 1750 m^2 through season on 2003- 2004. This area was divided into 3 parts of 500, 625, and 625 m^2 to apply the sprinkler, drip, and flood irrigation respectively. To measure the drainage water, the applied water was calculated though seasons for each system. The soil samples was taken from layer of (0-15, 15-30, 30-45, 45-6 and 60-100) cm to measure losses , EC, and NPK and used different planting whereas, A1, A2 and A3 are irrigation method flood sprinkler and drie system respectively, B1, B2 and B3 are planting method manual method, respectively and seedling in two direction respectively.

Irrigation Requirements

The wheat of take about 2000 m/fed. in season. The water gave to land after measure the leaching requirements, it can be expressed by (Bernstein, 1973) equation as follows:

$$LR = \frac{Ecw}{(5\,Ece - Ecw)} \text{ mmhos/cm}$$

Where:

LR: Leaching requirement

EC_w: Electrical conductivity of irrigation water

EC_e: Electrical conductivity of drainage water under the root-zone.

Methods

Soil moisture content has been determined by the gramatic methods. Field capacity has been determined using the method . Soil bulk density has been determined by the core method .The permeate wetting point has been determined using a pressure membrane. Field water use efficiency is the' weight of marketable crop pa the volume unit of applied irrigation was expressed as cubic meter of water (Michael, 1978). It was calculated by the following equation:

$$W.U.E = \frac{Yield\,(kg/fed)}{Water\,applied\,(m3/fed)}$$

Measurements Soil Moisture and Soil Salinity Distribution

Soil samples were taken before sowing from different locations 0-15, 15-30 and 30-45cm. Sprinkler irrigation moisture and salinity were determined in four different locations at different horizontal distances 2.5 and 5m between sprinklers, and 3 and 6 m on the line distance.

Drip irrigation moisture and salinity were determined in four different locations at different horizontal distances 10 and 20 cm between two dippers, and 1 0 and 30 cm between two line.

Flood irrigation moisture and salinity were determined in different locations in the basin. Yield and its components taken into concentration .

RESULTS AND DISCUSSIONS

Applied Irrigation Water

The amounts of applied irrigation water number of irrigation, water delivered (m^3/fed) number of irrigation, discharge and saved water m^3/fed. and (%0) to different irrigation systems are shown, in Table 4. It is clearly observed from the data obtained that the number of irrigations during the whole season, were 6, 1 8, and 31 applications for surface, sprinkler and drip irrigation systems respectively. The discharge for irrigation were (333.3, 92 and 50.4) m^3/fed. under surface, sprinkler and drip irrigation systems respectively. The total, water applied was 2000, 1656 and 1562.40 m^3/fed. for the previous treatments.

Table 4. Water applied and saved percentage.

Treat.		No. of irrigation	Applied water per one irrigation (m^3/fed)	Total water applied (m^3/fed)	Saved (%)
A1	B1	6	333.3	2000	
	B2	6	333.3	2000	
	B3	6	333.3	2000	
A2	B1	18	92.0	1656	17.20
	B2	18	92.0	1656	17.20
	B3	18	92.0	1656	17.20
A3	B1	31	50.4	1560.40	21.88
	B2	31	50.4	1560.40	21.88
	B3	31	50.4	1560.40	21.88

Respectively, the results showed that the drip irrigation system was saved 437.6 m^3/fed. (21.88%) and 344 m^3/fed. (17.20%) under sprinkler irrigation system comparing with surface irrigation system which did not show any water saving.

These results are in agreement with, those obtained by (*Bucks et al* 1980). Bucks *et al.*, (1981)., James (1988) and El-Gindy (1989). The total water applied did not affected by planting methods.

Soil Moisture Distribution and salt Distribution

The results indicated that in case of drip irrigation methods moisture content decreased at the increasing the distance form drippers in both horizontal, and vertical directions, For the across and along laterals, The highest moisture content was obtained in the surface layer. These results are in agreement with those obtained by El-Kobia et al., (1986) and Mohamed (1995).

Concerning sprinkler irrigation, the same trend was obtained where the highest moisture content was obtained in the surface layer. But there was not a big difference between the layers. For surface irrigation method the results revealed that the soil moisture content, increased with increased soil profile. In general soil moisture content was higher with drip and sprinkler comparing with surface irrigation methods in surface layers. It could be concluded that the drainage system needed under surface irrigation system.

Under Surface Irrigation

The water movement in the coarse texture soils is much deeper and rapid than in heavy textured soils, also water distribution is highly affected, with soil porosity, texture, nature of topography and

soil layering. The salt concentration and distribution and different soil layers were assumed for surface irrigation system and it is graphically presented in Fig. 1.. The data showed that salt concentration decreased with surface irrigation system there was gradual increment in salt accumulation with the increase in depth and the maximum value was observed in the lower layer. Also data showed that there was no big different between the EC during the growth stages .

Drip Irrigation

Fig.1 showed the salt distribution pattern under drip irrigation system. The data indicated that salt concentration increased during the growth stages. Also the data showed that there was no big different in soil depths.

Sprinkler Irrigation

Also Fig.1 showed the salt distribution pattern under sprinkler irrigation system. The data showed the value of EC did not affected during growth stages but increased slightly in soil depths.

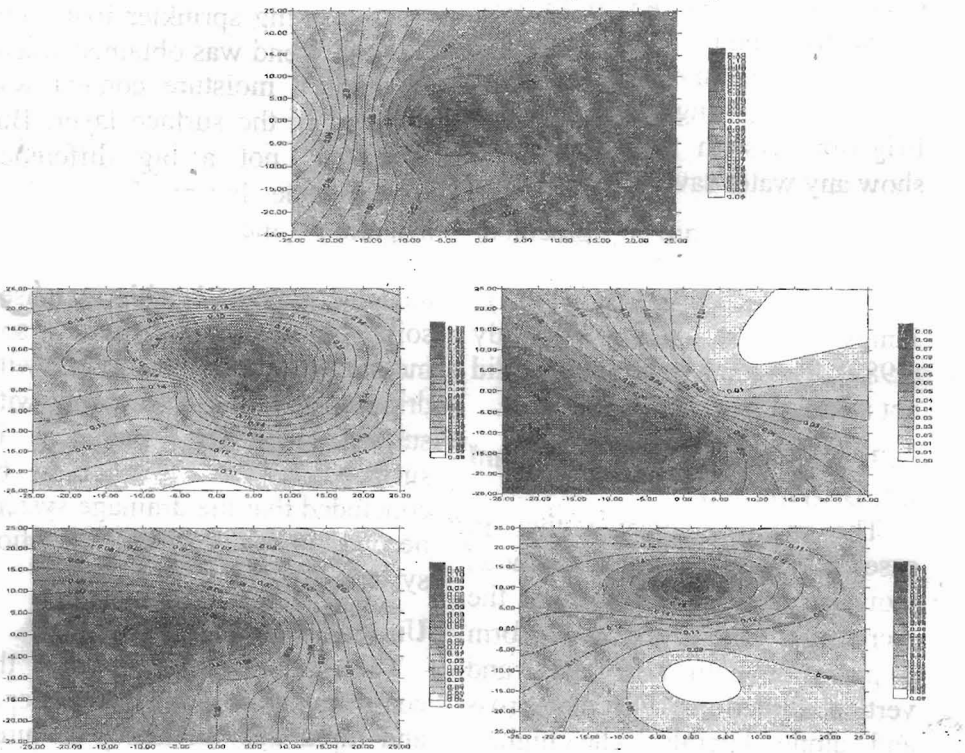

Figure 1. Soil salinity distribution

Crop Yield

Data Tabulated in Table 5 showed the effect of different irrigation systems on grain and straw yield, it is noticed that the grain and straw yield was highly significant affected with different irrigation systems treatments. Results indicted that the mean values of grain and straw yield were 2995, 3150 and 3274.5 kg/fed. and 4.0, 4.25 and. 4.47 ton/fed for surface, sprinkler and drip irrigation system respectively. It can be concluded that as we applied modern irrigation increased the yield of crops. These results are in accordance with those reported by Baker and Shakshook (1997), Buck *et al.*, (1981). James (1988), El-Berry *at al.*, (1989), Abdel-Maksoud *at al.*, (1992), Mohamed (1995), Kassem (2002) and El-Nemr (2002).

Grain Yield

Data listed in Table 6 showed the effect of different irrigation systems on weight of 1000 grain. The data showed, that the weight of 1000 grain, tended to increase clue to used modern irrigation systems. The highest value of weight of 1000 grain was 35.9 gm obtained with drip irrigations systems while the lowest value (32.74) gm was obtained with surface irrigation system. It can be noticed that the weight of 1000 grain for sprinkler irrigation is 33.08gm. From the obtained data it is clearly observed that, the weight of 1000 grain is significantly affected by the irrigation system Fig. 2.

Data presented in Table 7 showed the plant height of wheat plant as affected by different irrigation systems. It is cleared from obtained data that the plant height affected significantly by irrigation systems. The plant height was 67.75, 69.00 and 71.5 cm under flood, sprinkler and drip irrigation systems respectively. It could be concluded that the plant high increased with used modern irrigation system (drip irrigation).

Table 5. Grain and straw yield for wheat crop as affected by different irrigation systems

Irrigation systems	Grain (kg/fed)	Straw (ton/fed)
Surface	2995	4.00
Sprinkler	3150	4.25
Strip	3274.5	4.47
Mean	3473.16	4.24
F test	**	**
L.S.D 1%	155.11	0.18
L.S.D 5%	102.38	0.12

Table 6.Weight of 1000 grain kg as affected by different irrigation systems.

Irrigation systems		Weight of 1000 grain (gm)
Surface		32.74
Sprinkler		33.68
Strip		35.9
Mean	34.11	34.11
F test	**	**
L.S.D 1%	1.21	1.21
L.S.D 5%	0.80	0.80

Table 7.Plant height as affected by different irrigation systems.

Irrigation systems	Plant height (cm)
Surface	67.75
Sprinkler	69.00
Drip	71.5
Mean	69.42
F test	*
L.S.D 1%	-
L.S.D 5%	2.81

Straw Yield

As shown in Figure 3 the straw yield tons /fed. ranged between 4.22 ton/fed with surface irrigation method, 4.33 ton/fed with sprinkler irrigation method and 4.42 ton/fed with drip irrigation method.

It is cleared from obtained data that the average of straw yield ton /fed. as affected by use different planting methods was (4.06, 4.36 and 4.55) ton /fed. with B_1, B_2 and B_3 treatments respectively. The interaction between the aforementioned treatments was highly significant effect.

Weight of 1000 Grains

Data listed in Fig. 4 showed effect of use some irrigation systems and different planting methods on weight of 1000 grains. It is noticed that the weight of 1000 grains increased with drip irrigation treatment. The mean value were 33.61, 34.13 and 34.62 Kg with A_1, A_2 and A_3 treatments respectively.

Concerning the effect of planting method the data showed that the grain yield was highly significant effect. The mean values were 33.32, 34.29 and 34.75 Kg. with B_1, B_2 and B_3 treatments respectively. The interaction between the aforementioned treatments was not significant effect.

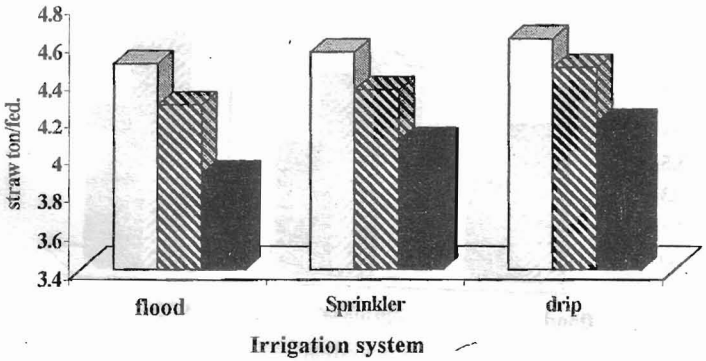

Figure 2. Effect of some irrigation systems and different planting methods on grains kg/fed.

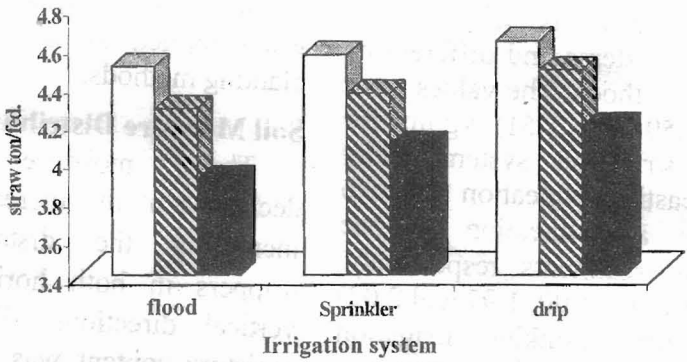

Figure 3. Effect of some irrigation systems and different planting methods on straw ton/fed.

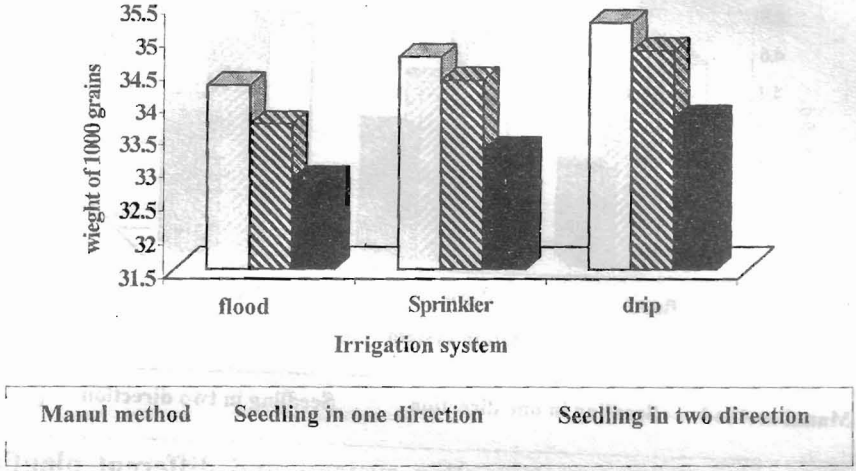

Figure 4. Effect of some irrigation systems and different planting methods on weight of 1000 grains.

Water Use Efficiency

Data presented in Table 8 revealed the values of field water use efficiency as affected by irrigation systems and different of planting methods. The values were (1.50, 1.50 and 1.51) kg/m^3 for surface irrigation system under broad casting, lineation in two direction and lineation in one direction treatments respectively. While it were (1.90, 1.97 and 2.02) kg/m^3 for sprinkler irrigation system under the previous treatments respectively. Finally it were (2.08, 2.19 and 2.26) kg/m^3 for drip irrigation system under the previous treatments respectively.

CONCLUSIONS

Total Irrigation Water

The results showed that the drip irrigation system was saved 4376 m^3/fed 21.88% and 344 m^3/fed 17.20% under sprinkler irrigation system comparing with surface irrigation system. The total water applied did not affected by planting methods.

Soil Moisture Distribution

The moisture content decreased at the increased at the increasing the distance from drippers in both horizontal and vertical directions. The highest moisture content was obtained in the surface layer. The same trend was obtained with sprinkler irrigation. The soil moisture content increased soil profile with surface irrigation. It could be concluded that the drainage system needed under surface irrigation system.

Table 8. Total water applied grain yield and field water use efficiency:

Treatments		Total water applied (m^3/fed)	Grain yield (kg/fed.)	Field water use efficiency m^3/fed
	B1	2000	2996	1.50
A1	B2	2000	2997.3	1.50
	B3	2000	3023.3	1.51
	B1	1656	3143.3	1.90
A2	B2	1656	3261.7	1.97
	B3	1656	3350	2.02
	B1	1560.4	3240	2.08
A3	B2	1560.4	3416.7	2.19
	B3	1560.4	3533.3	2.26

Soil Salinity Distribution

The salt concentration decreased with surface irrigation system there was gradual increment in salt accumulation with the increase in depth and the maximum value was observed in the lower layer. There was no a big different between the EC during the growth stages. The salt concentration increased during the growth and stages there was no big different in soil depth. The value of EC did not affected during the growth stages but increased slightly in soil depth.

The highest value of field water use efficiency was obtained with drip irrigation systems under Lineation in are direction.

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تأثير بعض نظم الري على عملية الصرف

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أجريت التجربة فى محطة البحوث الزراعية بمحافظة الاسماعيلية لدراسة تأثير بعض نظم الرى على عملية الصرف وإنتاجية المحصول وتوزيع الرطوبة والملوحة تحت أنواع مختلفة من الزراعة لمحصول القمح أثناء موسمى ٢٠٠٣/٢٠٠٤ فى أرض رملية .

تم فيها تقسيم الارض إلى ثلاثة قطع استخدمت فى كل قطعة منها بطريقة عشوائية طريقة رى مختلفة حيث كانت مساحة الأرض ١٧٥٠م^2 قسمت إلى ٥٠٠ ، ٦٢٥ ، ٦٢٥م^2 ، وهى الرى بالرش ، الرى السطحى ، الرى بالتنقيط .

حيث تم فيها تقسيم كل قطعة إلى ثلاث قطع استخدمت فى كل قطعة منها بطريقة عشوائية طريقة زراعة مختلفة وهى : زراعة بدار ، زراعة تسطير فى اتجاه واحد ، زراعة تسطير فى اتجاهين .

وقد أسفرت التجارب عن النتائج التالية :

قام الرى بالتنقيط بتوفير ٤٣٧,٦م٣ / فدان ٢١,٨٨% والرى بالرش ٣٤٤م٣/فدان ١٧,٢٠% مقارنة بالرى السطحى . وكانت كمية الحبوب ٢٩٩٥ ، ٣١٥٠ ، ٣٢٧٤,٥ كجم / فدان والقش ٤، ٤,٢٥ ، ٤,٤٧ طن / فدان لكل من الرى السطحى والرش والتنقيط على الترتيب وكانت توزيع الرطوبة يقل كلما بعدنا عن النقاطات فى اتجاهين الرأس الأفقى وكانت اعلاها فى الطبقات السطحية وكانت ذاتها فى الرى بالرش أما فى الرى السطحى فقد زادت لذلك نحن بحاجة لأنشاء شبكة صرف وتوزيع الملوحة فى التربة تحت الرى السطحى كان اقل الطرق المستخدمة والرى بالتنقيط يزيد خلال فترات النمو أما الرى بالرش فيزيد فى الأعماق المختلفة من التربة وكانت اعلى كفاءة لاستخدام المياه تحت نظام الرى بالتنقيط مع الزراعة فى اتجاهين .