# WHEAT ,SOYBEAN PRODUCTION AND SOME WATER RELATIONS AS INFLUENCED BY IRRIGATION SCHEDULING AT NORTHDELTA.

**BY**

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## ABSTRACT

Two field experiments were conducted at the Experimental Farm of Sakha Agric. Res. Station during the winter season (2005/2006) and summer season (2006). The aim of this work is, to study the influence of irrigation scheduling (traditional, 50 % soil moisture depletion and irrigation at 100, 80 % from cumulative pan evaporation) and irrigation discharge (30 and 60 L/sec), on productivity of wheat and soybean, and some irrigation efficiencies. The experiments were conducted in a split-plot design.

Data showed that the grain yield of wheat and seed of soybean had significant differences with various irrigation treatments. Irrigation at 100, 80% from cumulative pan evaporation and 50 % soil moisture depletion, respectively were superior to traditional treatment, by about 21.3, 9.0 and 17.7 % for wheat grain yield and by 13.1, 10.2 and 20.1% for soybean seeds. The corresponding values were 14.8, 11.2 and 10.8 % for straw yield of wheat, respectively. Wheat grain yield and soybean seeds were higher under water discharge of 60 L/sec than that of 30 L/sec, by about 248.8 and 73 (kg/fed), respectively. Results showed that there were significant effects in wheat and soybean yields, by the interactions between irrigation scheduling treatments and water discharge rate.

Total amount of applied water and consumptive use for wheat and soybean crops under irrigation scheduling treatments were in the order: Traditional > 50 % soil moisture depletion > 80% pan> 100% pan evaporation. As regards to irrigation discharge, the amounts of water applied and consumptive use (m3/fed), under discharge of 30 L/sec were higher than that of 60

L/sec for both crops. Field water use and crop water use efficiencies (kg/m3) for wheat and soybean yields generally, take the same trend; the lowest values were found under traditional treatment and discharge of 30 L/sec compared with the other treatments.

Water application efficiency values were higher with treatments of 100% and 80% from cumulative pan evaporation and 50 % depletion than traditional treatment, respectively by about 12.9, 7.49 and 6.5 % for wheat and about 13.29, 10.73 and 5.0 % for soybean. Water application efficiency increased with increasing water discharge. Irrigation losses had almost the opposite trend to that encountered with water application efficiency %. Results revealed that 100, 80 % cumulative pan evaporation and 50% depletion could save irrigation water by 12.9, 4.49 and 6.5% respectively, compared to traditional treatment under wheat crop. The corresponding values were 13.29, 10.73 and 5.0 % respectively, under soybean crop. Irrigation discharge of 60 L/sec saved irrigation water amounted by about 4.09 % and 4.08 % for wheat and soybean crops, respectively compared to 30L/sec.

It can be recommended to use class A pan evaporation in irrigation scheduling (proper time and amount of water), to maximize the return from unit of water. Also, this method is simple to transfer the information to extension worker and farmers. In other words, wheat crop could be irrigated every three weeks during growth stages. While soybean could be irrigated every 10 days during the different growth stages under conditions of North Delta Egypt.

**Keywords. Irrigation, Water discharge, Depletion, Pan evaporation, wheat, soybean.**

## INTRODUCTION

Egypt is almost solely dependent on The River Nile as the main water source. Approximately 96% of Egypt's water supply is from that main source. Nearly 85% of the available supply, (approximately 55.5 billion cubic meters annually) is consumed by the agriculture sector. The possibility to increase water supply is limited and conditioned. Moreover the competition for limited water resource is increasing among urban, industrial, and agricultural interests. An available alternative is to increase irrigation efficiency and minimize water losses under irrigation. Economic irrigation requires application of water at the proper time, and suitable amount to meet the needs of the crop growth, to prevent salt accumulation in the soil, and to prevent the excessive waste of water. Improving the irrigation system constitutes the key element in achieving the national goal of increasing irrigation efficiency, and fulfilling the equity of water distribution among farmers in order to achieve the maximum crop yield. **( El-Mowelhi et al., 1999, and Abo Soliman et al, 2005).**

Wheat (Triticum aestivum) is the principal winter crop in Egypt, it is the most important grain crop in the world. The world production exceeds that of any other grain crop, and in many respects it is superior to any other human food. Wheat is the major breadmaking cereal, and Egypt has to supplement production by importing just over half of its needs to supply the annual demand. **Jiamin et al. (2005)** found that the irrigation schedules of pre-sowing irrigation only, pre-sowing irrigation + irrigation at jointing stage, and pre-sowing irrigation + irrigation at jointing and flowering stages, were identified and recommended for practical winter wheat production. Also he found that the wheat grain yield reached their maximum value of 7423 kg/ha at the ET rate of 509 mm. **Buchong et al, (2006)** found that, the optimum controlled soil water deficit levels, should range 50–60% of field water capacity (FWC) at the middle vegetative growth period (jointing), and 65–70% of FWC at both of the late vegetative period (booting), and early reproductive period (heading) followed by 50–60% of FWC at the late reproductive periods (the end of filling or filling and maturity). **Ali et al. (2007)** showed that the highest water productivity and productivity of irrigation water, were obtained in the alternate deficit treatment (single- or two-stage deficit and no-deficit), where deficits were imposed at maximum tillering (jointing to shooting) and flowering to soft dough stages of growth period, followed by single irrigation at crown root initiation stage. Under both land- and water-limiting conditions, the alternate deficit strategy showed maximum net financial return.

Soybean (Glycine max L.) is considered to be one of the most important protein and oil crops, introduced all over the world. The work of **Korte et al. (1983), Eck et al. (1987), Speck et al. (1989)**, and of many others, has shown that soybean is amenable to limited irrigation. **Stegman et al. (1990)** indicated that although short-term water stress in soybean during early flowering, may result in flower and pod drop in the lower canopy, increased pod set in the upper nodes compensates for this, where there is a resumption of normal irrigation.

**Abd El-Rahman (1985)** concluded that water application and water use efficiency increased as the flow rate increased. **El-Mowelhi et al. (1999)** indicated that the less amount of irrigation water delivered to the fields was recorded under irrigation discharge of 6 L/sec/m, while the highest amount was recorded under irrigation discharge of 2 L/sec/m. Also they found that the highest values of field water use and crop water use efficiencies were achieved under irrigation discharge of 6 L/sec/m, while the lowest values were under discharge of 2 L/sec/m. **Jiamin et al. (2005)** found that the soil water use efficiency (SWUE) and irrigation water use efficiency IWUE were negatively related to the irrigation water volume. WUE reached their maximum value of 1.645 kg/m$^3$ at the ET rate of 382 mm.

The aim of this work is to study the influence of irrigation scheduling and irrigation discharge on productivity and some water relations of wheat and soybean crops.

## MATERIALS AND METHODS

Two field experiments were conducted at the Experimental Farm of Sakha Agric. Res. Station during the winter season (2005/2006) and summer season (2006). The aim of the study was to investigate the influence of irrigation scheduling and irrigation discharge, on productivity and some water relations of wheat and soybean crops. The experiments were conducted in a split-plot design with four replicates. The main plots were randomly assigned to four irrigation scheduling, and the sub-plots were assigned to two irrigation discharge as follows:

**Main plots:**

1. Traditional irrigation where the amount of irrigation waterapplied was equal to farmer practices in the area ($I_1$).
2. Irrigation at 50% soil moisture depletion of available water to refill the root zone to field capacity ($I_2$).
3. Irrigation at 80 % of class A pan evaporation ($I_3$)
4. Irrigation at 100 % of class A pan evaporation ($I_4$).

**Sub-plots:**

1. Irrigation discharge 30 L/s, low water flow rate ($D_1$).
2. Irrigation discharge 60 L/s, high water flow rate ($D_2$).

**Scheduling irrigation using evaporation records:**

Usable capacity of the soil moisture reservoir for a field and crop must be determined. The soil moisture reservoir capacity is limited by soil depth from which the crop extracts appreciable amounts of water so; the upper 60 cm depth of the soil surface were used in estimating the soil moisture reservoir in the present study **(Eid et al. 1982)**. Soil moisture constants are given in Table (2).

Soil available water for 60 cm depth was 128 mm .Multiply this result by 50 % to get 64 mm which is the usable moisture at every irrigation.

Multiply the usable moisture 64 by 80 and 100 % for wheat and soybean crops. The usable moisture at every irrigation is 51.2 mm ($I_3$) and 64 mm ($I_4$).

The equivalent amount of evaporation that cans occur while this amount of moisture is being used i.e. usable evaporation must be determined from Table (1).

Crop coefficient $K_c$ was quoted from FAO Irrigation and Driange Technical (1998) Paper No. 56 and used in irrigation scheduling for wheat and soybean crops. Wheat $K_c$ values are 0.7, 1.15 and 0.4 of initial, development and late season growth stages, respectively. The corresponding values for soybean are 0.5, 1.15 and 0.5, respectively.

In case of soil moisture depletion treatment, irrigation started when 50 % of soil available water was depleted by monitoring soil moisture content every week by gravimetric method. Traditional irrigation was as the recommendation of Ministry of Agriculture. Irrigation scheduling treatments were started after almohayah irrigation in both wheat and soybean crops.

In winter season, wheat (Triticum aestivum) Giza 168 variety was planted on November 1, 2005. All plots received a total of 75 Kg Ca-superphosphate/fed., during cultivation. Nitrogen fertilizer in the form of urea was side dressed at a rate of 75 Kg N/fed, in two doses after first and second irrigations. Wheat was harvested on May, 5, 2006 for all treatments. Yield and yield components were determined during the growing season.

In summer season, soybean (Glycine max L.) was planted on June 1, 2006. All plots received a total of 50 Kg Ca-superphosphate/fed., during cultivation. Nitrogen fertilizer in the form of urea was side dressed at a rate of 30 Kg N/fed, in two doses before the first and the second irrigations. Soybean was harvested on September 7, 2006 from all treatments. Yield and yield components were determined during the growing season.

**Amount of water applied**

Amount of irrigation water was measured by using a rectangular sharp crested weir. The discharge was calculated using the following equation as described by (Masoud, 1969).

$$Q = CLH^{3/2}$$

Where: $Q$ = Discharge ($m^3$/sec)

$L$ = Length of the crest in meters.

$H$ = Head in meters.

$C$ = Empirical coefficient that must be determined from discharge measurement.

The metrological data were recorded from Sakha Climatologically Station are presented in Table (1)

**Table(1):** The metrological data of Sakha Climatologically Station during the growing seasons.

| Month | Air Temp.C° | | Relative humidity,% | | wind peed, km /24 hr.at 2 m height | Solar radiation, MJ /m2 | Soil Temp.C° | Ep, mm/day | Total rain, mm |
|---|---|---|---|---|---|---|---|---|---|
| | T, MAX | T, MIN | RH, MAX | RH, MIN | | | | | |
| Nov. 05 | 20.697 | 11.766 | 94.483 | 54.552 | 73 | 9.4 | 17.40 | 3.95 | 7.0 |
| Dec. 05 | 18.440 | 9.480 | 94.600 | 52.800 | 59 | 6.6 | 13.97 | 3.19 | 8.0 |
| Jan. 06 | 20.967 | 11.177 | 94.933 | 56.233 | 48.43 | 8.1 | 10.580 | 2.46 | 84.0 |
| Feb. 06 | 23.067 | 11.515 | 92.185 | 48.741 | 69.72 | 13.7 | 14.600 | 3.32 | 16.0 |
| Mar-06 | 26.547 | 16.647 | 93.967 | 47.433 | 103.87 | 15.4 | 19.320 | 3.51 | 17.0 |
| Apr-06 | 29.293 | 18.829 | 94.679 | 45.750 | 91 | 19.5 | 23.000 | 4.51 | 19.0 |
| May-06 | 31.529 | 23.381 | 93.613 | 53.290 | 111 | 22.8 | 26.632 | 5.43 | 0.0 |
| Jun-06 | 31.572 | 23.490 | 93.655 | 59.586 | 78 | 20.4 | 27.528 | 6.48 | 0.0 |
| Jul-06 | 33.553 | 24.327 | 93.367 | 57.233 | 117 | 23 | 28.457 | 6.97 | 0.0 |
| Aug. 06 | 33.076 | 22.959 | 93.966 | 48.621 | 65 | 22.3 | 25.876 | 7.58 | 0.0 |
| Sep. 06 | 29.221 | 19.938 | 92.897 | 48.103 | 76 | 20.3 | 21.457 | 6.61 | 0.0 |

**Water consumptive use (C.U)**: was calculated according to (Israelson and Hansen, 1962) as follows:

$$CU = \sum_{i=1}^{i=n} \frac{Pw_2 - pw_1}{100} \times D_{bi} \times D_i$$

Where:

C.U. : Water consumptive use in cm.

$Pw_2$ : Soil moisture percent after irrigation in the i $^{th}$ layer

$Pw_1$: Soil moisture percent before the next irrigation in the i $^{th}$ layer

$D_{bi}$ : Bulk density g/cm$^3$ of the i $^{th}$ layer of the soil

$D_i$ : Depth of the i $^{th}$ layer of the soil, cm

i : Number of soil layer sampled in the root zone depth (D).

**Field water use efficiency**: was calculated as follows:
**FWUE (kg/m$^3$)** =Yield **(kg/fed.)**/ Amount of water applied **(m$^3$/fed).**

**Crop Water use efficiency** (C.W.U.E) was calculated by using formula:
**C.W.U.E (kg/m$^3$)** = Yield **(kg/fed.)** / Seasonal water consumptive use **(m$^3$/fed)**, (Doorenbos and Pruitt, 1977).

**Table (2): Some soil properties for the experimental field.**

| Soil depth (cm) | Particle size distribution | | | Texture grade | Bulk density , g/cm3 | EC, dS /m | Soil moisture characteristics | | | I R, cm/hr |
|---|---|---|---|---|---|---|---|---|---|---|
| | Sand% | Silt% | Clay% | | | | FC% | WP% | AW% | |
| 0--15 | 9.14 | 33.75 | 57.11 | Clayey | 1.14 | 1.3 | 40.4 | 22.02 | 18.38 | 1.35 |
| 15--30 | 9.55 | 33.14 | 57.31 | Clayey | 1.18 | 1.3 | 42.95 | 23.32 | 19.63 | |
| 30--60 | 8.98 | 38.49 | 52.53 | Clayey | 1.26 | 1.5 | 36.25 | 19.7 | 16.55 | |
| 60--90 | 9.21 | 39.05 | 51.74 | Clayey | 1.26 | 1.5 | 37.76 | 20.69 | 17.07 | |

EC=Electrical conductivity FC=Field capacity WP=Wilting point AW= Available water IR= Infiltration rate

**Statistical analysis:** Data are subjected to statistical analysis according to Snedecor and Cochran (1980).

**Water application efficiency**: It is the ratio of the average depth of irrigation water infiltrated and stored in the effective root zone to the average depth of irrigation water applied, Michael (1978).

**Irrigation water losses**: consists of deep percolation and runoff:

Loss % =100 − Water application efficiency %

**Infiltration rate (IR)**: It was determined using double cylinder infiltrometer as described by Garcia (1978). Soil bulk density was determined according to Klute (1986) and other soil properties were analyzed before planting and presented in Table (2).

## RESULTS AND DISCUSSION

### Wheat crop:

### 1- Yield and yield components.

Data in Table (3) showed that there were a highly significant differences in the grain and straw yields, 1000 grain weight, number of tillers/plant, spiklets/spike, plant height and panicle length with various irrigation scheduling. Grain yield increased by about 17.74, 8.98 and 21.31 % under 50 % soil moisture depletion, 80 % and 100 % from cumulative evaporation pan, respectively as compared to traditional treatment. The corresponding values were 11.14,10.82 and 14.81 % for straw yield and 9.63, 8.1 and 23.41 % for 1000 grain weight and 1.73, 1.27 and 6.01 % for plant height and 2.33 , 1.16 and 6.98 % for panicle length and 3.08, 1.54 and 7.79 % for tillers/plant and 6.21, 5.0 and 12.76 % for spiklets/spike, respectively. It is clear from data that scheduling irrigation at 100 % pan evaporation resulted in the highest values of wheat grain yield and yield components comparing with the other methods of irrigation scheduling The results were supported by the findings of **Jiamin et al. (2005), Buchong et al. (2006) and Ali et al. (2007).**

Results in Table (3) showed that there were highly significant differences with various irrigation water discharges (30 and 60 L/sec), for all studied parameters. The values under irrigation discharge of 60 L/sec were higher than 30 L/sec by about 248.8 (kg/fed) for grain yield and 2.9 (gm) for 1000 grain weight. The corresponding mean values were 0.1 (cm) for panicle length, 0.4 tillers/plant and 1.5 spiklets/spike. While, irrigation water

**Table (3):** Wheat yield and its components as affected by various irrigation scheduling and water discharge

| Treatments | Parameters | | | | | | |
|---|---|---|---|---|---|---|---|
| | Grain yield (kg/fed.) | Straw yield (kg/fed.) | Plant height (cm) | Panicle length (cm) | Average number of tillers /plant | Spiklets per spike | 1000 grain weight (gm) |
| **Irrigation scheduling** | | | | | | | |
| Traditional | 2661 | 3188 | 109.9 | 8.6 | 6.5 | 58.0 | 45.7 |
| 50% depletion | 3133 | 3543 | 111.8 | 8.8 | 6.7 | 61.6 | 50.1 |
| 80 % pan evaporation | 2900 | 3533 | 1113 | 8.7 | 6.6 | 60.9 | 49.4 |
| 100% Pan evaporation | 3228 | 3660 | 116.5 | 9.2 | 7.0 | 65.4 | 56.4 |
| F-test | ** | ** | ** | ** | ** | ** | ** |
| L.S.D. 0.05 | 102.6 | 60.36 | 0.448 | 0.074 | 0.138 | 1.05 | 1.26 |
| L.S.D. 0.01 | 145.43 | 86.22 | 0.701 | 0.107 | 0.169 | 1.51 | 1.79 |
| **Irrigation discharge** | | | | | | | |
| 30 L/sec | 2856 | 3596 | 113.0 | 8.8 | 6.5 | 6.5 | 48.9 |
| 60 L/sec | 3105 | 3366 | 111.7 | 8.9 | 6.9 | 62.2 | 51.8 |
| F-test | ** | ** | ** | ** | ** | ** | ** |
| L.S.D. 0.05 | 106.16 | 40.09 | 0.339 | 0.077 | 0.134 | 0.78 | 1.07 |
| L.S.D. 0.01 | 148.8 | 56.20 | 0.476 | 0.108 | 0.188 | 1.09 | 1.5 |
| Interactions | | | | | | | |
| S × D | [illegible] | ** | ns | ns | ** | ns | ** |

Table (4): Interactions between irrigation scheduling methods and irrigation discharge for wheat crop.

| Irrigation scheduling | Grain yield, kg/fed. Irrigation discharge, l/s | | Straw yield, kg/fed. Irrigation discharge, l/s | | Weight of 1000 grain ,g Irrigation discharge, l/s | | Tillers/plant Irrigation discharge, l/s | |
|---|---|---|---|---|---|---|---|---|
| | D1 | D2 | D1 | D2 | D1 | D2 | D1 | D2 |
| Traditional | 2643.75 b | 2677.5 d | 3222.5 c | 3152.5 c | 45.05 c | 46.38 c | 6.4 c | 6.53 d |
| 50% depletion | 2975.0 a | 3290.0 b | 3657.5 b | 3430.0 b | 48.0 b | 52.20 b | 6.55 b | 6.83 c |
| 80 % pan evaporation | 2745.0 b | 3055.0 c | 3690.0 b | 3377.5 b | 47.08 b | 51.63 b | 6.20 d | 7.03 b |
| 100% Pan evaporation | 3060.0 a | 3396.25 a | 3815.0 a | 3505.0 a | 55.65 a | 57.08 a | 6.78 a | 7.28 a |

discharge of 60 L/sec were lower than 30 L/sec by about 230 (kg/fed) for straw yield and 1.4 (cm) for plant height.

These decrements in production of wheat crop could be attributed to that under traditional and low discharge or low water flow rate (30 L/sec.) treatments; the chance for more leaching downward for both water and its load of fertilizers could be happened. On the other hand, under other treatments which accompanied with less water content, more energy is forced to extract more water with its content of fertilizers which in turn resulted in decreasing the withdrawn of fertilizers. Similar results were obtained by **El-Hamdi and Knany (2000).**

The interaction between irrigation scheduling and irrigation discharge (S×D), results in Table (4) showed that, there were significant differences with the grain and straw yields, 1000 grain weight and number of tillers/plant. While, insignificant differences were found with plant height, panicle length and spiklets/spike. The interaction between irrigation at 100 % pan and water discharge 60 l/s (D2) resulted in the highest values of grain yield, 3396.25 kg/fed. , weight of 1000 grain, 57.08 g and the tillers per plant, 7.28.The highest straw yield. 3815.0 kg/fed. was obtained by irrigation at 100 % pan and water discharge 30 l/s (D1).

**2. Water relations:**

**2.1. Water applied, water consumptive use and some irrigation efficiencies:**

Total amount of water applied (m3/fed) including rainfall (151 mm) for wheat crop was shown in Table (5). It has been noticed that the total amount of water applied for irrigation scheduling treatments, were in the following order: Traditional > 50 % depletion >80 % pan evaporation > 100 % pan evaporation, whereas, the values were 2416.7, 2181.5, 2070.3 and 1962.8 m3/fed, respectively. It was observed that irrigation at 80 % pan evaporation received amount of water higher than that received under irrigation at 100 % pan evaporation due to the more number of irrigations under (I3) treatment. Data show that, the amount of water applied under discharge of 30 L/sec. was higher than 60 L/sec. by about 8.5%.This could be attributed to the low water flow rate. Similar results were obtained by **El-Mowelhi et al. (1999).** Water consumptive use (m3/fed) generally behaved the same trend of water applied for all treatments. With regarding to field water use and crop water use efficiencies (kg/m3) for grain and straw yields (Table 5) generally take the same trend; the lowest values were achieved under traditional and discharge of 30 L/sec. treatments compared with the other treatments. While, the highest values were obtained under irrigation at 100 % pan evaporation with irrigation water discharge 60 L/sec. Similar results were obtained by **Abd El-Rahman (1985), El-Mowelhi et al. (1999), Zhen Li et al. (2004) and Jiamin et al. (2005).** The highest values of CWUE and FWUE may be due to that higher yield was produced in all treatments than under traditional treatment.

Data also, revealed that irrigation scheduling methods and water discharge affected the stored water in the soil. The highest average value, 1664.36 m3/fed. was recorded with traditional irrigation (I1) while, the lowest one, 1604.9 m3/fed. was obtained under irrigation at 100 % cumulative pan evaporation (I4). The stored water under discharge 60 L/sec., 1601.23 m3/fed. was lower than that under discharge of 30 L/sec., 1645.92 m3/fed. The difference between the stored water could be attributed to that under the low water discharge the time of irrigation are high and hence, the opportunity to loss water by percolation.

As regards to water application efficiency %, it is worthy to mention that the irrigation at 100 % cumulative pan evaporation achieved the highest value (81.77%) followed by 80 % cumulative pan evaporation (76.36%) and 50 % soil moisture depletion (75.37%). While the lowest value (68.87%) was achieved under the traditional treatment. Concerning the water discharge treatments, water application efficiency % was higher under 60 L/sec. than 30 L/sec. by about 4.09 %. Similar results were obtained by **Abd El-Rahman (1985) and El-Mowelhi et al. (1999).** On the other hand, water losses at on farm levels % (Table, 5) had almost the opposite trend to that encountered with water application efficiency %. The values of water losses % were 18.23, 23.64, 24.63 and 31.13 % for 100 %, 80 % cumulative pan evaporation, 50 % soil moisture

**Table (5) :** Some water relations as affected by various irrigation scheduling and water discharge under wheat crop.

| Treatments | Water applied (m3/fed) | F.W.U.E.,kg/m3 water | | C.U, m3/fed. | C.W.U.E.,kg/m3 water | | Stored water, m3/fed. | Water application efficiency % | Losses % |
|---|---|---|---|---|---|---|---|---|---|
| | | Grain | Straw | | Grain | Straw | | | |
| **Irrigation scheduling** | | | | | | | | | |
| Traditional | 2416.7 | 1.10 | 1.32 | 1675.9 | 1.59 | 1.90 | 1664.36 | 68.87 | 31.13 |
| 50% depletion | 2181.5 | 1.44 | 1.62 | 1640.1 | 1.91 | 2.16 | 1644.09 | 75.37 | 24.63 |
| 80 % pan evaporation | 2070.3 | 1.40 | 1.71 | 1632.6 | 1.78 | 2.16 | 1580.95 | 76.36 | 23.64 |
| 100% Pan evaporation | 1962.8 | 1.64 | 1.86 | 1571.8 | 2.05 | 2.33 | 1604.9 | 81.77 | 18.23 |
| **Irrigation discharge** | | | | | | | | | |
| 30 L/sec | 2233.2 | 1.28 | 1.61 | 1659.9 | 1.72 | 2.17 | 1645.92 | 73.7 | 26.3 |
| 60 L/sec | 2058.5 | 1.51 | 1.64 | 1600.3 | 1.94 | 2.1 | 1601.23 | 77.79 | 22.21 |

**2.2. Irrigation date and number of irrigations:**

The obtained results in Table (6) showed that the method on which irrigation was scheduled affected the date of irrigation and the number of irrigations for wheat crop. Irrigation at 80 % from cumulative pan evaporation resulted in the highest number (8) of irrigations. While traditional irrigation, irrigation at 50 % soil moisture depletion of soil available water and irrigation at 100 % from cumulative pan evaporation, resulted in 7 irrigations but differed in dates.

**Table (6):** Effect of irrigation scheduling methods on the irrigation date and number of irrigations.

| Traditional Irrigation | | Irrigation at 50 % depletion | | Irrigation at100% pan | | Irrigation at 80 % pan | |
|---|---|---|---|---|---|---|---|
| Irrigation date | Number of irrigations | Irrigation date | Number of irrigations | Irrigation date | Number of irrigations | Irrigation date | Number of irrigations |
| 01-Nov-05 | | 01-Nov-05 | | 01-Nov-05 | | 01-Nov-05 | |
| 21-Nov-05 | | 21-Nov-05 | | 21-Nov-05 | | 21-Nov-05 | |
| 25-Dec-05 | | 14-Dec-05 | | 08-Dec-05 | | 06-Dec-05 | |
| 05-Feb-06 | | 12-Jan-06 | | 04-Jan-06 | | 23-Dec-05 | |
| 26-Feb-06 | 7 | 28-Feb-06 | 7 | 20-Feb-06 | 7 | 08-Feb-06 | 8 |
| 18-Mar-06 | | 20-Mar-06 | | 09-Mar-06 | | 01-Mar-06 | |
| 08-Apr-06 | | 10-Apr-06 | | 31-Marr-06 | | 19-Mar-06 | |
| | | | | | | 09-Apr-06 | |

**Table (8):** Interaction between irrigation scheduling methods and irrigation discharge for soybean crop.

| Irrigation scheduling | Seed yield, kg /fed. | | Plant height, cm | |
|---|---|---|---|---|
| | Irrigation discharge, l/s | | Irrigation discharge, l/s | |
| | D1 | D2 | D1 | D2 |
| Traditional | 1200.00 d | 1245.00 c | 66.00 d | 73.00 c |
| 50% depletion | 1337.5 b | 1427.5 b | 74.45 b | 80.70 a |
| 80 % pan evaporation | 1295.00 c | 1398.75 b | 67.83 c | 77.13 b |
| 100% Pan evaporation | 1442.50 a | 1495.00 a | 77.75 a | 81.70 a |

## 2. Water relations:

### 2.1. Water applied, water consumptive use and irrigation efficiencies:

Results in Table (9) showed that the highest amount of water applied and water consumptive use (m3/fed) were found under traditional treatment followed by 50 % soil moisture depletion and 80 % from cumulative evaporation pan. While the lowest amount were found with 100 % from cumulative evaporation pan. The amounts of water applied were 2740.76, 2484.5, 2285.4and 2231.6 (m3/fed.) for the traditional, 50 % soil moisture depletion, 80 % and 100 % from cumulative evaporation pan respectively. It was observed that irrigation at 80 % pan evaporation received amount of water higher than that received under irrigation at 100 % pan evaporation due to the shortest irrigation intervals and consequently more number of irrigations under (I3) treatment. The corresponding amount of water consumptive use were 1905.65, 1827.40, 1817.5 and 1745.65 (m3/fed), respectively. As regards to irrigation water discharge, the amount of water applied and water consumptive use (m3/fed) under discharge of 30 L/sec were higher than 60 L/sec by about 166.1 and 73.75 m3/fed, respectively. Field water use and crop water use efficiencies (kg/m3) for seed yield (Table 9) generally take the same trend; the highest values were found under irrigation at 100 % from cumulative evaporation pan treatment and discharge of 60 L/sec compared to the other treatments. Similar results were obtained by **Abd El-Rahman (1985) and El-Mowelhi et al. (1999).**

The obtained results in Table (9) showed that water application efficiency % under 100%, 80% from cumulative pan evaporation and 50% depletion were higher than traditional irrigation by about 13.29, 10.73 and 4.99 %, respectively. Concerning irrigation water discharge, it is clearly that, water application efficiency was increased with increasing discharge rate. The values of water application efficiency % were 72.56 and 76.64 % for irrigation water discharge of 30 and 60 L/sec respectively. Data in Table (9) revealed that the irrigation losses at on farm levels had almost the opposite trend to that encountered with water application efficiency. Whereas, irrigation losses % under traditional,50 % depletion, 100 and 80 % from cumulative evaporation pan and were31.71, 26.71, 20.98 and 18.42%, respectively. Also, irrigation losses % were higher under discharge 30 L/sec than 60 L/sec by about 4.08 %.

**2.2. Irrigation date and number of irrigations:**

The obtained results in Table (10) showed that the method on which irrigation was scheduled, affected the date of irrigation and the number of irrigations for soybean crop. Irrigation at 80 % pan evaporation resulted in the highest numbers (10) of irrigations, while traditional one received the lowest numbers (7). While irrigation at 50 % of soil available water and 100 % pan evaporation resulted in 8 irrigations but differed in dates.

**Conclusion:**

It can be recommended to use class A pan evaporation in irrigation scheduling (proper time and amount of water), to maximize the return from unit of water. Also, this method is simple to transfer the information to extension worker and farmers. In other words, wheat crop could be irrigated every three weeks during growth stages. While soybean could be irrigated every 10 days during the different growth stages under conditions of North Delta Egypt.

**Table (9):** Some water relations as affected by various irrigation scheduling and water discharge under soybean crop.

| Treatments | Water applied (m3/fed) | F.W.U.E. ,kg/m3 water | C.U, m3/fed. | C.W.U.E. ,kg/m3 water | Stored water , m3/fed. | Water application efficiency % | Losses % |
|---|---|---|---|---|---|---|---|
| **Irrigation scheduling** | | | | | | | |
| Traditional | 2740.76 | 0.45 | 1905.65 | 0.64 | 1871.80 | 68.29 | 31.71 |
| 50% depletion | 2484.5 | 0.56 | 1827.40 | 0.76 | 1821.00 | 73.29 | 26.71 |
| 80 % pan evaporation | 2285.4 | 0.59 | 1817.50 | 0.74 | 1806.00 | 79.02 | 20.98 |
| 100% Pan evaporatio | 2231.6 | 0.66 | 1745.65 | 0.84 | 1820.50 | 81.58 | 18.42 |
| **Irrigation discharge** | | | | | | | |
| 30 L/sec | 2538.25 | 0.52 | 1860.93 | 0.71 | 1841.73 | 72.56 | 27.44 |
| 60 L/sec | 2372.15 | 0.59 | 1787.18 | 0.78 | 1817.93 | 76.64 | 23.36 |

**Table (10):** Effect of irrigation scheduling methods on the irrigation date and number of irrigations.

| Traditional Irrigation | | Irrigation at 50 % depletion | | Irrigation at100% pan | | Irrigation at 80 % pan | |
|---|---|---|---|---|---|---|---|
| Irrigation date | Number of irrigations | Irrigation date | Number of irrigations | Irrigation date | Number of irrigations | Irrigation date | Number of irrigations |
| 01-Jun-06 | 7 | 01-Jun-06 | 8 | 01-Jun-06 | 8 | 01-Jun-06 | 10 |
| 12-Jun-06 | | 12-Jun-06 | | 12-Jun-06 | | 12-Jun-06 | |
| 28-Jun-06 | | 25-Jun-06 | | 28-Jun-06 | | 26-Jun-06 | |
| 07-Jul-06 | | 05-Jul-06 | | 08-Jul-06 | | 04-Jul-06 | |
| 19-Jul-06 | | 15-Jul-06 | | 18-Jul-06 | | 12-Jul-06 | |
| 01-Aug-06 | | 28-Jul-06 | | 28-Jul-06 | | 20-Jul-06 | |
| 17 Aug-06 | | 06-Aug-06 | | 08-Aug-06 | | 28-Jul-06 | |
| | | 16-Aug-06 | | 16-Aug-06 | | 05-Aug-06 | |
| | | | | | | 13-Aug-06 | |

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## الملخص العربي

## تأثير جدولة الري و معدل التصرف على بعض العلاقات المائية والإنتاجية لمحصولي القمح وفول الصويا

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مركز البحوث الزراعية- معهد بحوث الأراضى والمياه والبيئه - الجيزة – مصر

أجريت تجربتين حقليتين فى المزرعة التجريبية بمحطة البحوث الزراعية بسخا خلال الموسم الشتوى ٢٠٠٦/٢٠٠٥ والموسم الصيفى٢٠٠٦ وذلك لدراسة تأثير التحكم فى كمية مياه الرى (١٠٠ ،٨٠% من وعاء البخر وعند إستنفاذ ٥٠% من الرطوبة الأرضية والرى التقليدى) و معدل تصرف المياه (٣٠ و٦٠ لتر فى الثانية) على بعض كفاءات الرى والإنتاجية لمحصولي القمح وفول الصويا. وصممت التجربة بطريقة القطع المنشقة مرة واحدة فى أربع مكررات.

وتشير النتائج إلى زيادة إنتاجية محصولي القمح وفول الصويا من الحبوب نتيجة التحكم فى الرى وأيضا نتيجة زيادة معدل التصرف. حيث زاد الإنتاج مع المعاملات التى تروى عند ١٠٠، ٨٠% من وعاء البخر وإستنفاذ ٥٠% من الرطوبة الأرضية على التوالي بمقدار ٢١,٣، ٩,٠، ١٧,٧ % بالنسبة لحبوب القمح وبمقدار ٢٠,١، ١٠,٢ و١٣,١% بالنسبة لبذور فول الصويا وذلك مقارنة بمعاملة الرى التقليدية. وكانت القيم المماثلة على التوالي فى إنتاج قش القمح ١٤,٨، ١١,٢، ١٠,٨ %.
كما تشير النتائج أيضا إلى زيادة إنتاجية محصولي القمح وفول الصويا نتيجة زيادة تصرف المياه حيث أدى معدل التصرف ٦٠ لتر فى الثانية إلى زيادة إنتاجية حبوب القمح بمقدار٢٤٨,٨ كيلوجرام للفدان و بذور فول الصويا بمقدار ٧٣ كيلوجرام للفدان مقارنة بمعدل التصرف ٣٠ لتر

فى الثانية. وتشير النتائج إلى وجود إختلافات معنوية فى إنتاج حبوب وقش القمح وبذور فول الصويا نتيجة التفاعل المشترك بين جدولة الرى و معدل التصرف.

وتشير النتائج إلى أن كمية المياه المضافة للحقل والمستهلكة بواسطة النبات ( م$^3$/ف) مع معاملات الرى المختلفة أخذت الترتيب التالي : الرى التقليدي > إستنفاذ ٥٠% > ٨٠% من وعاء البخر > ١٠٠% من وعاء البخر. وأيضا زادت كمية المياه المضافة والمستهلكة مع التصرف ٣٠ لتر فى الثانية مقارنة بالتصرف ٦٠ لتر فى الثانية لكلا المحصولين. وتشير النتائج أيضا إلى أن كفاءات إستخدام المياه لكلا المحصولين أخذت نفس الإتجاه وكانت اقل كفاءات لاستخدام المياه مع معاملة الرى التقليدية ومعاملة التصرف بمعدل ٣٠ لتر فى الثانية وذلك مقارنة بالمعاملات الأخرى.

وتشير النتائج أيضا إلى زيادة كفاءة الرى التطبيقية (%) مع المعاملات ١٠٠% من وعاء البخر و٨٠% من وعاء البخر وإستنفاذ ٥٠ % من الرطوبة الأرضية بمقدار ١٢,٩ ، ٧,٤٩ ،٦,٥ % مقارنة بمعاملة الرى التقليدية لمحصول القمح وأيضا بمقدار ١٣,٢٩، ١٠,٧٣، ٥,٠ % لمحصول فول الصويا. كما أن كفاءة الرى التطبيقية (%) زادت مع زيادة معدل التصرف فى مياه الرى. وتشير النتائج أيضا أن فواقد الرى على مستوى الحقل(%) أخذت الإتجاه المعاكس لكفاءات الرى التطبيقية (%). حيث تشير النتائج إلى أن المعاملات التى تروى عند ١٠٠% من عاء البخر، ٨٠% من وعاء البخر وإستنفاذ ٥٠ % من الرطوبة الأرضية حققت توفير فى مياه الرى بمقدار ١٢,٩ و٧,٤٩ و٦,٥ % على التوالي مقارنة بمعاملة الرى التقليدية مع محصول القمح وأيضا حققت نفس المعاملات توفير فى مياه الرى قدره ١٣,٢٩ ، ١٠,٧٣ و ٥,٠ % على التوالي مع محصول فول الصويا. كما أن زيادة معدل التصرف حققت توفير فى مياه الرى بمقدار ٤,٠٩ و٤,٠٨ % لمحصولي القمح وفول الصويا على التوالي مع التصرف ٦٠ لتر فى الثانية مقارنة بالتصرف ٣٠لتر فى الثانية.و يمكن التوصية برى القمح كل ثلاثة أسابيع خلال مراحل النمو أما فترات الرى لمحصول فول الصويا يجب أن تكون كل ١٠ أيام خلال مراحل النمو تحت ظروف شمال دلتا مصر.