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EFFECT OF A MODIFIED SURFACE IRRIGATION USING GATED PIPES SYSTEM ON WHEAT CROP.

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ABSTRACT: *The current study was carried out at Gehena, Sohag Govenorate during 2008 season in clay soil, to study the effect of a modified surface irrigation system using gated pipe and precision land leveling on the wheat seeds and the percent of total losses of wheat grain. Wheat seeds (Giza168) was planted in 27/11/2008 and received 6 irrigations. All the experimental treatment received the same agricultural practices as usual in the area. The results showed that:-*

The average depth of the infiltration for entire border irrigation was found to be approximately 53.57, 52.08, 51.05 and 50.25 mm for traditional leveling, 0.0%, 0.03% and 0.05% slope respectively. The advanced time decreased with 12.72, 16.36 and 21.82 % for 0.0%, 0.03% and 0.05% slope compared with traditional leveling respectively. The calculated value of (Du min) were 84.94, 88.33, 91.67 and 93.53 % for traditional leveling, 0.0%, 0.03% and 0.05% slope respectively.

The application efficiency of low – quarter was increased by increasing the percentage of border slope under modified irrigation system. Distribution uniformity of low- quarter (DUlq) was increased by increasing the percentage of border slope % under modified irrigation system.

The water applied was 2785, 2070, 1940 and 1815 m^3/feddan, for traditional leveling, 0.0%, 0.03% and 0.05% slope, respectively. The unthreshed grain increased from 2.3 to 5.8 % when grain moisture content increased from 16 to 23 % respectively. The grain damage has the same trend it was increased from 2.1 to 2.7 %when grain moisture increased from 16 to 23 %, respectively.

The grain diameter and weight of 100 seeds have the same trend as the grain diameter increased by 1.25, 3.66 and 6.40% for 0.0%, 0.03 and 0.05% slope, respectively. Compared with traditional leveling. The weight of 100 seeds increased by4.26, 10.0 and 11.76% for 0.0%, 0.03 and 0.05% slope, respectively, compared with traditional leveling.

Key Words: *Modified surface irrigation, laser leveling, Wheat grain, distribution uniformity low-quarter, application efficiency.*

INTRODUCTION

In general there is much losses of wheat grain during transport from fields to the threshing region. This study aims to define the effect of the irrigation when using gated pipes on some physical properties of wheat grain and grain moisture content.

Surya Noth, *et al* (1982), reported that the highest machine losses are 7.8% at 27 % moisture because more grain is unthreshed at high moisture. The minimum machine losses with respect different moisture content are represented. The machine losses do not change fast up to 18 % grain moisture, but beyond 18 % they do. El-Shazly, (1990) found that the relation ship between grain moisture content and the unthreshed grain percentage was an invisibly proportionate, with increasing the grain moisture content from 15.5 to 17.5 % the unthreshed grain percentage increased from 0.8 to 3.1 % respectively. Sharobeen (1996) developed the harvester and the used crop was wheat, average plants height was 0.72 m, number of plants per meter square 200, the soil moisture was 16 %, the grain yield was 2500 kg/fed and the grain moisture content was 14 %. He added the pre-harvest losses reached 2.1 kg/fed. Solomon (1990) indicated that irrigation uniformity is also linked to the efficiency with which agricultural resources are used. Non uniformity irrigation resulted in the application of excess water.

El-Gindy *et. al.* (1996) concluded that precision land leveling with 0.03% slope along with seedbed preparation by two passes with a chisel plow, one pass with a disk harrow had the following advantage for wheat crop. Water saving 20 %, increased application efficiency 28 %, increased yield 30 %, increased water use efficiency 44%. and reduced irrigation time by 35%.

Hansan (1998) indicated that, there are many methods for improving the performance of surface irrigation, but all of them depend on the main factors related to soil characteristics, leveling and application method. He also stated that the use of perforated pipe system instead of ditches for conveying and distributing the irrigation water over the entire field may improve the surface irrigation efficiency avoid weed problems, avoid losses of productive land, avoid losses of water by seepage and evaporation and also decreases the irrigation water losses up to 25% during distributing the irrigation water. Osman (2002) stated that using gated pipes, resulted water saving with 29.64, 29.90, 14.50 and 19.70% in cotton, wheat, corn and rice, respectively compared with traditional (flooding) system. Mohammed (2008) concluded that uniformity coefficient, as well as, distribution uniformity increased when inlet discharge increased but acceptable values achieved for all discharge treatments although the Uc (95.70%) and Du (93.10%) were the highest for 6 m^3 / h inlet flow. Application efficiency achieved a value of 92.80% for 6 m^3/h discharge due to increasing water deficit in root zone, but storage efficiency achieved the value of 94 % for 4.50 m^3/h due to decreasing dried soil content in root zone.

MATERIALS AND METHODS

The present work was carried out at Gehena, Sohag Govenorate during 2008 season to study the effect of a modified surface irrigation system using gated pipes on some physical properties of wheat grain and grain moisture.

An area of 48m width and 60 m length was divided into 4 plots each plot 12 m wide, each plot divided into 3 strips each 4m wide. Each plot has three passes of chisel plow with depth 20 cm and the slopes of land surface as follow:

S1: zero level of strip surface applying laser leveling.
S2: 0.03% slope of strip surface applying laser leveling.
S3: 0.05% of strip surface applying laser leveling.
The fourth strip as a control has traditional leveling.
There was subsurface drainage for that the end of the border was closed.

Win SRFR 3.1

Computer program (win SRFR 3.1 2008) is used for predicting field uniformity and efficiency of surface irrigation system (border, basin and furrow). Also the present study was carried out in order to compare the results of SRFR with slope % in border irrigation. The pilot area was leveled using laser technique with slope (5cm/100m). Long border (60m) irrigated with modified surface system using gated pipes. The width of the field for each treatment was (12m). The following parameters required for input in the win SRFR 3.1 model are: system geometry – border, no drain back, blocked end, length 60m, width 12m, depth 600mm, area 0.07ha, slope 0.05 % and inflow rate 22l/s. However, using SRFR computer program before design surface irrigation applied will be helped a lot to choose best design with high water application efficiency and distribution uniformity, also save a lot of time and increased water use efficiency.

At each station along the length of the border, the opportunity time (time while water was above the ground), and top was found by measuring the time interval between the advance and the recession time.

Wheat seeds (Giza168) was planted in 27/11/2008 in clay soil and received 6 irrigations. All the experimental treatment received the same agricultural practices as usual in the area. Before beginning the experimental work, soil samples were taken from three locations, at the head, the middle and the tail of the experimental field. These soil samples were taken for the determination of some soil physical properties (bulk density) and soil mechanical properties, the field capacity, and the welting point according to Anter *et al.*(1987) and presented in Table (1). At harvest time, the weight of the crop in each plot was measured for each treatment, the water application efficiency (Ea), the water distribution uniformity of low – quarter (DU_{lq}), the water use efficiency (WUE) as well. During the execution of experimental work, soil samples were collected two days after irrigation from each strip for the determination of soil moisture content and soil moisture distribution pattern. Also, soil samples were taken just before irrigation to determine soil moisture distribution pattern. The samples were taken every 5 meters for each strip. The samples were taken at four depths: (0-15cm), (15-30cm), (30-45cm) and (45-60cm). The infiltration rate for the experimental soil was

measured using the double ring method. From the advance time and recession time the opportunity time was determined. The depth of the water infiltrated into the soil at each station along the length of border was determined from the opportunity time and the behavior of the cumulative infiltration rate. Grain moisture content meter was used to measure the grain moisture content; the digital device can read out the moisture levels from zero to 40%. The grain was collected from 1 m^2 for five different places before harvesting operation started for each treatment.

The distribution uniformity (Du) as defined by Merrian and Keller (1978) is the ratio of average low quarter depth of water infiltrated to the average depth of irrigation water infiltrated. The average low-quarter depth in infiltrated is the average of the lowest one-fourth of the field length. Distribution uniformity low- quarter is computed as follows:

$$DU_{lq} = \frac{\text{average low quarter depth of water infiltrated}}{\text{average depth water infiltrated}} \times 100$$

The distribution uniformity, (DU) is the average depth of minimum depth infiltrated at the end of the field divided by average depth infiltrated over actual border length. The (DU) describes how the water was distributed along the border for the condition tested.

Larry and James (1988) reported that the actual border average depth of water applied (Z) m, can be computed by using the following relation ship:

$$Z = \frac{Q \times T}{(L \times Wp)}$$

Where:-

Q: inflow rate on the border (m^3/min).
T: time cut of (min).
L: length of border (m).
WP: wetted width of border (border spacing) (m).

Jensen (1983) classified water – application as follows:

Application efficiency (AE) is the ratio of the average depth of the irrigation water infiltrated and stored in the root zone to the average depth of water applied.

$$AE = \frac{\text{average depth of water infiltrated and stored in the root zone}}{\text{average depth of water applied}} \times 100$$

Actual application efficiency of low – quarter (AE_{lq}) is the ratio of the average low – quarter (lq) depth of irrigation water infiltrated and stored in the root zone to the average depth of irrigation water applied expressed as

percent. The average (lq) depth infiltrated is the average of the lowest one – fourth of the measured values where each value represents an equal unit of area and can not exceed the soil moisture deficiency (SMD). Values of (AE_{lq}) indicate both the uniformity of water distribution and adequacy of irrigation. When the lq value is less than the SMD or the desired management allowed deficiency (MAD) indicates the adequacy of the irrigation.

$$AE_{lq} = \frac{\text{average low – quarter depth of water infiltrated and stored}}{\text{average depth of water applied}} \times 100$$

All experimental treatments are replicated three times. The experiment was planted in 27/11/2008. the amount of irrigation water was measured, the advance and recession time along each irrigation run were recorded.

Table (1): The mechanical analysis and the bulk density of the different layers of the experimental area.

Depth, cm	Coarse sand, %	Fine sand, %	Silt %	Clay %	Texture	Organic mater, %	$CaCo_3$	Bulk density, gm/cm^3
(0-15)	4.67	15.96	17.53	61.84	clay	6.00	3.50	1.11
(15-30)	4.50	14.00	17.50	64.50	clay	5.00	4.00	1.09
(30-45)	4.40	14.50	17.60	63.50	clay	2.00	3.90	1.14
(45-60)	3.00	16.00	16.00	65.00	clay	2.00	3.50	1.14

RESULTS AND DISCUSSION

The yield versus water relationship for any crops is a complicated function. If the irrigation system provides a uniform distribution of water, then each plant should receive on identical amount of water. For this reason, not only the average application, but also the spatial distribution of the application is important. Results of the various methods validating SRFR will be presented. These results will be compared to determine the differences between the various methods. For comparison the differences between the advance and recession of actual field data with advance and recession of SRFR with 0.05 % slope are presented in Table (2) in addition advance and recession time are showed in Figs (1, 2 and 3). The data illustrated in Table (2) indicated slight difference between their values. The comparison the application efficiency (AE %) with 0.05 % slope of actual field data and SRFR are presented in Table (2) and plotted in Fig (3). Data in Table (2) indicate that the actual field advance time increased by 10, 14.28 and 16.28% compared with SRFR data for field length 10, 30 and 60 meter respectively. Also, the actual field recession time increased by 34.76, 33.55 and 33.21% compared with SRFR data for field length 10, 30 and 60 meter, respectively. The percentages of application efficiency, distribution uniformity low-quarter (DUlq) were decreased by 4.15 and 13 %, respectively compared with SRFR data. On the other hand, the minimum distribution uniformity was increased

by 6.22 %. Results of comparative study between SRFR and field data experiment show that small variation between SRFR and field data.

Table (2): Comparison differences between the advance and recession, water application efficiency and distribution uniformity % of actual field data and SRFR with 0.05% slope under different border length.

	Field length m	Actual field data (min)	SRFR (min)	Difference %
Advance time	10	4	3.6	10
	30	14	12	14.28
	60	43	36	16.28
Recession time	10	51.5	33.6	34.76
	30	56	37.4	33.55
	60	60.5	40.2	33.21
Application efficiency%		95.85	100	4.15
Distribution uniformity lq %		77.52	89.1	13
Distribution uniformity %		72.51	68	- 6.22

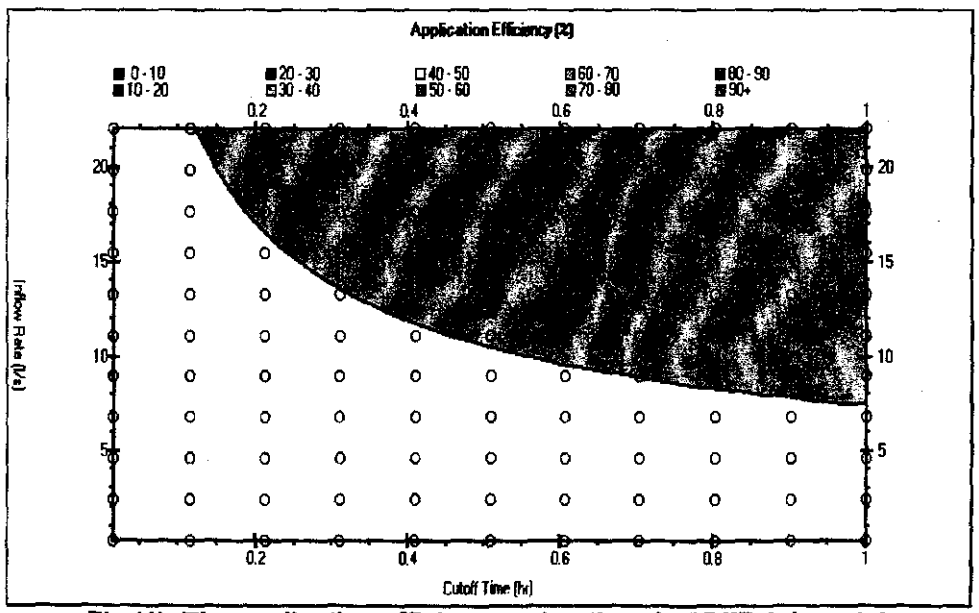

Fig (1): The application efficiency using the win SRFR 3.1 model.

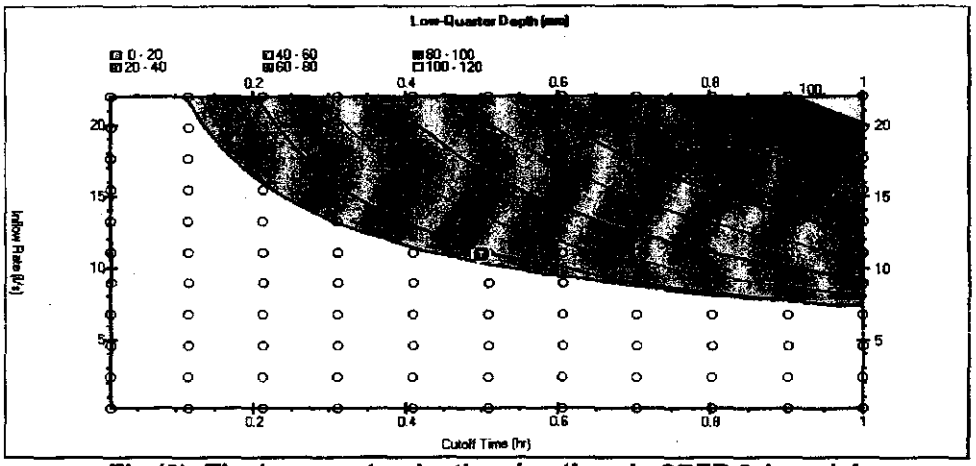

Fig (2): The low quarter depth using the win SRFR 3.1 model.

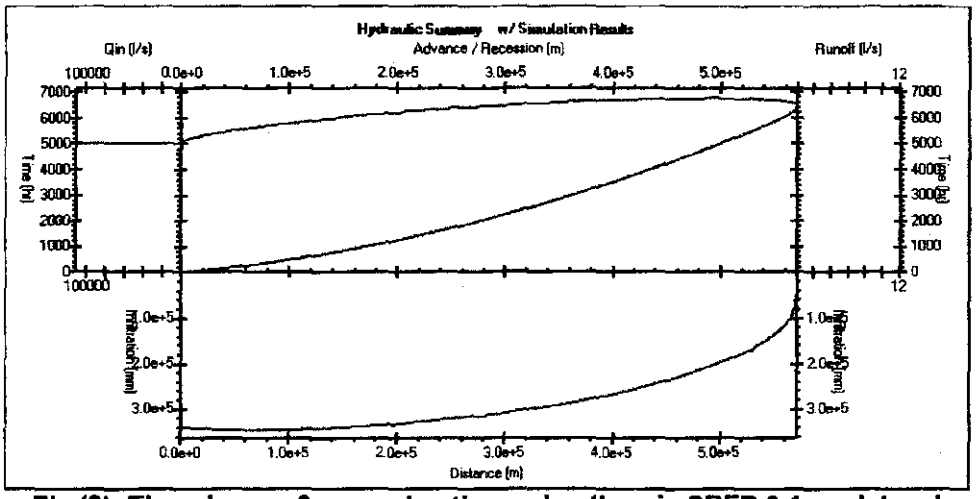

Fig (3): The advance & recession time using the win SRFR 3.1 model and actual field measurement.

Infiltrated Depth

The corresponding depth of infiltration was calculated .Table (3) represents the calculated depth for the different treatment at all station. The average depth of the infiltration for entire border was found to be approximately 53.57, 52.08, 51.05 and 50.25 mm for traditional leveling, zero level, 0.03% slope and 0.05% slope respectively. Results show that , in Table

(3) the advanced time was about 55, 48, 46 and 43 min for traditional leveling, 0.0%, 0.03% and 0.05% slope respectively. On the other hand, the advance time was decreased by 12.72, 16.36 and 21.82 % for 0.0%, 0.03% and 0.05% slope compared with traditional leveling respectively.

Application efficiency

The actual border average depths of irrigation water applied were 99.47, 73.93, 69.28 and 64.82, for traditional leveling, 0.0%, 0.03 and 0.05% slope respectively.

The application efficiency (AE) was computed for the studied treatments were 53.86, 70.45, 73.69 and 77.52 %, for traditional leveling, 0.05, 0.03 and 0.05% slope respectively.

Actual application efficiency of low- quarter

Soil moisture deficiency (SMD) is the average depth of the lowest one – fourth for the least 15 m in this study are 45.5, 46, 46.8 and 47 mm for the treatments traditional leveling, 0.0%, 0.03 , and 0.05% slope, respectively. And the values of the actual application efficiency of low – quarter were 45.74, 62.22, and 67.55 and 72.51% for the traditional leveling, 0.0%, 0.03, and 0.05% slope, respectively. The results show that, the application efficiency of low – quarter increased by using gated pipes and the border slope % were increased.

Distribution uniformity (Du min)

A high percentage would indicate that the advance and recession curves are parallel but would not tell whether the irrigation was adequate. For this percentage, which concerns only the infiltrated water, run off is not pertinent. The calculated values of (DU) were 84.94, 88.33, 91.67 and 93.53 % for traditional leveling, 0.0%, 0.03 and 0.05% slope, respectively.

Distribution efficiency of low- quarter.

Using Table (3) the average depth infiltration (d) for the 60m found to be 53.57, 52.08, 51.05 and 50.25 mm, for traditional leveling, zero leveling, 0.03% and 0.05% slope respectively. The values of distribution efficiency calculated according to James (1988), it was 94.06, 94.39, 94.55 and 95.85 %. for traditional leveling, 0.0%, 0.03 and 0.05% slope, respectively. So distribution efficiency was increased by using the gated pipes and the border slope % increased.

Water applied

In traditional leveling the quantity of water applied was about 2785 m^3/fed for wheat crop. Meanwhile it was decreased by using the laser leveling and gated pipes. Table (3) show that the water applied was 2070, 1940 and 1815 m^3/fed. for 0.0%, 0.03% and 0.05% slope, respectively.

Effect of modified surface irrigation on some physical properties and unthreshed grain under different slopes.

The modified surface irrigation under slope had effect on physical properties such as grain diameter, weight of 100 seeds, length of spikes and grain moisture the spike length (cm) increase by using modified surface irrigation and slope it was increased by 10.53, 15.00 and 19.05% for 0.0%, 0.03 and 0.05% slope, respectively, compared with traditional leveling

The grain diameter and weight of 100 seeds have the same trend the grain diameter increased by 1.25, 3.66 and 6.40% for 0.0%, 0.03 and 0.05% slope, respectively, compared with traditional leveling. The weight of 100 seeds increased by4.26, 10.0 and 11.76% for 0.0%, 0.03 and 0.05% slope, respectively. Compared with traditional leveling.

Also data in Table (4) show the effect of grain moisture content on unthreshed grain and grain damage. The unthreshed grain and grain damage were affected by the levels of grain moisture content. The unthreshed grain increased from 2.3 to 5.8 % when grain moisture content increased from 16 to 23 % respectively. Also the grain damage has the same trend. It was increased from 2.1 to 2.7 %when grain moisture increased from 16 to 23 % respectively.

Table (3): Relation between average water applied depth in the soil under different slope.

		Distance from border inlet (m).						
		0	10	20	30	40	50	60
Traditional leveling	T adv. min	0	6.50	11	17	27	39	55
	T rec. min	57	61	64.5	67	71	73	76
	T op. min	57	54.5	53.5	50	44	34.4	21
	Ave. Depth mm	58.25	56.70	55.20	53.75	52.00	45.50	
	Average depth infiltration mm	53..57						
	Average depth of irrigation water applied mm	99.47						
Zero level slope	T adv. min	0	5.50	9.50	14.50	22.50	31	48
	T rec. min	53	55	57	59.5	61	63	66
	T op. min	53	49.5	47.5	45	38.5	32	18
	Ave. Depth mm	56.5	55	53.5	52	49.5	46	
	Average depth infiltration mm	52.08						
	Average depth of irrigation water applied mm	73.93						
0.03% slope	T adv. min	0	4.5	11	16	23	33	46
	T rec. min	51	53	55	57.5	59	61	63
	T op. min	51	48.5	44	41.5	36	28	17
	Ave. Depth mm	55	54	52	50	48.5	46.8	
	Average depth infiltration mm	51.05						
	Average depth of irrigation water applied mm	69.28						
0.05% slope	T adv. Min	0	4	9	14	21	31	43
	T rec. min	50	51.5	53	56	58.5	59.5	60.5
	T op. min	50	47.5	44	42	37.5	28.5	17.5
	Ave. Depth mm	54	52.5	50.5	49	48.5	47	
	Average depth infiltration mm	50.25						
	Average depth of irrigation water applied mm	64.82						

Wheat yield and water use efficiency

Considering the water use efficiency, it can be concluded that the 0.05% slope treatment is the higher value (1.78 kg/m^3) as presented in Table (4).On

the other hand the water use efficiency in traditional treatment was (0.98 kg/m^3).

Table (4): Effect of modified surface irrigation on some physical properties and unthreshed grain, grain damage under different slope.

	Traditional leveling	Gated pipe		
		Zero level slope	0.03% slope	0.05% slope
Grain moisture content %	23.00	20.00	18.00	16.50
length of spikes cm	17	19	20	21
Grain diameter mm	3.95	4.00	4.10	4.22
Weight of 100 seeds(g)	4.50	4.70	5.00	5.10
Unthreshed grain %	6.80	5.20	3.10	2.30
Grain damage %	2.90	2.20	1.90	1.50
Total losses %	9.70	7.40	5.00	3.80
Water applied m^3/fed	2785	2070	1940	1815
Yield kg/fed.	2733	3010	3150	3225
WUE kg/ m^3	0.98	1.45	1.62	1.78

CONCLUSION

The results obtained can be summarized as follow:

The application efficiency of low – quarter was increased by increasing the percentage of border slope under modified irrigation system. Distribution uniformity of low- quarter (DUlq) was increased by increasing the percentage of border slope % under modified irrigation system. The unthreshed grain increased from 2.3 to 5.8 % when grain moisture content increased from 16 to 23 % respectively. The grain damage has the same trend it was increased from 2.1 to 2.7 %when grain moisture increased from 16 to 23 %, respectively. The weight of 100 seeds increased by4.26, 10.0 and 11.76% for 0.0%, 0.03 and 0.05% slope, respectively, compared with traditional leveling.

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تأثير الرى السطحى المطور بأستخدام الأنابيب المبوبة على محصول القمح.

صلاح الدين اسماعيل الخطيب

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الملخص العربى

أجريت هذه التجربة فى محافظة سوهاج – مركز جهينة موسم ٢٠٠٨ وذلك لدراسة تأثير ميل الشريحة والرى بأستخدام الأنابيب المبوبة على التوزيع الرطوبى وكفاءة التطبيق وأنتظامية التوزيع ونسبة الرطوبة بحبوب القمح وبعض الخواص الطبيعية لمحصول القمح وتأثير ذلك على عملية الدراس.وتم استخدام برنامج SRFR 3.1 قبل أجراء التجربة للتنبأ بالتوزيع الرطوبى وكفاءة التطبيق وانتظامية التوزيع . تم زراعة القمح صنف جيزة ١٦٨ فى ٢٠٠٨/١١/٢٧ كما تم ريه ٦ ريات وتلقى جميع العمليات الزراعية المعتاده فى زراعة القمح مثل تجهيز التربة والتسميد. وأوضحت النتائج التالى:-

١- كانت النتائج المتحصل عليها من برنامج SRFR 3.1 قريبة من النتائج المتحصل عليها من التجربة الحقلية للتوزيع الرطوبى وكفاءة التطبيق وزمن التقدم وزمن الأنحسار.

٢- تأثرت انتظامية التوزيع وكفاءة التوزيع بالرى بالأنابيب المبوبة وميل الشريحة.

٣- قل متوسط عمق الماء الداخل للتربة بالرى بالأنابيب المبوبة وميل الشريحة.

٤- زادت انتظامية التوزيع بأستخدام الأنابيب المبوبة وزيادة نسبة الميل (من صفر الى ٠,٠٥ %) .

٥- زادت كفاءة التطبيق للربع الأخير بأستخدام الأنابيب المبوبة وزيادة نسبة الميل(من صفر الى ٠,٠٥ % .

٦- كفاءة استخدام المياه زادت بزيادة ميل الشريحة حيث كانت ٠,٩٨ ،١,٤٥ ، ١,٦٢ ، ١,٧٨ كجم / م^{3} مع التسوية ورى تقليدى وتسوية بالليزر بدون ميول ونسبة ميل ٠,٠٣ % و٠,٠٥ % على التوالى.

٧- تأثرت بعض الخواص الطبيعية لمحصول القمح مثل طول الحبة وطول السنبلة وقطر الحبة بميل الشريحة واستخدام الرى السطحى المطور بالأنابيب المبوبة.

٨- تأثرت رطوبةحبوب القمح بأستخدام الأنابيب المبوبة والميل حيث كانت رطوبة الحبوب ٢٣ ، ٢٠ ، ١٨ ، ١٦,٥ % فى التسوية والرى التقليدى وتسوية بالليزر بدون ميول ونسبة ميل ٠,٠٣ % و ٠,٠٥ % على التوالى.

٩- زادت نسبة حبوب القمح الغير مدروسة بزيادة نسبة الرطوبة.