YIELD AND WATER RELATIONS OF WHEAT UNDER TILLAGE SYSTEMS AND IRRIGATION REGIMES AT FAYOUM.

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ABSTRACT:

Two field experiments were conducted at Fayoum Agric. Res. Station (Kom Osheem) during 2002/2003 and 2003/2004 seasons to study the effect of tillage operations (number of ploughing) and irrigation at different levels of available soil moisture (ASMD), on yield, its components and some water relations of wheat crop (Giza 168 cv). Three tillage operations, *i.e.*, reduced till. 1, ploughing once to 20 cm depth (T_1), reduced till. 2, ploughing twice to 20 cm depth (T_2) and conventional till., (T_3) were combined with three irrigation regimes, i.e., irrigation at 35% ASMD (I_1), at 55% ASMD (I_2) and at 75% ASMD (I_3), in a split- plot design with four replications. The main results obtained were as follows:

- Conventional tillage (T_3) and irrigation at 35% ASMD gave the highest averages of plant height, spike number/ m^2, 1000- grain weight, grain yield/fed. and straw yield/fed. in both seasons. The lowest averages of yield and its components were obtained from using reduced till-1 (T_1) and irrigation at 75 % ASMD (I_3) in both seasons.
- Increasing tillage operation from T_1 to T_3 significantly increased grain and straw yields/fed. and yield components in both seasons. However, increasing the ASMD significantly decreased the yield and its components.
- Seasonal consumptive use (ETc) averaged 39.24 and 41.44 cm in 2002 /2003 and 2003/2004 seasons, respectively. Increasing tillage from T_1 to T_3 and decreasing the ASMD from 75% to 35% ASMD increased the seasonal ETc from 33.78 and 36.66 cm to 44.52 and 46.76 in the two successive seasons.
- Monthly ETc rate increased gradually from Nov., to reach its maximum values during Mar. and April. Then declined till harvesting. The crop coefficient (Kc) as an average of the two seasons during the growing season duration from Nov., to May were 0.53, 0.74, 0.87, 0.91, 0.99, 0.60 and 0.41, respectively.
- The highest water use efficiency values were 1.010 and 0.891Kg grains / m^3 water consumed, resulted from using conventional tillage and irrigation at 35% ASMD in both seasons.

Key words: Wheat yield, Water relations, (Ploughing), Tillage.

INTRODUCTION:

Wheat crop is certainly more important cereal crop planted in Egypt. The need to maximize soil water conservation and optimize wheat grain production in Egypt has contributed to tillage practices and irrigation scheduling. No or reduced tillage is necessary for energy saving in a broad sense. The efficiency of soil water use by wheat crop needs to be improved or reduce irrigation. **Marbet (2000)** indicated that grain yield under no- tillage (2.47 t/ ha.) was equal to those obtained using a chisel plough or deep tillage and superior to yields obtained by rotovating, conventional off-set discing or subsurface traditional tillage. Water use efficiency (6.6- 7.1 kg/mm/ ha) was similar and following those of no- tillage, deep discing and chisel ploughing, while other tillage systems had lower, but of similar values (5.4-5.9 kg/ mm/ ha). Tillage systems did not significantly differ in terms of total dry matter or straw production and water use. **Weber and Hrynczuk (2001)** reported that yield and yield components significantly affected by different tillage systems and number of grains per ear had the greatest effect on yield. **Marbet (2002)** pointed out that no-tillage and deep tillage with disk plough performed equally well while sub surface tillage with an offset disk produced the lowest yield. Both bare and full no- tillage covers depressed the wheat production. **Murty *et al*. (2004)** found that no-tillage treatment conserved lowest moisture, while ridges and furrows conserved highest moisture of 8.4% higher than no tillage, followed by deep tillage. Deep tillage gave the highest wheat yield (13.6 g/ ha), followed by tied ridges. **Liu-Li Jing *et al*. (2004)** indicated that conservation tillage in North China plains saved water, enhancing water use efficiency and increased the crop yield. **Tomar *et al*. (2004)** reported that the level of tillage and irrigation schedules significantly influenced the grain yield and total biomass at harvesting. **Iqbal *et al.* (2005)** concluded that the tillage method significantly affected soil physical properties as it increased field saturated hydraulic conductivity, while decreased bulk density of soil, in addition the 1000 –grain weight and grain yield were increased.

Regarding the irrigation effect, **Doorenbos *et al.* (1979)** reported that the depletion less than 50% available soil moisture (ASMD) had a little effect on water uptake by wheat plants, while at 70% ASMD moderate stress occurred and severe stress noticed at level exceeding 80% ASMD. For the high yield water use was 450-650 mm and the crop coefficient (Kc) values were 0.7- 0.8, 1.05-1.20 and 0.65- 0.70 for development, mid- season and late growing season stages, respectively.

Metwally *et al.* (1984) showed that irrigation at 50 % ASMD was the suitable regime for wheat. Water consumptive use was 47.65, 41.71 and 36.30 cm for irrigation at 25, 50 and 75 ASMD, respectively. **Barber *et al*. (1986)** obtained a negative relationship between soil moisture stress and spike characters and grain yield of wheat was abtained. **Abdel-Mottaleb and Metwally (1992)** found that wheat grain and straw yields were increased with increasing soil moisture. The highest yield was obtained from irrigation at 2 bars, while the lowest one was resulted from irrigation at 8 bars. Consumptive use was decreased by increasing soil moisture stress. The highest water use efficiency (1.831 kg grains/m^3 water consumed) was obtained from irrigation at 8 bars. **Yousef and Eid (1994)** found that the highest values of grain yield and its components were obtained from irrigation at 30% ASMD. Increasing ASMD from 50% to 70% significantly reduced yield components, grain and straw yields under Fayoum condition. Consumptive use was increased as soil moisture depletion decreased. Irrigation at 30% ASMD gave the highest value of water use efficiency. **Yousef and Hanna (1998)** concluded that spike number/m^2, grain number/spike, 1000–grain weight and grain yield/fed were decreased significantly decreased by increasing ASMD from 35% to 70% at Fayoum. It was added that seasonal ET values were 42.77 and 37.83 cm for irrigation at 35 and 70% ASMD, respectively. However, the crop coefficient (Kc) values were 0.4, 0.68, 0.79, 1.02, 1.00, 0.61 and 0.39 for Nov., Dec., Jan, Feb., Mar., Apr and May months, respectively. However, the highest WUE (1.603 kg grains/m^3 water consumed) was resulted from irrigation at 35% ASMD. **Yousef and Eid (1999)** revealed that irrigating wheat at 30% ASMD produced the highest values of spike number/m^2, 1000 grain weight, grain and straw yield/fed, seasonal ETc (42.9 or 44.6 cm) and WUE (1.065 kg grains/ m^3 water consumed). While, Irrigation at 80% ASMD reduced all the mentioned measurements. **Hussain *et al*. (2003)** indicated that the highest number of spikes/ m^2 (238) was obtained from irrigating wheat at 4 weeks after emergence. However, the highest grain yield (4103 kg/ ha) and biological yield (10207 kg/ ha) were resulted with irrigation at 2 weeks after emergence.

MATERIALS AND METHODS:

Two field experiments were conducted at the farm of Kom Osheem Research Station, Fayoum Governorate during 2002/2003 and 2003/2004 seasons. This investigation aimed to study the effect of tillage practices and irrigation regimes on wheat yield and its components, as well as some water relations of the crop. A split – plot design with four replications was used. Three tillage treatments, *i.e.*, T_1: reduced tillage-1 (ploughing once to a depth of 20 cm), T_2: reduced tillage -2 (ploughing twice to a depth of 20 cm) and T_3: conventional tillage, were combined with three irrigation regime treatments, i.e., I_1: irrigation at 35% available soil moisture depletion (ASMD), I_2: irrigation at 55 % ASMD and I_3 : irrigation at 75% ASMD. The sub- plot area was 21 m^2 (3x7m). Calcium super phosphate (15.5 % P_2O_5) at the rate of 150 kg/ fed was added during field preparation. Wheat grains of Giza 168 cv., at the rate of 70 kg grains / fed were sown on November 23rd and 20th in 2002/2003 and 2003/ 2004 seasons, respectively. Nitrogen fertilization (ammonium nitrate 33.5 % N) at the rate of 80 kg N/ fed was applied in three equal doses (at planting, the 1st irrigation and the 2nd irrigation). Harvesting was done on May 1st and April 28th in 2002/2003 and 2003/2004 seasons, respectively.

The soil physical and chemical properties of the experimental field as the decribed by **Klute (1986) and Page, *et al.* (1982)** are shown in Table (1). Application of irrigation regimes started from the second irrigation. The monthly averages of climatic factors for Fayoum region during the two growing seasons are shown in Table (2). The soil moisture constants of the experimental field are presented in Table (3), whereas dates of irrigation and irrigation intervals for different irrigation regime treatments are recorded in Table (4).

The soil moisture values were determined gravimetrically on oven dry basis, as the technique of water requirements and Field Irrigation Dept., A.R.C., Egypt, for different soil layers, each of 15.0 cm from the soil surface and down to 60.0 cm depth. At harvesting time the following data were recorded for each sub- plot.

Tables 1,2

Table (3). The soil moisture constants of the experimental plots during the two seasons (2002/2003 and 2003 / 2004).

Soil depth	Field capacity %	Wilting point %	Bulk density g/ cm^3	Available soil moisture %
0 - 15	37.57	19.28	1.44	18.28
15 - 30	31.77	16.27	1.54	15.50
30 - 45	29.33	15.92	1.45	13.41
45 – 60	25.14	13.31	1.51	11.82

I. Yield and its component.

1. Plant height (cm) 2. Spike number /m^2 3. 1000 – grain weight (g) 4. Grain yield (kg/ fed.) 5. Straw yield (kg/ fed.).

The collected data were subjected to statistical analysis of variance according to the procedures outlined by **Gomez and Gomez (1984).**

II. Crop water relations:

I. Seasonal consumptive use (ETc).

For obtaining the crop water consumptive use (ETc), soil samples were taken just before and 48 hours after each irrigation, as well as at harvest time. The crop water consumptive use between each two successive irrigations was calculated according to the following equation **(Israelsen and Hansen, 1962).**

$$Cu\ (ETc) = [(\Phi_2 - \Phi_1) / 100] * Bd * D$$

Where: Cu = crop water consumptive use (cm)
Φ_2 = Soil moisture percentage 48 hours after irrigation.
Φ_1 = Soil moisture just before irrigation.
Bd = Soil bulk density (g / cm^3).
D= Soil layer depth (cm).

2. Monthly ETc rate (mm/ day).

Calculated from the seasonal ETc divided by the number of days / month.

3. Reference evapotranspiration (ET_0).

Estimated as a monthly rate (mm/ day), using the monthly averages of climatic factors of Fayoum Governorate and the procedures of the FAO-Penman. Monteith equation **(Allen *et al.*, 1998).**

4. Crop Coefficient (Kc).

The crop coefficient was calculated as follows:

$$Kc = \frac{\text{Actual crop evapotranspiration (ETc)}}{\text{Reference evapotranspiration } (ET_0)}$$

5- Water use efficiency (WUE).

The water use efficiency as kg grains / m^3 water consumed was calculated for different treatments as the method described by **Vites (1965):**

$$WUE = \frac{\text{Grain yield (kg/ fed)}}{\text{Seasonal crop consumptive use “Cu” } (m^3/ \text{fed})}$$

Table 4

RESULTS AND DISCUSSION

I. Yield and yield components

1. Yield components.

The presented results in Table (5) show that increasing tillage operations from reduced -1 or reduced -2 to conventional tillage significantly increased all studied wheat yield components, *i.e.*, plant height, spike number /m^2 and 1000 – grain weight in both seasons. However, the differences between the averages of yield components resulted from reduced tillage -1 or reduced tillage -2 operations were insignificant in the two seasons, unless the averages of plant height in time of 2003/2004 seasons. Conventional tillage gave the highest averages of plant height, spike number/m^2 and 1000- grain weight in 2002/2003 and 2003/2004 seasons. Reduced tillage -1 significantly decreased plant height, spike number/ m^2 and 1000 - grain weight by 7.7%, 25.0 % and 10.2 %, respectively, in 2002/2003 season, and by 15.8 %, 17.7% and 5.4%, respectively, in 2003/ 2004 season, compared with those resulted from conventional tillage. On the other hand, reduced tillage -2 decreased plant height, spike number/m^2 and 1000-grain weight by 6.5%, 20.2% and 7.97%, respectively, in 2002/2003 season, and by 4.3%, 11.9 % and 3.5%, respectively, in 2003/2004 season, compared with those of conventional tillage in both seasons. These results may be due to the effects of increasing tillage operations on improving soil physical properties and this in turn increased roots extension causing more water and nutrient absorption, which reflects on increasing stem elongation, tillers number /m^2 and dry matter accumulation in the plant organs. Such findings are in accordance with those reported by **Weber and Hrynczuk (2001), Tomar *et al.* (2004) and Iqbal *et al*. (2005)**.

Concerning, the effect of irrigation regime treatments, data listed in Table (5) reveal that irrigation regime treatments had a significant effect on wheat plant height, spike number /m^2 and 1000 grain weight in both seasons. Increasing available soil moisture depletion (ASMD) from irrigation at 35% to irrigation at 55% ASMD significantly decreased plant height, spike number /m^2 and 1000 -grain weight by 10.3%, 25.5% and 5.6%, respectively, in the first season and by 2.7%, 28.6% and 5.1%, respectively, in the second season. However, more increase in the soil moisture depletion from 35% to 75% ASMD, resulted in higher and remarkable reductions in plant height, spike number/ m^2 and 1000- grain weight equal to 16.2 %, 39.2% and 7.74%, respectively, in 2002/2003 season, and equal to 6.8%, 43.0% and 5.33%, respectively, in 2003/ 2004 season. It can be concluded that, as ASMD increased the wheat yield components significantly decreased. These results may be attributed to the effect of soil moisture stress on reducing cell division, internodes elongation, number of tillers/m^2 and dry matter accumulation in grain during grain filling stages. These results are in consistent with those found by **Barber *et al*. (1986), Yousef and Eid (1994), Yousef and Hanna (1998) and Yousef and Eid (1999).**

The data recorded in Table (5) indicate that the averages of spike number/m^2 were significantly affected by the interaction between tillage operations and irrigation regime treatments in both seasons. The highest averages of plant height spike number/m^2 and seed index were obtained from conventional tillage operation and irrigation at 35% ASMD in the two seasons. The lowest averages were resulted from reduced tillage -1 and irrigation wheat at 75% ASMD (T_1 I_3 treatment) in both seasons. From such results, it can be concluded that increasing tillage operations and irrigating wheat at low depletion of available soil moisture gave the highest yield components in such soils under Fayoum conditions.

2. Grain Yield / fed.

The results of Table (5) reveal that the averages of grain yield/fed were significantly affected by tillage operation treatments in both seasons. The grain yield/fed was increased by 20.04% and 24.44 % in 2002/2003 and 2003/2004 seasons, respectively, as tillage operations was increased from reduced -1 to conventional tillage. However, increasing tillage operations from reduced -2 (T_2) to conventional tillage (T_3) increased the grain yield/ fed by 18.7% and 9.86% in the two successive seasons, respectively. On the other hand, increasing tillage operation from reduced -1 (T_1) to reduced -2 (T_2) significantly increased the grain yield/ fed. only in the second season (2003/2004 season). It could be concluded that planting wheat crop in such soils of Kom Osheem area (Fayoum Governorate) under conventional tillage operation is preferable for high yield production. These results may referred to the effect of conventional tillage on improving the soil physical properties and the increase of spike number/m^2, 1000- grain weight and the dry matter accumulation of all the plant organs. These results are in agreement with those reported by **Weber and Hrynczuk (2001), Murty *et al. (*2004), Tomar *et al*. (2004) and Iqbal *et al*. (2005)**.

Regarding the effect of irrigation treatments, the results in Table (5) show that the averages of grain yield/fed were significantly differed due to irrigation regime treatments in both seasons. The highest grain yield (1573.1 and 1587.5 kg/fed) in 2002/2003 and 2003/ 2004 seasons, respectively, were obtained from irrigation at 35% ASMD (I_1 treatment). The grain yield/fed was decreased by 22.6% and 27.5% in 2002/2003 and 2003/2004 seasons, respectively, as the ASMD increased from 35% to 75%. Whereas, increasing ASMD from 35% to 55% resulted in grain yield reduction of 11.8 and 19.2% in 2002/2003 and 2003/2004 seasons, respectively. Such findings may be attributed to the effect of water deficits on reducing spike number/m^2 and 1000-grain weight. It could be revealed that irrigating wheat plants at high ASMD (long irrigation intervals) significantly decreased the grain yield /fed. The results are in harmony with those obtained by **Doorenbos *et al*. (1979), Barber *et al*. (1986), Abdel-Mottaleb and Metwally (1992), Yousef and Eid (1994), Yousef and Hanna (1998) and Yousef and Eid (1999)**. Results in Table (5) indicate that wheat grain yield/fed was significantly affected by the interaction between tillage operations and irrigation treatments in 2002/ 2003 season only. The highest grain yield (1883.7 kg/fed) was observed from conventional tillage and irrigation at 35% ASMD in the first season, whereas the lowest one (1159.1 kg/fed), obtained from reduced tillage-2 and irrigation at 75% ASMD in 2002/2003 season.

3. Straw yield / fed:

The results presented in Table (5) show that the differences between the averages of straw yield/fed were significant due to the effect of tillage treatments in both seasons. Conventional tillage (T_3) gave the highest averages of straw yield/fed, i.e. 2836.0 and 4016.6 kg in 2002/2003 and 2003/2004 seasons, respectively. The lowest straw yield/fed (2498.1 and 3178.9 kg in the two successive seasons) were resulted from planting wheat under reduced tillage -1 (T_1). It can be revealed that increasing tillage operations caused a pronounced increase in straw yield/fed, and this may be due to the effect of conventional tillage on improving soil physical properties which in turn caused increases in shoot growth and dry matter accumulation. The obtained results are in the same line of those reported by **Tomar *et al*. (2004).** Data listed in Table (5) reveal that the straw yield/fed was significantly affected by irrigation regimes in the two seasons of this study. Irrigating wheat plants at 35% ASMD significantly increased straw yield by 597.6 and 797.1 kg/ fed in 2002/2003 and 2003/2004 seasons, respectively, when compared with irrigation at 75% ASMD. It can be noticed that increasing soil moisture depletion under wheat plants led to considerable reduction in straw yield/ fed. These results may be referred to the effect of water stress on decreasing shoot growth and dry matter accumulation in plants. Such findings are in agreement with those mentioned by **Abdel-Mottaleb and Metwally (1992), Yousef and Eid (1994), Yousef and Hanna (1998), Yousef and Eid (1999) and Hussain *et al.* (2003)**. Results of Table (5) show that the interaction between tillage operations and irrigation treatments significantly affected the averages of straw yield/ fed in both seasons. The highest averages of straw yield (3110.0 and 4885.5 kg/ fed, in 2002/2003 and 2003/2004 seasons, respectively) were obtained from conventional tillage and irrigation at 35% ASMD. The lowest ones (2267.8 and 2979.1 kg/fed, in the two successive seasons) were resulted from reduced tillage -1 and irrigating wheat plants at 75% ASMD.

II. Crop water relations:

1. Seasonal consumptive use (ETc).

Results presented in Table (6) show that values of seasonal consumptive use by wheat plants, as a function of tillage operations and irrigation regimes were 39.24 and 41.44 cm in 2002/2003 and 2003/2004 seasons, respectively. Conventional tillage gave the highest values of seasonal ETc, i.e., 41.72 and 43.74 cm in the two successive seasons. Reducing tillage to reduced – 1 decreased the seasonal ETc to the lowest values (36.48 and 39.10 cm in the seasons) It can be revealed that the seasonal consumptive use of wheat was increased by increasing tillage operations. These results may be referred to the effect of tillage processes on the physical soil properties (increasing permeability, water percolation, water capillary movement through the root zone). This may enhance wheat roots to absorb more water and increased evaporation from the soil surface. The obtained results are in harmony with those reported by **Murty *et al*. (2004), Liu-LiJing *et al*. (2004) and Iqbal *et al.* (2005).** The data recorded in Table (6) indicate that irrigation regimes were different in seasonal ET_c under each tillage system used. Irrigating wheat at 35% ASMD gave the highest values of ET_c in both seasons (42.14 and 44.12 cm). Increasing the depletion of ASM from 35% to 75% decreased the ETc of wheat plants to 36.47 and 38.87 cm in 2002/2003 and 2003/2004 seasons, respectively. It can be noticed that irrigating wheat plants at a higher depletion of ASMD (long irrigation intervals) results in decreasing the ETc. These results may due to the low evaporative demands from the soil and low transpiration from the plants, subjected to soil moisture stress. These results are in accordance with those found by **Doorenbos *et al.* (1979), Metwally *et al*. (1984), Abdel-Mottaleb and Metwally (1992), Yousef and Eid (1994 and 1999).**

Table 5

2. Monthly ETc rate (mm / day):

Data recorded in Table (7) indicate that the monthly ETc rate values, as a function of tillage and irrigation treatments in both seasons, started with low values during November and December months, then increased gradually to reach their maximum, respectively, then declined to low values, as plants started maturity.

These results are due to that at the initial period of the growing season, most of water losses are caused by evaporation from the bare soil. Thereafter, as the plant cover increased, transpiration from plants took place beside the evaporation from the soil surface, while at maturity stage the plants tended to be dry and the ET_c rate reduced sharply. Table (7) revealed also that the highest monthly ET_c rates during the growing months of wheat in both seasons were detected by using the conventional tillage operation (T_3). However, using the reduced tillage -1 (T_1) gave the lowest values of monthly ET_c rates during the growing month in both seasons. It could be concluded that increasing tillage operations resulted in increasing monthly ETc rate. Data presented in Table (7) show that irrigating wheat at short intervals (35% ASMD) caused an increase in the monthly ET_c rates during the growing season months, except during April and May in 2002/2003 season. Whereas, increasing the ASMD to 75% at irrigation time gave the lowest monthly ET_c rates during the growing months in both seasons. These results revealed that increasing the ASMD in the root zone of wheat plants (irrigation in short intervals) caused an increase in the ET_c rate during all the growing season months.

Table (6). Effect of tillage operations, irrigation regime treatments and their interaction on seasonal consumptive use of wheat plants in 2002/2003 and 2003/2004 seasons.

Seasons	2002/ 2003				2003/2004			
Tillage treatments	Irrigation treatments (ASMD)				Irrigation treatments (ASMD)			
	(I_1) 35%	(I_2) 55%	(I_3) 75%	Mean	(I_1) 35%	(I_2) 55%	(I_3) 75%	Mean
T_1: Reduced – 1	39.32	36.33	33.78	36.48	41.73	38.90	36.66	39.10
T_2: Reduced – 2	42.58	39.13	36.85	39.52	43.87	41.64	38.93	41.48
T_3: Conventional	44.52	41.86	38.77	41.72	46.76	43.45	41.02	43.74
Mean	42.14	39.10	36.47	39.24	44.12	41.33	38.87	41.44

3. Reference evapotranspiration (ET_0).

The reference ET (ET_0) values, estimated from the FAO-Penman- Monteith method using the meteorological data of Fayoum Governorate in 2002/2003 and 2003/2004 seasons from planting until wheat harvesting are recorded in Table (8). The obtained data revealed that the monthly ET_0 rate values were high during November, and then decreased during December and January months. Thereafter, the monthly ET_0 rates increased gradually from February to May in both seasons. These results are mainly referred to the changes occurred in climatic factors from month to another. In this respect, **Allen *et al.* (1998)** indicated that the ET_0 values depend on the evaporative power of the air, i.e. temperature, radiation, wind speed and relative humidity.

4. Crop coefficient (kc).

The crop coefficient reflects the crop cover percentage on the ET_0 values, therefore the kc values were calculated from the crop consumptive use (monthly ETc in Table, 7) and the monthly ET_0 rate (Table, 8). Results in Table (8) indicate that the Kc values for wheat crop, as a function of different applied treatments were low at the initial growth stages (Nov., and Dec.), then increased during January and February, as the plant growth increased and reached its maximum value at heading – grain filling stage (February, and March).

Thereafter, the kc values redecreased again when the plants started maturity (April) to reach the minimum value at harvest (May). These results may be referred to the large diffusive resistance of bare soil at the initial growth stages which reduced with increasing the crop cover percentage until heading and grain filling stages. At maturity stage the transpiration decreased because the stem and leaves drying and this caused the Kc reduction during April and May. These results were found to be true in the two seasons. Data in Table (8) reveal that increasing tillage operations increased the kc values during the growing months in both seasons. Conventional tillage gave the higher kc values during the growing months in both seasons. However, reduced – 1 gave the lowest kc values during the growing season months. On the other hand, increasing ASMD decreased the kc values during the growing months of both seasons. Irrigation wheat at 35% ASMD gave the highest kc values, whereas the lowest ones were detected from irrigation at 75% ASMD, in both seasons. Such findings are in the same trend of those reported by **Doorenbos *et al*. (1979) and Yousef and Hanna (1998).**

5.Water use efficiency (WUE).

Results presented in Table (9) show that values of WUE, as a function of tillage operations and irrigation regimes were 0.842 and 0.759 kg grains/m^3 water consumed in 2002/2003 and 2003/2004 seasons, respectively. Planting wheat under conventional tillage system (T_3) gave the highest averages of WUE, i.e. 0.908 and 0.824 kg grains/m^3 water consumed in 2002/2003 and 2003/2004 seasons, respectively. However, the lowest WUE values were 0.781 and 0.692 kg/m^3 water consumed, obtained from the reduced tillage -2 and reduced tillage -1 in 2002/2003 and 2003/2004 seasons, respectively. It can be concluded that conventional tillage is preferable in such soils of Kom Osheem area for high WUE values. These results are in the same order of those reported by **Marbet (2000), Murty *et al*. (2004) and Liu- LiJing *et al*. (2004).**

Data listed in Table (9) reveal that irrigation at 75% ASMD decreased WUE of wheat by 9.9 and 17.8% in 2002/2003 and 2003/2004 seasons, respectively, compared with irrigation at 35% ASMD (0.886 and 0.855 kg grains/m^3 water consumed in the two successive seasons). It is evident that as the ASMD increased under wheat plants the WUE values decreased. These results agree with those found by **Abdel- Mottaleb and Metwally (1992)**, **Yousef and Eid (1994), Yousef** and **Hanna (1998) and Yousef and Eid (1999).**

Table (9) shows that the values of WUE by wheat plants, as affected by the interaction between tillage systems and irrigation regimes were differe from year to the other. In 2002/2003 season, planting wheat under conventional tillage and irrigation at 35% ASMD gave the highest WUE value (1.010 kg grains/m^3 water consumed), whereas the lowest one (0.749 kg grains/m^3) was detected from reducing tillage-2 and irrigation at 75% ASMD. However, in 2003/ 2004 season, planting wheat under reduced tillage -2 and irrigation at 35% ASMD gave the highest WUE value (0.89/kg grains/m^3 water consumed). The lowest one (0.662 kg grains /m^3) was observed from reduced tillage -1 and irrigation at 75% ASMD. It is obvious that for high water use efficiency by wheat at such soils of (Kom Osheem) Fayoum, the conventional tillage must be adopted and irrigation should be in short intervals (35% ASMD).

Table 7

Table 8

Table (9). Effect of tillage operations, irrigation regime treatments and their interaction on wheat water use (kg grains/m^3 water consumed) in 2002/2003 and 2003/2004 seasons.

Seasons	2002/ 2003				2003/2004			
Tillage treatments	Irrigation regimes (ASMD)				Irrigation regimes (ASMD)			
	(I_1) 35%	(I_2) 55%	(I_3) 75%	Mean	(I_1) 35%	(I_2) 55%	(I_3) 75%	Mean
T_1: Reduced – 1	0.821	0.810	0.876	0.836	0.793	0.662	0.622	0.692
T_2: Reduced – 2	0.827	0.768	0.749	0.781	0.891	0.705	0.689	0.762
T_3: Conventional	1.010	0.946	0.768	0.908	0.881	0.791	0.799	0.824
Mean	0.886	0.841	0.798	0.842	0.855	0.719	0.703	0.759

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المحصول والعلاقات المائية للقمح تحت نظم الخدمة والري في الفيوم

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أقيمت تجربتان حقليتان بمحطة البحوث الزراعية بكوم أوشيم (محافظة الفيوم) خلال موسمي الزراعة ٢٠٠٣/٢٠٠٢ و٢٠٠٤/٢٠٠٣ لدراسة تأثير عمليات الخدمة (عدد مرات الحرث) والري عند استنزاف نسب مختلفة من رطوبة التربة الميسرة على محصول القمح (صنف جيزة ١٦٨) ومكوناته وبعض العلاقات المائية للمحصول. ولذلك توافقت ثلاث معاملات للحرث وهى (T_1) حرث قليل-١(مشوار حرث واحد بعمق ٢٠سم) و(T_2) حرث قليل -٢(مشوارين حرث بعمق ٢٠سم) و(T_3) حرث تقليدي (٣ مشاوير متعامدة) مع ثلاث معاملات للري وهى: الري عند استنزاف ٣٥% و٥٥% و٧٥% من رطوبة التربة الميسرة وذلك في تصميم قطع منشقة مرة واحدة في ٤ مكررات وكانت أهم النتائج المتحصل عليها كما يلي:

١- الحرث التقليدي (T_3) مع الري عند فقد ٣٥% من الماء الميسر (I_1) أعطى أعلى متوسطات لارتفاع النبات وعدد السنابل/م٢ ، وزن الألف حبه، محصول الحبوب والقش للفدان وذلك في كلا الموسمين بينما نتجت اقل متوسطات للصفات السابقة من استخدام الحرث القليل -١ (T_1) مع الري عند فقد ٧٥% من الماء الميسر (I_3) في الموسمين.

٢- زيادة عدد مرات الحرث من حرث قليل -١(T_1) إلى حرث تقليدي (T_3) أدى إلى زيادة معنوية في محصول الحبوب ومكوناته ومحصول القش للفدان في كلا الموسمين بينما الري عند زيادة الماء المستنفذ من ٣٥% إلى ٥٥% أو ٧٥% أدى لنقص معنوي في مكونات المحصول ومحصول الحبوب والقش للفدان.

٣- كان متوسط الاستهلاك المائي الموسمي تحت جميع المعاملات المختلفة ٣٩.٢٤ و٤١.٤٤سم خلال الموسم الأول والثانى على الترتيب وكذلك أدى زيادة عدد مرات الحرث من حرث قليل -١ إلى حرث تقليدي وزيادة نسبة الرطوبة من الري عند ٧٥% إلى الري عند ٣٥% من الماء الميسر إلى زيادة الاستهلاك المائي الموسمي من ٣٣.٧٨، ٣٦.٦٦ سم إلى ٤٤.٥٢، ٤٦.٧٦ سم في الموسمين المتعاقبين على التوالي.

٤- زاد معدل الاستهلاك المائي الشهري تدريجيا من نوفمبر حتى وصل إلى أقصى معدل له خلال مارس وابريل ثم انخفض مرة ثانيه حتى الحصاد وكان ثابت المحصول (Kc) كمتوسط للموسمين خلال شهور موسم النمو (من نوفمبر حتى مايو) هو. (٠.٥٣، ٠.٧٤، ٠.٨٧، ٠.٩١، ٠.٩٩، ٠.٦٠، ٠.٤١) على الترتيب.

٥- كانت أعلى قيم لكفاءة استهلاك ماء الري هي ١.٠١٠، ٠.٨٩١ كجم حبوب// م٣ ماء مستهلك قد نتجت من زراعة القمح تحت نظام الحرث التقليدي والري عند فقد ٣٥% من ماء التربة الميسر.