Effect of Water Discharge and Seedbed Type on Soybean Crop and Some Irrigation Efficiencies under Furrow Irrigation System

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ABSTRACT

The effect of water discharge and seedbed type on soybean crop and some irrigation efficiencies under furrow irrigation system was investigated. Field experiments were carried out during the summer of season 2006 in the farm of Rice Mechanization Center, "Meet El-Deepa, Kafr El-Sheikh Governorat". Surface irrigation system with three different water discharges of 1.252, 2.511 and 3.445 l/s were examined using three different spile pipe diameters. Meanwhile, the seedbed types were T1 (chisel plow one pass followed by disk harrow two passes), T2 (chisel plow two passes followed by disk harrow one pass) and T3 (chisel plow three passes followed by disk harrow one pass). The results showed that advance and recession times along the furrows were affected by water discharge and seedbed type. The initial water infiltration rate and cumulative infiltration were decreased with increasing water discharge when preparing soil with seedbed types (T1), (T2) and (T3). The cumulative infiltration was 55.4 mm, 52.7 mm and 49.5 mm for water discharges of 1.252 l/s, 2.511 l/s and 3.445 l/s, respectively, when preparing soil with seedbed type (T1). The highest soybean grain yield of 1.57 t/fed was obtained for combination of 3.445 l/s water discharge and seedbed type (T3). Water use efficiency increased from 0.466 to 0.635 kg/m^3 and water application efficiency increased from 69.1 to 81.1% as water discharge increased from 1.252 to 3.445 l/s when the soil was prepared with seedbed type (T3). The average values of plant height, No. of pods per plant, pod length and thousand grain weight were increased with increasing water discharge from 1.252 to 3.445 l/s when the soil was prepared with seedbed type (T3). The results of this study could be help in planning, design and management of surface irrigation schemes.

INTRODUCTION

Water demand is augmenting to face the incessant in population. Thus it was necessary to control and manage the available water supply to face overuse problem and minimize water losses to improve irrigation efficiency (Badawy et al., 2001). Soybean is one of the four most important annual crops in the world grown for edible oil. So, it is recommended to increase the planting area of soybean in Egypt. The suitable application of the irrigation water should always have main objectives to reduce production costs and to increase crop yield. According to Rosa et al.

(2001), there is a different crop response to the applied water through irrigation, in a way that the water use efficiency could be measured by the net profit that could be obtained for each water depth unit applied. Thus, the irrigation requires the determination of when and how much water should be applied to each crop; however, they showed that the average irrigation depth application for soybeans was 222 mm. The number of irrigations required depends upon environmental conditions particularly rainfall and the rate of evaporation. The relationships between crop yield and water applied such as water use efficiency and water production are necessary for application in planning, design and management of irrigation (Nasseri and Fallahi, 2007). On the other hand irrigation discharge has significant effect on crop yield and water use efficiency. However, Morsi (2001) indicated that the water use efficiency decreased as the irrigation discharge increased as his irrigation discharge were 1.95, 4.26, 6.20 and 8.50 l/s for corn crop in clay soil under any of furrow length of 40, 60, 80 and 100 m. Also, the combination of seedbed type and irrigation discharge has effect on water use efficiency. Whereas, El Saadawy (2004) indicated that the applied water decreased as the irrigation discharge increased and for the irrigation discharge of 2 l/s, the water use efficiency recorded the highest value for any of the used seedbed type compared to other irrigation discharge of 1.5 and 3 l/s. Also, Zwart and Bastiaanssen (2004) indicated that crop water productivity (yield per unit of seasonal evapotranspiration) could be significantly increased if irrigation was reduced and crop water deficit was intentionally induced.

For furrow irrigation, there are different factors affecting water advance and recession time such as tillage practices, ect. However, El Sherbeny et al. (1997) and Kassem and El Khatib (2000) stated that water advance and recession times increased for traditional furrow irrigation compared with alternate irrigation system. The water use efficiency increased with alternate irrigation system. Alternate furrow irrigation system received lowest amount of irrigation water with saving 22 to 28%. Also, Attia et al. (1999) found that the irrigation every 14-day of soybean with 90 cm between rows, reduced amount of applied irrigation water by 19.7 and 18.8% in two growing seasons. El Tantawy et al. (2006) conducted a field trial to study the effect of land leveling, land sloping and distance between furrows on water use efficiency and grain yield of soybean crop. Their results showed, decreasing the advance and recession times with ratio percentage of about 25.6 and 11.4% for furrow 50 cm width and of about 25.2 and 9.5% for furrow 100 cm width, respectively, saving the applied water with a percentage of about 19.4 and

29.7% in both two widths (50 and 100 cm). Increasing soybean yield with a percentage of about 29.0 and 30.2%, respectively and increasing water use efficiency with percentage of about 6 and 8% in both two widths (50 and 100 cm), respectively.

There are several factors affecting soybean grain yield. El Sayed (2001) studied the effect of some planting and land leveling systems on soybean crop grain yield and water requirements. The results showed that, average of plant height was 62.5 cm, No. of pods per plant were 88.6 and average of grain productivity was 1.58 t/fed under manual planting with traditional land leveling. Touchton and Johnson (1982) indicated that, deep tillage was used prior to planting soybean. Joseph et al. (2001) conducted an experiment to compare crop performance and soil condition under ridge tillage and conventional tillage. Their results showed that average soybean grain yield was 1997 kg/ha (0.84 t/fed) with ridge tillage and 2058 kg/ha (0.86 t/fed) with conventional tillage and soybean grain yield was 3% greater under conventional tillage than under ridge tillage.

Busscher et al. (2006) compared production systems with crop rotations or deep tillage before planting with less intensive management. Production systems included double-crop wheat and soybean and the treatments included surface tillage (disked or none), deep tillage (paratilled or none), deep tillage with winter fallow and maize in rotation, and disked/deep tillage with an in-row subsoiler where soybean was planted in conventional 76 cm wide rows. Results indicated that, soybean yields were 360 kg/ha (0.15 t/fed), greater for paratilled than for subsoiled or non-deep-tilled treatments. For soybean, management of uniform loosening from deep tillage and narrow rows led to higher yields. Silivio et al. (2005) conducted experiments to study the effect of different soil tillage systems on yield of soybean. The tillage systems included Conventional tillage (moldboard plow and disc harrow), Conservation tillage (chisel plow and multitiller) and no-till system. The results showed that, the greatest soybean grain yield of 2710 kg/ha (1.14 t/fed), achieved conservation tillage. Finally, Mulungu et al. (2006) reported that seedbed type affected soybean grain yield.

The objective of this research work was to study the effect of water discharge and seedbed type on soybean crop and some irrigation efficiencies under furrow irrigation system.

MATERIALS AND METHODS

Site and Treatments:

Field experiments were carried out in the farm of Rice Mechanization Center, Meet El-Deepa, Kafr El-Sheikh Governorat during summer season of 2006. The field experimental area was divided into three main plots; each one was divided into three sub-main plots. The sub-main plot was 30 m length and 20 m wide. Twenty-seven furrows were installed in each sub-main plot. The furrow spacing was designed to be 60 cm apart in order to suit the water discharge. Planting soybean grains variety (Giza-21) was practiced manually at rate of 6 kg/fed in the middle of the furrows with one plant per hill, spacing between hills were 50 cm. This variety needs about 120 days to maturity. All the treatments were ridged with three unite ridges. Different equipments were used to conduct seedbed type. The characteristics of these equipments are explained in another work (Guirguis et al., 2007).

No treatment of no-tillage (control treatment) was conducted. After conducting tillage, traditional land leveling was done for all treatments. Soybean furrows were irrigated by using different three spiels diameters. These diameters were 45.5 mm, 60.15 mm and 70 mm, which gave average three different water discharges Q1, Q2 and Q3, respectively based on changes of water depth over the center of spiels (H). Split-plot design was used with two replicates. Meanwhile, seedbed types were chisel plow one pass followed by disk harrow two passes (T1), chisel plow two passes followed by disk harrow one pass (T2) and chisel plow three passes followed by disk harrow one pass (T3). Nine treatments were laid out in completely randomized blocks with spilt-plots design with two replicates. Treatments combinations comprised three levels of water discharges and three levels of seedbed types. The main plots were assigned for the three seedbed types (T1, T2 and T3); while water discharges (Q1, Q2 and Q3) were randomly distributed in the sub plots. All furrows in all plots were blocked-end.

Field Measurements:

Soil characteristics of the experimental field are shown in Table (1). Three samples were obtained from the experimental field before tillage using standard steel core to determine soil bulk density and soil moisture content. Soil moisture content was determined by the standard oven method by drying soil samples in oven at 105^{o}C for 24 hours and moisture was determined based on dry base. All soil characteristics were determined according to Black et al. (1965). Five samples were taken randomly from each plot to determine plant height, pod length, No. of pods per plant, thousand grain weight and grain yield.

Table (1): Some soil characteristics of the experimental field.

Soil depth	Particle size distribution			Texture class	Soil bulk density	Soil moisture content
	Sand	Silt	Clay			
(cm)	(%)	(%)	(%)	(---)	(g/cm^3)	(%, d.b)
0-15	20.6	23.8	55.6	Clay	1.18	18.7
15-30	23.4	21.7	54.9	Clay	1.27	16.5
30-45	19.8	21.7	58.5	Clay	1.29	16.9
45-60	18.7	21.4	59.9	Clay	1.31	16.2

Standard management practices were implemented regarding fertility; pest and seeding date expect crop rotation. Six irrigations were applied during soybean growing season. The time of irrigation of each plot was recorded by digital stopwatch. The irrigation run of each plot was divided into stations with equal distance, 5 m apart. Times of advance (t_1) and recession (t_2) of irrigation water were recorded at the stations along the irrigation run. Infiltration rate of soil was measured after seedbed preparation in each plot by using two flumes in separated furrows. Flumes were installed at the upstream and downstream ends of the furrow for measuring inflow and outflow. According to Oyonarte et al. (2002), experiments were conducted for measuring infiltrated water volume versus time. This procedure was repeated for each water discharge over the experimental field plot. Average cumulative infiltration and infiltration rate were calculated.

Data Analysis:

The field data were analyzed statistically using SAS program (SAS, 1986) using ANOVA procedure. The opportunity time, t_o , was calculated as follows:

$$t_0 = t_2 - t_1 \qquad \text{……………………………………………(1)}$$

Water discharge namely Q1, Q2 and Q3 (l/s) were calculated by the following equation (Michael, 1978):

$$Q = 0.61\times10^{-3} a \times \sqrt{2gH} \qquad \text{……………………………………(2)}$$

Where 'H' is water head above the center of spiles (cm) and 'a' is the area of cross-section of the orifice of the spiles (cm^2) and 'g' is acceleration due to gravity (981 cm/s^2). The volume of applied water to the plot (*V, l*) during each irrigation period was determined by the following equation:

$$V = n \times Q \times t \qquad \text{………………………………………(3)}$$

Where't' is the time required to irrigate the plot (s), 'Q' is the water discharge (l/s/furrow) and 'n' is number of furrows. Water use efficiency (WUE, kg/m^3) could be calculated according to James (1988) as follows:

$$WUE = \frac{Y(kg/fed)}{AW(m^3/fed/season)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

Where Y is grain yield and AW is applied water during growing season. However, the applied water (AW, m^3/fed/season) was calculated as follows:

$$AW = \sum_{i=1}^{i=6} V\,(l/season) \times \left[\frac{4200\,(m^2/fed)}{1000\,(l/m^3 \times 600\,m^2)}\right] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

Water consumptive use was estimated for the 60 cm soil depth according to Israelson and Hansen (1962) as follows:

$$WCU = \sum_{i=1}^{i=6} \frac{(\theta_2 - \theta_1)}{100} \times D \times \rho \times 42 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(6)$$

Where 'WCU' is water consumptive use (m^3/fed/season), θ_1 and θ_2 are soil moistures before and after irrigation (%, d.b), respectively, D is soil layer depth (15 cm), ρ is soil bulk density for the specific soil layer (g/cm^3), 42 is conversion unit and subscript i = 6 means six irrigations. Water application efficiency (Ea, %) was calculated according to Michael (1978) :

$$Ea = \frac{WCU}{AW} \times 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(7)$$

RESULTS AND DISCUSSION

The average water discharge was determined based on different water head during irrigation periods. The average values of Q1, Q2 and Q3 were 1.252, 2.511 and 3.445 l/s, respectively.

The advance and recession times are illustrated in Figure (1) for different water irrigation discharges and seedbed types. It is obvious that the advance and recession times increased under using low water irrigation discharge Q1 (1.252 l/s) with any of seedbed types compared with other water irrigation discharges Q2 (2.511 l/s) and Q3 (3.445 l/s). These results may be due to the effect of soil surface roughness, surface slope, flow rate, soil infiltration characteristics and furrow shape. Also, the advance rate down the field is affected by particles size diameter, pore size distributions, aggregates breakdown, and soil close backing. The single parameter essentially controls not only the amount of water entering the soil, but also the advance rate of the overland flow. Overland flow applied

shear forces to the soil surface. This causes soil aggregate breakdown and particle movement that can result in a thin low-conductivity depositional layer at the soil surface, commonly referred to as it a soil surface seal (El-Sherbeny et al., 1997). These results may be influenced by breakdown of big aggregates into small aggregates and the effect of present of low pore size spaces, which filled (closed) during irrigation by fine particles. This phenomenon causes the velocity of water moves faster through furrow. High water discharge observed large amount of water passed through furrow in a short time. The data of advance time in proportional to volume of water infiltrated through furrow. These results are in agreement with this obtained by El-Tantawy et al. (2006).

The recession times were increased when using low water irrigation discharge Q1 (1.252 l/s) with seedbed types (T1), (T2) and (T3). These results may be due to the effect of the depth of water in the furrow above ground, water storage in the furrow, soil migration, swilling of clay, decrease of soil infiltrability and formation of partial sealing of topsoil surface layer. The average values obtained of the opportunity time are shown in Figure (2). It is obvious that, the average values of opportunity time were 18.8, 16.8 and 15.3 min under different water discharges Q1, Q2 and Q3, with seedbed type (T3), respectively. Meanwhile, they were 23.8, 21.2 and 18.7 min under different water irrigation discharges Q1, Q2 and Q3 with seedbed type (T1), respectively as indicated by Figure (2). Larger opportunity time may be due to the layer under plowing depth of seedbed type (T1) was dense layer (unconfined layer) and characterized by less permeable for water. These results were in agreement with those obtained by Amer (2007).

Table (2) shows average of measured initial and final water infiltration and cumulative infiltration after 180 min as affected by seedbed type and water discharge.

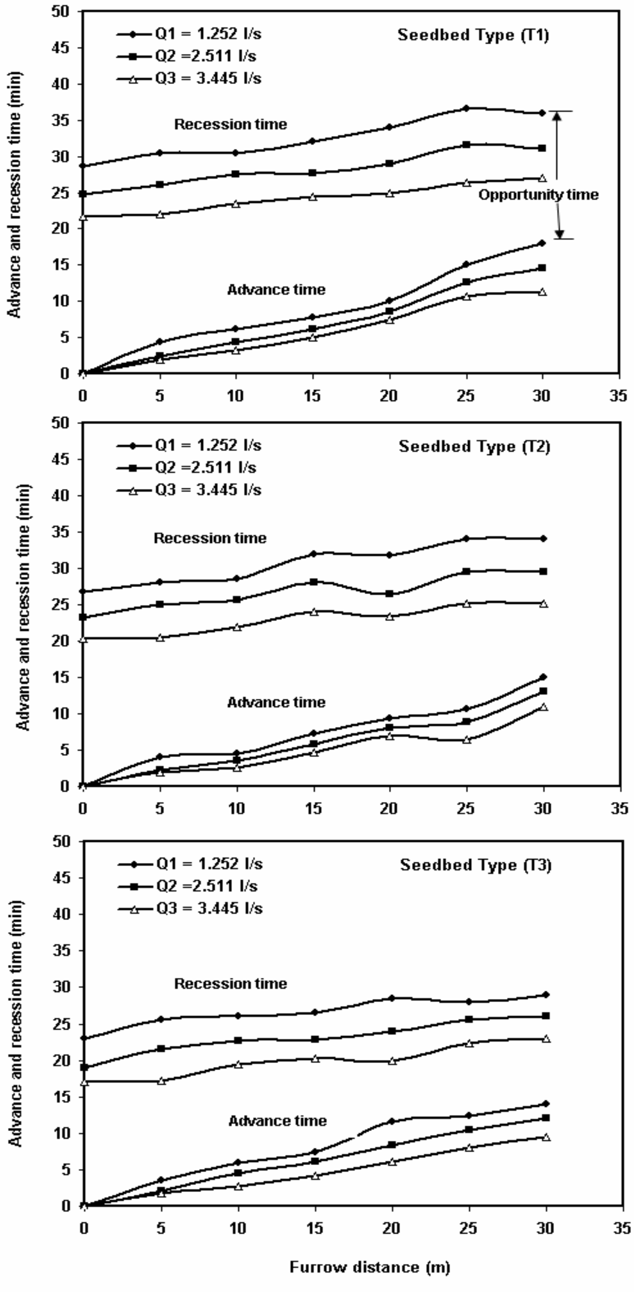

Figure (1): Advance and recession times as affected by water discharges and seedbed types.

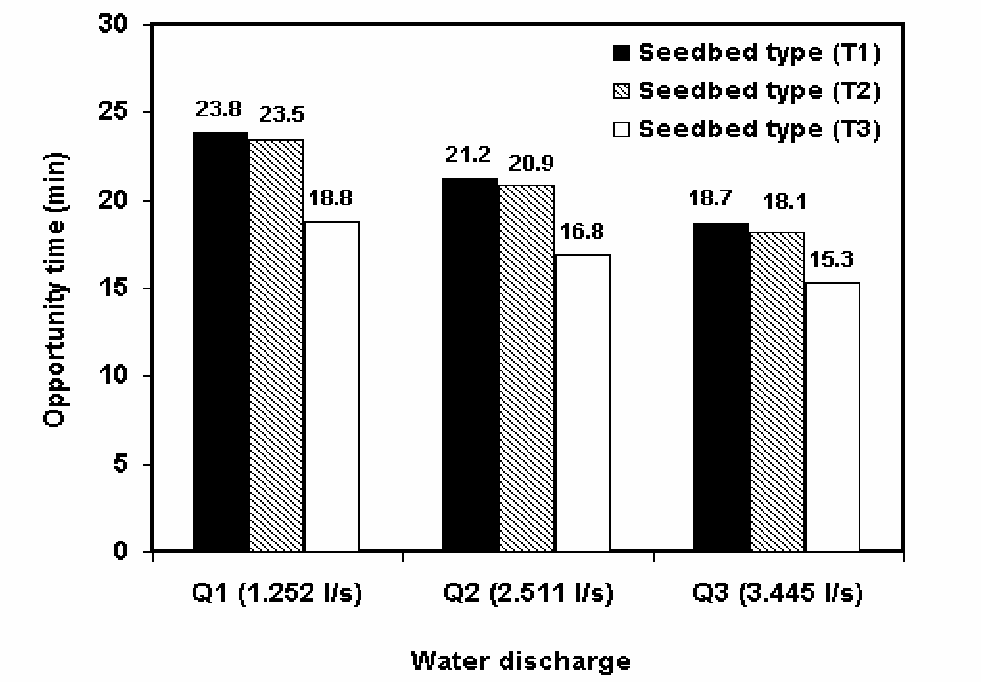

Figure (2): Average opportunity time as affected by water discharges and seedbed types.

Table (2): Average of measured initial and final water infiltration and cumulative infiltration after 180 min as affected by seedbed type and water discharge.

Seedbed type	Water discharge	Initial water infiltration (mm/h)	Final water infiltration (mm/h)	Cumulative infiltration (mm)
T1	Q1 (1.252 l/s)	550.5	1.98	55.4
T1	Q2 (2.511 l/s)	544.9	1.66	52.7
T1	Q3 (3.445 l/s)	501.1	1.30	49.5
T2	Q1 (1.252 l/s)	427.1	2.87	59.6
T2	Q2 (2.511 l/s)	417.6	2.36	58.9
T2	Q3 (3.445 l/s)	337.0	2.03	57.3
T3	Q1 (1.252 l/s)	248.5	3.65	75.7
T3	Q2 (2.511 l/s)	239.4	3.37	62.7
T3	Q3 (3.445 l/s)	230.8	3.25	60.6

As shown in Table (2), the initial water infiltration rates were decreased with increasing water discharge when preparing soil with seedbed types (T1), (T2) and (T3). They were 550.5 mm/h, 544.9 mm/h and 501.1 mm/h for water discharges of 1.252 l/s, 2.511 l/s and 3.445 l/s, respectively, when preparing soil with seedbed type (T1). Also, the cumulative infiltration was decreased with increasing water discharge when preparing soil with seedbed types (T1), (T2) and (T3). It was 55.4 mm, 52.7 mm and 49.5 mm for water discharges of 1.252 l/s, 2.511 and 3.445 l/s, respectively, when preparing soil with seedbed types (T1) as listed in Table (2) and this is due to large amount of water penetrated the soil during low water discharge and water will moved slowly through the furrow and more water penetrated the soil in long time (Guirguis, 2005).

The results showed that, lowest values of average depth of water storage on furrow were obtained from lowest water discharge (1.252 l/s). Meanwhile, highest values of average depth of water storage on furrow obtained from highest water discharge (3.445 l/s) and this is because low amount of water penetrated the soil during the irrigation with high water discharge and water will move quickly through the furrow than penetrate it. These results are in agreement with this obtained by Oyonarte et al. (2002).

The results showed that, the water infiltration rates were decreased with time during advance time along the furrow. Average lowest value of final infiltration rate was found to be 1.30 mm/h with water discharge of 3.445 l/s, when preparing soil with seedbed type (T1). Meanwhile, the average highest value of final infiltration rate was found to be 3.65, 3.37 and 3.25 mm/h with water discharge, Q1, Q2 and Q3, respectively when preparing soil with seedbed type (T3) as listed in Table (2). This is because the observed volume of water storage on furrow decreased along the furrow with time, also water will penetrate rapidly into the soil, but within the time it will decrease. Also, the decrease of soil infiltrability from initially high rate in some cases resulted from gradual deterioration of the soil structure and the consequent partial sealing of the soil profile, detatchment and migration of pore-blocking particles, swelling clay, which occur as infiltration proceeds, entrapment of air bubbles or bulk water compression of soil air if it is prevented froth escaping as it is displaced by incoming and the inevitable decrease in the matric suction gradient. These results are in agreement with those obtained by Lowery et al. (1996).

The analysis of variance given in Tables (3, 4 and 5) shows that differences in soybean grain yield, water use efficiency, water application efficiency, applied water , water consumptive use, average plant height, No. of pods per plant, pod length and thousand grain weight are highly significant ($P \le 0.01$) among seedbed types. Meanwhile, differences in average irrigation time of six irrigations during growing season are not significant ($P \le 0.05$) among seedbed types.

Table (3): Summary of the analysis of variance for the effect of water discharge and seedbed type on soybean grain yield, water use efficiency and water application efficiency.

Source of variation	DF	Soybean yield grain	Water use efficiency	Water application efficiency
		(ton/fed)	(kg/m^3)	(%)
Seedbed type (T)	2	**	**	**
Water discharge (Q)	2	**	**	**
T*Q	4	**	**	*

*** and ** significant at the 5% and 1% level of probability, respectively.**
DF = degree of freedom.

Table (4): Summary of the analysis of variance for the effect of water discharge and seedbed type on applied water, water consumptive use and average irrigation time.

Source of variation	DF	Applied water	Water consumptive use	Average irrigation time
		(m^3/fed/season)	(m^3/fed/season)	(min)
Seedbed type (T)	2	**	**	NS
Water discharge (Q)	2	**	**	**
T*Q	4	*	**	NS

*** and ** significant at the 5% and 1% level of probability, respectively.**
NS = not significant.

Table (5): Summary of the analysis of variance for the effect of water discharge and seedbed type on plant height, No. of pods per plant, pod length and thousand grain weight0

Source of variation	DF	Plant height (cm)	No. of pods plant per (-----)	Pod length (cm)	Thousand grain weight (g)
Seedbed type (T)	2	**	**	**	**
Water discharge (Q)	2	**	**	**	**
T*Q	4	*	*	*	**

*** and ** significant at the 5% and 1% level of probability, respectively.**

Differences in soybean grain yield, water use efficiency, water application efficiency, applied water, water consumptive use, average irrigation time of six irrigations during growing season, average plant height, No. of pods per plant, pod length and thousand grain weight are highly significant ($P \leq 0.01$) among water discharge as shown in Tables (3, 4 and 5). Meanwhile, differences due to interactions among seedbed types and water discharge are significant with the exception of those in average irrigation time of six irrigations during growing season and water consumptive use as shown in Table (4).

Effect of combination among water discharge and seedbed type on soybean grain yield, water use efficiency, water application efficiency, applied water, water consumptive use, average irrigation time, average plant height, No. of pods per plant, pod length and thousand grain weight is presented in Table (6), Table (7) and Table (8), respectively.

Table (6): Effect of water discharge and seedbed type on soybean grain yield, water use efficiency and water application efficiency.

Seedbed type	Water discharge	Soybean yield grain (ton/fed)	Water use efficiency (kg/m^3)	Water application efficiency (%)
T1	Q1	1.19	0.415	63.5
T1	Q2	1.26	0.471	69.6
T1	Q3	1.37	0.531	73.5
T2	Q1	1.20	0.428	66.1
T2	Q2	1.29	0.493	72.1
T2	Q3	1.42	0.554	75.8
T3	Q1	1.29	0.466	69.1
T3	Q2	1.47	0.579	75.3
T3	Q3	1.57	0.635	81.1

Table (7): Effect of water discharge and seedbed type on applied water, water consumptive use and average irrigation time.

Seedbed type	Water discharge	Applied water	Water consumptive use	Average irrigation time*
		(m^3/fed/season)	(m^3/fed/season)	(min)
T1	Q1	2879.3	1828.9	27.3
T1	Q2	2665.2	1855.3	12.6
T1	Q3	2582.8	1897.5	8.9
T2	Q1	2794.9	1847.2	26.5
T2	Q2	2622.9	1892.1	12.4
T2	Q3	2553.8	1935.3	8.8
T3	Q1	2759.3	1905.9	26.1
T3	Q2	2538.3	1911.6	12.0
T3	Q3	2466.8	2001.2	8.5

Table (8): Effect of water discharge and seedbed type on average plant height, No. of pods per plant, pod length and thousand grain weight.

Seedbed type	Water discharge	Average plant height	No. of pods per plant	Pod length	Thousand grain weight
		(cm)	(----)	(cm)	(g
T1	Q1	59.0	50	3.7	57.9
T1	Q2	68.6	71	3.5	61.4
T1	Q3	81.4	137	4.3	81.9
T2	Q1	73.0	64	4.2	65.4
T2	Q2	75.8	90	4.1	78.9
T2	Q3	85.7	149	4.4	88.6
T3	Q1	81.3	73	4.6	69.9
T3	Q2	85.0	114	4.6	87.2
T3	Q3	95.6	187	4.9	90.6

The lowest value of total applied water per season for high water discharge 3.445 l/s was 2466.8 m^3/fed/season when preparing soil with seedbed type (T3) as shown in Table (7). Meanwhile, the highest value of total water applied per season was 2879.3 m^3/fed/season for low water discharges of 1.252 l/s with seedbed type (T1) as shown in Table (7). Also the values of seasonal water consumptive use were ranged from 1828.9 to 2001.2 m^3/fed/season under different water discharges and seedbed types. For the same mentioned treatments, it is obvious that more available soil moisture through increasing the irrigation water applied which gave a chance for more consumption of water and these results are in agreement with those obtained by El-Kady (1985).

It is clear that highest water discharge Q3, (3.445, l/s) with seedbed type (T3) gave the highest soybean grain yield compared with other water discharges and seedbed types as shown in Table (6). This result may be occurred due to seedbed type (T3) had good plowing. Higher water discharge Q3 gave higher water application efficiency of 81.1% and water use efficiency of 0.635 kg/m^3 at seedbed type (T3) as shown in Table (6). This result was agreed with those obtained by Kassem and El Khatib (2000) who mentioned that, increasing water discharge from 0.7 to 2.1 l/s results in increasing water application efficiency from 67.2 to 71.6% at furrow length 50 m in clay soil. The highest values of water application efficiency means that less deep percolation losses below soybean root zone and less tail water furrow. The highest values of water use efficiency may be due to small amount of applied water. There is significant difference of water discharges on grain yield and Q3 gave the highest grain yield. This result may be due to uniformity distribution of water in the root zone of soybean when higher water discharge was applied and decreasing water losses. It is clear that, the combination of water discharge Q3 and seedbed type (T3) gave the highest value of grain yield of 1.57 t/fed as listed in Table (6).

Data in Table (8) showed an increase in all yield components with increasing water discharges from 1.252 to 3.445 l/s regardless of seedbed type (T3). These results may be due to uniform distribution of water which gave a suitable planting and permit light to pass through. Higher water discharge gave water a higher chance for more water-infiltrated distributions through soil, as a result of higher plowing depth. Also these results may be due to improvement of soil aeration conditions and these results are in agreement with those obtained by Joseph et al. (2001), who found that average soybean grain yield was 1997 kg/ha (0.84 t/fed) under ridge tillage and 2058 kg/ha (0.86 t/fed) with conventional tillage and soybean grain yield was 3% greater under conventional tillage than under ridge tillage.

CONCLUSION

The cumulative infiltration was decreased with increasing water discharge when preparing soil with seedbed types (T1), (T2) and (T3). It was 55.4 mm, 52.7 mm and 49.5 mm for water discharges of 1.252 l/s, 2.511 and 3.445 l/s, respectively, when preparing soil with seedbed types

(T1). The average values of plant height, No. of pods per plant, pod length and thousand grain weight were increased with increasing water discharge when preparing soil with chisel plow three passes followed by disk harrow one pass. The average highest grain yield of 1.57 t/fed was observed for combination of water discharge of 3.445 l/s and seedbed by chisel plow three passes followed by disk harrow one pass. Water use efficiency increased from 0.466 to 0.635 kg/m^3 as water discharges increased from 1.252 to 3.445 l/s when preparing soil with chisel plow three passes followed by disk harrow one pass. Water application efficiency increased from 66.1 to 75.8% when water discharge increased from 1.252 to 3.445 l/s when preparing soil with chisel plow two passes followed by disk harrow one pass. The results of this study could be help in planning, design and management of surface irrigation schemes.

REFERENCES

Amer, K. H. (2007). Mathematical and statistical analysis of infiltration water distribution in surface irrigation. Misr J. Ag. Eng., 24(3): 522-539.

Attia, M.M; A.M. Osman; M.A. Sayed and A.A. El Kafoury (1999). Effect of irrigation intervals and row width on-yield, water use efficiency and some economic studies on sesame (Sesamum indicum) in calcareous soil. Soil Water and Environ. Res. Inst, 3rd Conf. On-farm irrigation and Agroelimatology, January 25-27, 1999, Giza.

Badawy, M.E.; H.A. El Khateeb and M. I. Meleha (2001). Effect of different seedbed preparation on water requirement and sunflower yield. Misr J. Ag. Eng., 18 (3): 445-460.

Black, C.A.; D. D. Evans; J. L. White; L. E. Ensminger and F. E. Clark (1965). Methods of soil analysis (part I). Amer. Soc. Agron. Inc., Madison, Wisconsin, USA: 375-377 and 552-557.

Busscher, W.J; P.J. Bauer and J.R Frederik (2006). Deep tillage management for high strength southeastern USA costal plain soils. Soil & Tillage research. 85: 178-185.

El Kady, E. A. F. (1985). Effect of water and fertilizer requirements on the quantitative and quantitative characters of flax. Ph.D. Thesis. Fac. of Agric. Kafer El-Sheikh. Tanta Univ.

El Saadawy, M. A. (2004). Effect of irrigation flow rates, tillage and mulching on corn productivity. Misr J. Ag. Eng., 21 (3): 746-758.

El Sayed, H. G. (2001). Effect of some planting and land leveling on soybean crop productivity. The 9th Conf. of Misr Society of Agric Eng.: 219-232.

El Sherbeny, A.M; M.I.H.Ward and A.A.El Behery (1997). Evaluation alternate irrigation technique under furrow irrigation system. The 5th Conf. of Misr Society of Agric. Eng., 9th September.

El Tantawy, M.T; A.F. El-Sharkawy and M.N Abo-Elnour (2006). Effect of lased land leveling and width between furrows on water use efficiency and yield of soybean crop. Misr. J. Ag. Eng., 23(1): 108-121.

Guirguis, A. E. (2005). Comparative study of different methods for estimating infiltration parameters of irrigation water in furrow system. The 13th Conf. Of the Misr Society of Agric. Eng., 14-15 December 2005: 742-757.

Guirguis, A. E; A. M. Aboukarima; M. S. El Marazky and M.I. Egela (2007). Sunflower crop response to furrow irrigation inflow rate and tillage system. Misr J. Ag. Eng., 24(4):

Hillel, D. (1982). Introduction to soil physics. Academic Press, San Diego, CA.

Israelson, O. W. and V .E. Hansen (1962). Flow of water into and through soils. Irrigation principles and practices. 3rd Edition, John Wiley and Sons, Inc., New York, N. Y., U.S.A.

James, L.G. (1988). Principles of farm irrigation system design. John Wiley and Sons (ed), New York, p.543.

Joseph, L.P.; L.C. Bogge; M. Vigil; T. E. Schumacher; M.J Lindstrom and W. E. Riedell (2001). Crop yield and soil condition under ridge and chisel-plow tillage in the northern corn belt, USA. Soil & Tillage research, 60:21-33.

Kassem, M.A. and S.I. El Khatib (2000). Mathematical determination the effect of the major engineering factors on the efficiency of long furrows irrigation for corn crop. Misr J. Ag. Eng., 17 (3): 569-588.

Lowery, B; M. A. Arshad; R. Lal and W. J. Hickey (1996). Soil water parameters and soil quality. P: 143-157. In: J. W. Doran and A. J Jones (eds) Methods for assessing soil quality. Soil Sci. Soc. Am. Spec. Publ. 49. SSSA, Madison, WI.

Michael, A.M. (1978). Irrigation theory and practice. 1st ed., New Delhi.

Morsi, T. M. A. (2001). A study on irrigation systems: Developing of furrow irrigation method for corn crop under local conditions. M.Sc. Thesis, Agric. Eng. Dept., Fac. of Agric., Kafr El Sheikh, Tanta Uinv., 108p.

Mulungu, L.S; A.J.P. Tarimo; S.O.W. M.Reuben; D.N. Lema; R.H. Makundi and A.W. Massawe. (2006). Effect of seedbed type on yield and yield components of common bean (phaseolus vulgaris L.) commercial cultivars. Agron. J., 5(4): 583-588.

Nasseri, A. and H. A. Fallahi (2007). Water use efficiency of winter wheat under deficit irrigation. Journal of Biological Sciences, 7 (1): 19-26.

Oyonarte, N. A.; L. Mateos and M. J. Palomo (2002). Infiltration variability in furrow infiltration. J. Irrig. and Drain.Eng., ASCE, (128): 26-33.

Rosa, G.M.; M.T. and M. T. Petry (2001). Irrigation needs for maize, soybean and dry-beans during crop growing season in southern BRAZIL. ASAE Paper No. 01-2173, ASAE.

SAS (1986). User's guide, statistical analysis system. SAS Ins., Inc., SAS Circle, P.O.Box 8000, Cary, N.C.

Silivio, K; F. Dubravko; G. Zlatko; H. Stjepan; K. Lgor and C. Kresimir (2005). Effect of different soil tillage systems on yield of maize, winter wheat and soybean on Albic luvisol in north-west Slavonia. Journal of Central European Agriculture, 6(3):241-248.

Touchton, J.T and J.W. Johnson (1982). Soybean tillage and planting method effects on yield of double-cropped wheat and soybeans. Agron. J., 74:57-59.

Zwart, S. J. and W. G. M. Bastiaanssen (2004). Review of measured crop water productivity values for irrigated wheat, rice, cotton, and maize. Agric. Water Management, 69(2): 115-133.

الملخص العربي

تأثير معدلات تصرف المياه وطريقة تمهيد مرقد البذرة على محصول فول الصويا وبعض كفاءات الري تحت نظام ري الخطوط

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الهدف من البحث هو دراسة تأثير العلاقة بين معدلات تصرف المياه وطريقة تمهيد مرقد البذرة على إنتاجية فول الصويا وبعض كفاءات الري تحت نظام ري الخطوط. أجريت تجارب حقلية في مركز ميكنة الأرز بمحطة البحوث الزراعية ميت الديبة - محافظة كفر الشيخ خلال صيف موسم 2006. تم استخدام ثلاث تصرفات للمياه بمتوسطات 1.252، 2.511 ، 3.445 لتر/ث وقد استخدم

المحراث الحفار يليه المشط القرصي لتمهيد مرقد البذرة بثلاثة طرق مختلفة لتمهيد مرقد البذرة، وتمت الزراعة يدويًا. وأوضحت النتائج أن متوسط قيم التسرب التجميعي للمياه انخفض بزيادة معدلات التصرف من 1.252 إلى 3.445 لتر/ث وكانت القيم 55.4 مم و 52.7 و 49.5 مم علي الترتيب لمعدلات التصرف 1.252 لتر/ث و 2.511 لتر/ث و3.445 لتر/ث عند تمهيد مرقد البذرة بمرور المحراث الحفار مرة واحدة فوق سطح التربة يليه مرور المشط القرصي وجهان. وزادت كفاءة استخدام المياه من 0.466 إلى 0.635 كجم/م^3 بزيادة معدلات التصرف من 1.252 الي 3.445 لتر/ث عند تمهيد مرقد البذرة بمرور المحراث الحفار ثلاث أوجه فوق سطح التربة يليه مرور المشط القرصي وجه واحد. وزادت كفاءة إضافة المياه من 66.1 إلى 75.8 % عند زيادة تصرف المياه من 1.252 الي 3.445 لتر/ث عند تمهيد مرقد البذرة بمرور المحراث الحفار وجهان فوق سطح التربة يليه مرور المشط القرصي وجه واحد. وأكبر إنتاجية لحبوب فول الصويا كانت 1.57 طن/فدان عند أعلى تصرف للمياه وعند تمهيد مرقد البذرة بمرور المحراث الحفار ثلاث أوجه فوق سطح التربة يليه مرور المشط القرصي وجه واحد. ويمكن الاستفادة من نتائج الدراسة عند تخطيط أو تصميم أو إدارة نظم الري السطحي لزراعة فول الصويا في أراضي طينية.