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REDUCING OF WATER USE BY WATER STRESS REGIME ON SOME MAIN FIELD CROPS (WHEAT, SOYBEAN AND CORN)

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ABSTRACT

Being an arid country with rapid population growth and escalating living standard, Egypt is suffering from stresses on both water and land resources. It is obvious that agriculture is still considered the main economic activity as it consumes over 85% of the total water supply. Excessive usage of irrigation water has alerted sever problems and had caused harmful impact on soil and environment. Logging, fertility, and salinity are examples for the excess water hazard in lands. In this connection two field experiments were curried at Mallawy water Requirements research satiation –El Minia, of province, Middle Egypt, Water Management research institute – National water research center during the seasons of 2004 / 2005 and 2005 / 2006 to study the effect of water stress on water applied, water consumptive use, water use efficiency, water saving yield and economic evaluation for some major crops (wheat, soybean and corn).

The experiment included three irrigation of depletion A1, A2, A3 are irrigated at 25 %, 50% and 75% depletion of available water, beside tradition irrigation in studied area (the farmer practices) to compare with water applied and water consumptive use. The experimental design was a randomized complete block, replicated three times.

Results indicated that, from view point of water and economic the highest economic efficiency was obtained from irrigation with 50% depletion of available water for studied crops. Also results indicated that under the best irrigation treatments which 50% depletion of available water leads to an increase in yield about 16.3 %, 12.5% 10.9% and saving of irrigation water 16.1 %, 10.71% and 8.27 % for wheat, soybean and corn crops respectively. Hence, the obtained results indicate that it may be recommended to irrigate wheat, soybean and corn plants with depletion 50% of available water and irrigation frequency of with 18, 13 and 14 days respectively. In addition the applied water should reach the 90% of field capacity to produce high yield with least possible amount of water applied under El-Minia province conditions and other corresponding conditions.

INTRODUCTION

Water is fast becoming an economically scarce resource in many areas of the world, especially in arid and semi arid regions. In Egypt, there are many plans for increasing cultivable land and agricultural production to overcome problems of the food security. However, water is an affecting factor in any agricultural expansion. Accordingly, it is advised to evaluate new possible approaches to control the cop water requirements through modern irrigation systems and management techniques.

So the use of improve irrigation systems becomes very important to save water the best system should give favorable crop yield, optimum use of water and minimum labors requirement.

Estimating irrigation water becomes important for project planing and irrigation management. The over irrigation practiced by the farmers usually leads to low irrigation efficiency, water logging and high losses of water and fertilizer. So it is necessary to ascertain to what extent the water in the root zone can be depleted to produce high economic yield with using little water applied.

Planning best irrigation regime is very important for maintaining available irrigation water. The proper water management (irrigation scheduling) not only accurate determination of crop water requirements but also helps to know when and how much water should be applied to get high efficiency of each unit of water.

The present study is focusing on the best system of irrigation in order to obtain the maximum production of some main crops (wheat, soybean and corn). In this connection, Saenko (1977a), Metwally *et al* (1984), Semaka and Rady (1987) and Meleha (1992).The objective of this investigation was to reduce of water use by water stress technique on some main field crops at El-Minia region –Egypt.

MATERIALS AND METHODS

Two field experiments were carried out during the growing seasons of 2004/2005 and 2005/2006 at Mallawy Water Requirements Research Station – El Minia Governorate; Water Management and Irrigation System Research Institute National Water Research Center.

The objective of this investigation was to reduce of water use by water stress technique on some main field crops at El- Minia region –Egypt. Some physical and chemical properties of the experimental soils as shown in Table 1.

The Bulk Density : It was determined by using the undistributed core samples according to **Klulet (1986)** as shown in Table 2.

Field capacity (F.C %): It was determined by field method according to (Black, 1965) as shown in Table 2.

Permanent wilting point: It was determined by using a pressure membrane apparatus (Black, 1965) as shown in Table 2.

Available water (A.W :**) .**It was calculated as the difference between the F.C. and P.W.P as shown in Table 2

Each experiment included three irrigation treatments of depletion, with five replicates beside traditional irrigation for wheat, soybean and corn crops in the studied area (the farmer practices) to compare with water applied actual water consumptive use only so the experimental design used was randomized complete used was randomized complete blocks.

Irrigation treatments were used as follows:

1. Irrigation at a depletion of 25% from available soil moisture.
2. Irrigation at a depletion of 50% from available soil moisture.
3. Irrigation at a depletion of 75% from available soil moisture.

Water Measurements

In the two growing seasons for each crop water was measured by using a rectangular sharp crested weir. The discharge was calculated using the following formula:

$$Q = CLH^{3/2}$$ (Masoud, 1967)

Where:

Q : The discharge in cubic meters per second.
L : The length of the crest in meters.
H : The head in meters.
C: An empirical coefficient that must be determined from discharge measurements.

The plots of different treatments were left to dry gradually until the moisture percentage of different treatment reached to depletion of available water then the water added till 90% of field capacity to each irrigation treatment by weir meter. On the other hand ,quantity of water applied was measured in studied area (the farmer practices) by cut throat Flum size (20 x 90 cm) where water applied was added during every irrigation and at the end of each growth season the total quantity of water applied was estimated (m^3/ fed.) to each crop.

Crop water use efficiency (C.W.U.E)

Crop water use efficiency is the weight of marketable crop produced per the volume unit of water consumed by plants or the evapotranspiration quantity. The crop water use efficiency was computed for the different treatments to each crop by dividing the yield (kg) on units of evapotranspiration expressed as cubic meters of water **(**Abd El- Rasool *et al*. 1971). It was calculated by the following formula

$$C.W.U.E. = Yield\ (kg/fed.)/ water\ consumptive\ use\ (m^3/fed.)$$

Field water use efficiency (F.W.U.E.)

Field water use efficiency is the weight of marketable crop produced per the volume unit of applied irrigation was expressed as cubic meters of water (Michael, 1978).
It was calculated by the following equation:

$$F.W.U.E. = Yield\ (kg/fed.)/water\ applied\ (m^3/fed.)$$

Economic efficiency

Economic efficiency refers to the combinations of inputs that maximize individual or social objectives. Economic efficiency is defined in terms of two conditions: necessary and sufficient. Necessary condition is met in production process when there is producing the same amount of product with fewer inputs or producing more products with the same amount of inputs. But the sufficient condition for efficiency encompasses individual or social goals and values (John and Frank 1987). It was calculated by the formula:
Economic efficiency = net profit (L.E./ Fed.) /Total Costs (L.E/ Fed.)

1-3

RESULTS AND DISCUSSION

(1) Actual water consumptive use (m^3/ fed.)

From the data of actual consumptive use by the soil moisture depletion method for wheat, soybean and corn crops are shown in tables 3 and 4 and illustrated in figure 1. It could be noticed that the water consumptive use starts with small amount because small of little water needs of plants at initial growth stage, therefore, soil moisture are mainly affect by evaporation from soil surface at this time, with the advance with plant age, evapotranspiration increases and consequently the monthly consumptive use increased as plant foliage develops.

The monthly water consumptive use reaches its peak value in the middle of growing season which is considered the critical period in water demands of crops. Data in Table 3 and 4 reveal that the mean values of seasonal water consumptive use for the traditional irrigation were 53.10, 56.67 and 57.96 cm/season for wheat, soybeans and corn crops respectively, while values of seasonal water consumptive use for the same crops under water stress regime when we use the best irrigation regime (50% depletion of available water) were 47.63, 48.53 and 52.24 cm / season for wheat, soybean and corn crops respectively. These results are in a agreement with those obtained by Kruzhilin (1967), Hulpo *et al* (1970), Saenko (1977a) and Nel and Dikhuis (1990).

(2)Seasonal irrigation water amount (m^3/ fed.) :

The amount of applied water delivered (m^3 / fed.) to some field crops are shown in Table 5 and illustrated in figure 2. It is cleared from data obtained that the water supplied for majors field crops wheat, soybeans and corn were 3261.40, 3315.78 and 3264.57 m^3 / fed. respectively under common conventional irrigation in region while, the quantity of water supplied for the same crops under water stress when we use the best regime irrigation (50% depletion of available water) were 2737.58, 2960.66 and 2994.48 m^3/ fed. respectively. these results are similar to those obtained by *Metwally et al.* (1984), A bdel –Mottab and Metwally (1992), Askar *et al.* (1994) and Kheder *et al* (1996)

(3)Field water use efficiency

Data in Table 6 revealed that the average values of field water use efficiency were 0.82, 0.45 and 0.86 kg / m^3 under the best treatment (50% depletion of available water) for wheat, soybean and corn crops respectively during the two studied seasons while, it were 0.59, 0.36 and 0.71 for the same crops under traditional common irrigation respectively.

It obvious in Table 6 that the field water use efficiency increase when we use the best regime irrigation system so the use of regime irrigation system becomes very important to give favorable crop yield and optimum use of water. Therefor, estimating economic of irrigation water become very important for planning irrigation management. So the proper water management not only accurate determination of crop water requirements but also helps to know how, when and how much water should be applied to get high efficiency of each unit of water applied.

4-5

F1

f2

These results are in harmony with those reported by Abdel- Mottaleb and Melwally (1992), Meleha (1992) and Saenko (1997 a)

(4)Crop water use efficiency :

Data in Table 6 illustrate the crop water use efficiency values as influenced by soil moisture depletion. Data show that the highest values of crop water use efficiency was obtained at depletion 50% depletion available water were (1.12, 0.66 and 1.17 kg/m^3) for wheat, soybean and corn respectively compared with traditional irrigation at region.

From these results it could be concluded that these increments in crop water use efficiency with water stress at different levels of available water depletion was due to enchantment of total yield/ fed with least possible amount of water applied comparison with traditional irrigation by farmers.

(5) Water saving (m^3 / area)

Water saving per cubic meter/area represents the different between the quantity of present recommended water applied and actual water applied for conventional irrigation by farmer per feddan.

Data in Table 7 show that average quantity of water applied (m^3 / fed) and total saving irrigation water was achieved from the best irrigation regime under water stress (50% depletion of available water) and it gave high yield among other irrigation treatments in the two studied seasons.

The irrigation water can be saved was 99.606160, 9.131910 and 58.609530 million m^3/area, than conventional irrigation, which represents the farmer practices in the studied area for wheat, soybean and corn crops respectively under El-Minia condition. This quantity of saving water could be enough to cultivate in old land area about 15563.5, 1426.86 and 9157.74 (fed.) under E-Minia conditions. These results reflex how much of irrigation water can be saved when using the reasonable irrigation treatments.

In general, it could be concluded that water is fast becoming an economically scarce resource in many areas of the world. So the use of regime irrigation system becomes very important to save water. The best regime irrigation should give favorable crop yield and optimum use of water. Therefore, estimating economic of irrigation water becomes very important for planning irrigation management project where the over irrigation practiced by the farmers usually leads to low irrigation efficiency water logging and high losses of water and fertilizer.

Also data in Table 7 show that the percentage of increases in yield, (kg/ fed.) were more than the conventional irrigation method compared with irrigation regime (50% depletion of available water) 6.30, 12.50 and 10.96 % for wheat, soybean and corn crops respectively.

(6) The economic efficiency:

Concerning to economic efficiency, data present in Table 8 show that it was 0.68, 0.30 and 0.44 L.E/fed. for wheat, soybean and corn crops under traditional irrigation respectively while it was 0.87, 0.45 and 0.56 L.E/fed. under the best irrigation regime for the same crops respectively. From these results it could be conclude that when we use the best irrigation regime of depletion (50% of A.W.) for wheat, soybean and corn crops respectively the economic efficiency increased in the two studied seasons.

6-7

8

These increases in economic efficiency due to the enhancement of net profit with 50% depletion of available water for wheat, soybean and corn crops respectively compare with common traditional irrigation at region.

(7) Total costs, total income (L.E/ fed.) and net return from of irrigation water (L.E / m^3)

Data in Table 8 show that the highest values of total income were (2736.62, 2025.1, 2163.78 L.E/fed.), net profit were (1270.62, 625 and 778.78 L.E / fed), and net return from unit water consumptive use were (0.63, 0.31 and 0.35 L.E / m^3) were obtained from plants wheat, soybean and corn respectively which grown with 50% depletion of available water. From these results it could be conduced this increase in total income and net return of water irrigation are mainly due to high yield production from plants grown with 50% depletion of available water. These results are in agreement with those reported by Khalagi *et al* (1967) and Meleha (1992).

Conclusion

The obtained results indicate that it may be recommended to irrigate wheat, soybean and corn plants with depletion 50%, 40% and 50% of available water (18, 13 and 14 days apart irrigation) respectively then the water added until 90% of field capacity to produce high yield with least possible amount of water applied under El-Minia province conditions and other corresponding conditions.

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ترشيد استخدام المياه باستخدام اسلوب الاجهاد المائي علي بعض المحاصيل الحقلية الرئيسية (القمح – فول الصويا – الذرة الشامية)

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معهد بحوث ادارة المياه – المركز القومي لبحوث المياه

اجريت التجارب الحقلية خلال المواسم الزراعية لعامى 2004 / 2005 ، 2005/2006 بمحطة مقتنات ري ملوى البحثية التابعة لمعهد بحوث ادارة المياه – المركز القومى لبحوث المياه جمهورية مصر العربية وذلك بهدف دراسة تأثر الاجهاد المائي عند استنفاذ مستويات مختلفة من الرطوبة الارضية علي اهم المحاصيل الحقلية الرئيسية بهدف الحصول على انتاجية عالية باقل كمية مياه وتحقيق الوفر المائي وتعظيم العائد من وحدة المياه المستهلكة والمضافة فى الانتاج كما تهدف الدراسة الي تحديد كميات المياه المطلوب اضافتها خلال مراحل نمو المحصول المختلفة وذلك عن طريق تحديد افضل مستوى رطوبي مناسب الذى من خلاله يتم تحديد كميات المياه المطلوبة بهدف عمل جدولة لري هذه المحاصيل الحقلية ,وتم دراسة ثلاث معاملات ري وهي الري عند استنفاذ 25% و 50% و 75% من الماء الميسر مع مقارنة ذلك بمعاملة الفلاح العادية وقد تم استخدام تصميم قطاعات كاملة العشوائية في ثلاث مكررات واوضحت النتائج المتحصل عليها بأنه يمكن الحصول علي اعلى انتاجية لهذه المحاصيل الحقلية (قمح – فول صويا – ذرة شامية) وذلك عند اتباع افضل اسلوب لري هذه المحاصيل وهو الري بعد استنفاذ 50% من الماء الميسر بزيادة

فى الانتاجية 16.3 % ، 12.5 ، 10.96 % عن الانتاجية المتحصل عليها من المعاملة الطبيعية (الري التقليدى بمعرفة المزارع) السائدة بالمنطقة.

كما اوضحت النتائج بانه قد تم توفير كميات من المياه المضافة لهذه المحاصيل السابقة وذلك عند اتباع افضل اسلوب للري وهو الرى بعد استنفاذ 50% مع اضافه المياه حتى الوصول الى 90% من السعة الحقلية فقط لهذه المحاصيل السابقة على التوالى بنحو 10.61 % ، 17.2 % ، 8.27 % ذلك بالمقارنة مع المعاملة الطبيعية السائدة فى المنطقة.

كما اوضحت النتائج من وجهة النظر المائية والاقتصادية بان افضل اسلوب لرى محاصيل القمح وفول الصويا والذرة الشامية هو الري بعد استفادا 50% ، من الماء الميسر للتربة مع تحديد كميات المياه المضافة حتى الوصول الي 90 % من السعه الحقلية الامر الذى ادى الي زيادة الانتاجية وبالتالي الي زيادة صافى العائد من وحدة المياه وبالتالي زيادة الكفاءة الاقتصادية بمقدار 0.79، 0.3 ، 0.50 لكل جنية مصري منصرف تم انفاقه خلال مستلزمات الانتاج للمحصول لهذه المحاصيل الحقلية علي التوالي.

مما سبق يستخلص ان تطبيق افضل اسلوب للري وهو الري بعد استنفاذ 50% استنفاذ من الماء الميسر حتى الوصول الي 90% من السعة الحقلية لمحاصيل القمح وفول الصويا والذرة علي التوالي الامر الذى ادى الي الحصول علي اعلي انتاجية وكذلك اعلي معدلات لكفاءات الانتفاع بالوحدة المائية سواء على المستوى الحقلى او على المستوى المحصولى وكذلك اعلي صافى عائد مالي للفدان وبالتالي زيادة الكفاءه الاقتصادية لهذه المحاصيل ومن ذلك توصى الدراسة بامكانية تطبيق اضافة المياه وذلك عند الوصول الى المستويات الرطوبى 50% استنفاذا من الماء الميسر للتربة بمعدل (13،14،18، يوم بين الريات) مع اضافة كميات المياه حتى الوصول الى 90% من السعة الحقلية وذلك وذلك للحصول على اعلى انتاجية باقل كميات مياه مضافة تحت ظروف محافظة المنيا والمناطق الاخرى المماثلة لها فى الظروف الجوية.

قام بتحكيم البحث

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Table (1): Mechanical soil analysis of experimental sites at different depths in 2004 / 2005 and 2005 /2006 seasons.

Depth (cm)	Particle size distribution 2004-2005				Particle size distribution 2005-2006			
	Clay %	% Silt	% Sand	Texture	% Clay	% Silt	% Sand	Texture
0- 15	56.5	26.5	16.9	Clay	55	27.6	17.5	Clay
15 – 30	553.3	27.5	19.2	Clay	51	29.1	20	**Clay**
30 – 45	51.93	28.3	19.8	Clay	48.1	30.5	21.4	**Clay**
45 – 60	47.4	32.5	20.1	Clay	45.2	32	22.8	**Clay**

Table (2): Some soil – water characteristics for the experimental sites during the two growing seasons of wheat, soybean and corn crops at different depths in 2004 / 2005 and 2005 /2006 seasons.

Depth (cm)	Bulk density g/cm^3	2004-2005						2005-2006						
		Field capacity		Wilting point		Available water		Bulk density g/cm^3	Field capacity		Wilting point		Available water	
		%	cm	%	cm	%	cm		%	cm	%	cm	%	cm
0-15	1.17	44	7.72	20.1	3.53	23.9	4.19	1.19	43.4	7.75	20.3	3.44	23.1	4.31
15-30	1.2	37.9	6.81	17.3	3.11	20.6	3.7	1.24	37.9	7.05	17.5	3.18	20.4	3.87
30-45	1.26	35.3	6.67	15.8	2.99	19.5	3.68	1.28	35.2	6.82	16	3.07	19.5	3.75
45.6	1.33	32.9	6.55	14.8	2.95	18.1	3.6	1.32	32	6.33	14.9	2.95	17.1	3.38
Average	1.24	37.5	37.5	17				1.26	37.2		17.2			

Table (3): Actual monthly water consumptive use ET_a (cm / fed. , m3 / fed.) for wheat crop as effected by irrigation regime during the two studied seasons .

Months	Actual water consumptive use (cm/ month)							
	25% depletion of A.W		50% depletion of A.W		75% depletion of A.W		Traditional irrigation	
	cm/ fed	m^3/ fed.	cm/ fed	m^3/ fed.	cm/ fed	m^3/ fed.	cm/ fed	m^3/ fed.
Nov.	1.65	69.3	1.55	65.1	1.9	79.8	2.19	90.72
Dec.	6.79	285.18	6.79	283.92	4.8	201.9	6.94	291.48
Jan.	7.28	305.76	7.07	296.94	6.76	283.92	7.41	311.22
Feb.	10.06	422.52	9.69	406.98	9.44	396.48	10.42	437.64
Mar.	13.19	553.98	12.77	536.34	12.28	515.76	13.92	584.64
Apr.	8.25	346.5	7.92	332.64	6.15	558.3	8.85	371.7
May	2.04	85.86	1.87	78.54	1.8	75.6	3.40	142.8
Total	**49.26**	**2068.92**	**47.63**	**2000.46**	**43.13**	**1811.46**	**53.1**	**2230.2**

Table (4): Average actual monthly and seasonal evapotranspiration (cm / fed , m^3/ fed) for corn and soybeans crops during the two studies seasons

Months	Soybean crop								Corn crop.							
	25% depletion of A.W		50% depletion of A.W		75% depletion of A.W		Traditional irrigation		25% depletion of A.W		50% depletion of A.W		75% depletion of A.W		Traditional irrigation	
Jan.	11.05	464.1	9.4	394.8	8.35	350.7	11.52	483.84	11.22	471.24	10.44	480.48	9.45	396.9	12.18	511.98
July	16.46	491.32	14.85	623.7	13.79	579.18	17.02	714.84	17.42	731.64	16.65	699.3	15.65	657.3	8.57	779.94
Aug.	18.97	796.74	17.11	718.62	16.02	672.84	19.34	812.28	19.86	834.12	19.08	801.36	18.09	759.78	20.71	2869.82
Sept.	8.37	351.54	7.17	301.14	6.1	256.2	8.79	369.18	6.85	287.7	6.07	254.94	5.71	239.82	6.49	272.58
Total	**54.85**	**2303.7**	**48.53**	**2038.26**	**44.26**	**1858.92**	**56.67**	**2380.14**	**55.35**	**2324.7**	**52.23**	**2194.08**	**48.9**	**2053.8**	**57.96**	**2443.32**

Table (5): Average quantity of water applied (m^3/ fed.) for wheat , soybean and corn crop during the two studied seasons .

No. of irrigation	Water applied (m3/ fed)											
	Wheat				Soybean				Corn			
	25% depletion of A.W	50% depletion of A.W	75% depletion of A.W	Traditional irrigation	25% depletion of A.W	50% depletion of A.W	75% depletion of A.W	Traditional irrigation	25% depletion of A.W	50% depletion of A.W	75% depletion of A.W	Traditional irrigation
1	396.73	396.73	397.73	510.2	510.84	510.84	510.84	570.90	490.72	490.72	490.72	576.73
2	322.96	332.96	322.96	442.0	360.54	360.54	360.54	402.60	430.90	430.90	430.90	485.60
3	274.90	423.5	464.1	395.4	285.94	320.20	430.20	356.40	305.40	410.57	495.20	412.86
4	272.6	448.6	490.2	445.64	293.25	350.2	450.70	360.80	309.27	420.32	502.40	401.45
5	324.98	427.1	480.2	349.24	287.84	320.2	475.20	379.20	317.56	425.32	510.63	378.18
6	345.86	368.69	410.00	386.84	335.3	380.9	420.30	470.30	335.60	410.35	464.45	365.42
7	231.56	350	-	356.84	370.2	407.78	-	445.40	330.75	406.30	-	344.03
8	253.1	-	-	375.24	285.4	310	-	330.18	319.17	-	-	309.30
9	245.57	-	-	-	250.7	-	-	-	315.20	-	-	-
10	227.61	-	-	-	240.42	-	-	-	-	-	-	-
Total	2895.87	2737.58	2564.19	3261.40	3220.43	2960.66	2647.78	3315.78	3144.57	2994.48	2894.64	3264.57

Table (6) : Values of total yield (kg / fed.) , water consumptive use (m^3/ fed) , water applied (m3/ fed) , and water use efficiencies (kg / m3) for some field crops (wheat , soybean and corn) during the two studied seasons .

Treatments	Wheat					Soybean					Cron				
	Total yield (kg/ fed.)	Water consumptive use (m3/fed)	Crop water use efficiency (kg/m3)	Water applied (m3/fed)	Field water use efficiency (kg/ m3)	Total yield (kg/ fed.)	Water consumptive use (m3/fed)	Crop water use efficiency (kg/m3)	Water applied (m3/fed)	Field water use efficiency (kg/ m3)	Total yield (kg/ fed.)	Water consumptive use (m3/fed)	Crop water use efficiency (kg/m^3)	Water applied (m^3/fed)	Field water use efficiency (kg/ m^3)
25% depletion of available water	1819	2068.92	0.88	2895.87	0.63	950	2303.70	0.41	3220.43	0.29	2015	2324.7	0.87	3144.57	6.64
50% depletion of available water	2250	2000.46	1.12	2737.58	0.82	1350	2038.26	0.66	2960.66	0.45	2580	2194.08	1.17	2994.48	0.86
75% depletion of available water	1404	1811.46	0.77	2564.19	0.55	1050	1858.92	0.56	2647.78	0.40	1650	2053.80	0.80	2894.64	0.57
Traditional irrigation	1935	2230.2	0.88	3261.4	0.59	1200	2380.14	0.50	3315.78	0.36	2325	2443.32	0.95	3264.57	0.71

Table (7): Quantity of water saving (m^3/fed) and increase of yield (kg / fed.) when we use the best irrigation regime depletion compared with traditional irrigation for wheat , soybean and corn crops during the two studied season .

Crops	*Water applied		*Water saving*					Total yield (kg/ fed)		Increased of yield	
	Traditional irrigation	The best irrigation regime of depletion (50% of A.W)	m^3/fed	%	**Average area cultivated crops (wheat , soybean and corn) in El-Minia region	Total of water saving m^3 million/ area	The area (fed.) which can be cultivated as a result of saving water	Traditional irrigation	The best irrigation regime of depletion (50% of A.W)	Kg/fed.	%
Wheat	3261.40	2737.58	529.82	16.1	188000	99.606160	15563.5	1935	2250	315	16.30
Soybean	3315.78	2960.66	355.12	10.71	25715	9.131910	1426.86	1200	1350	150	12.50
Corn	3264.57	2994.48	270.09	8.27	217000	58.609530	9157.74	2325	2580	255	10.96

***Source : actual field irrigation water measurements .**

****Source : Directorate of Agriculture - El-Minia Department of Statistics 2005-2006**

Table (8): Average values of total income , Total costs (L.E / fed.) , net return per cubic meter a water (L.E/ m^3) and economic efficiency as affected by irrigation regime for wheat , soybean and corn crops during the two studied season

Crops	25% depletion of A.W								50% depletion of A.W								75% depletion of A.W								Traditional irrigation							
					Water issues (L.E /m^3)								Water issues (L.E /m^3)								Water issues (L.E /m^3)								Water issues (L.E /m^3)			
	Total income (L.E/fed.)	Total costs (L.E/fed.)	Net profit (L.E/fed.)	Economic efficiency	Water consumptive use (m^3/fed.)	Net return from unit water consumptive (L.E/m^3)	Water applied (m^3/fed)	Net return from unit water applied (m^3/fed.)	Total income (L.E/fed.)	Total costs (L.E/fed.)	Net profit (L.E/fed.)	Economic efficiency	Water consumptive use (m^3/fed.)	Net return from unit water consumptive (L.E/m^3)	Water applied (m^3/fed)	Net return from unit water applied (L.E/m^3)	Total income(L.E/fed.)	Total costs (L.E/fed.)	Net profit (L.E/fed.)	Economic efficiency	Water consumptive use (m^3/fed.)	Net return from unit water consumptive (L.E/m^3)	Water applied (m^3/fed)	Net return from unit water applied (m^3/fed.)	Total income (L.E/fed.)	Total costs (L.E/fed.)	Net profit (L.E/fed.)	Economic efficiency	Water consumptive use (m^3/fed.)	Net return from unit water consumptive (L.E/m^3)	Water applied (m^3/fed)	Net return from unit water applied (L.E/m^3)
Wheat	2091.3	1605	486.3	0.30	2068.92	0.23	2895.87	0.18	2736.62	1466	1270.62	0.87	2000.46	0.63	2737.58	0.46	1800.8	1505	295.8	0.20	1811.46	0.16	2564.19	0.11	2439.5	1455	984.5	0.68	2230.22	0.44	3261.40	0.30
Soybean	1600	1420	180	0.13	2303.70	0.09	3220.43	0.5	20251	1400	625	0.45	2038.26	0.31	2960.66	0.21	1575	1350	225	0.17	1858.92	0.12	2647.78	0.08	1800	1380	420	0.30	2380.14	6.18	3312.78	0.13
Corn	2030	1690	340	0.20	2324.7	0.15	3144.57	0.11	2163.78	1385	778.78	0.56	2194.08	0.35	2994.48	0.26	1400	1290	110	0.08	2053.80	0.05	2894.64	0.04	1950	1350	600	0.44	2443.32	0.24	3264.57	0.18

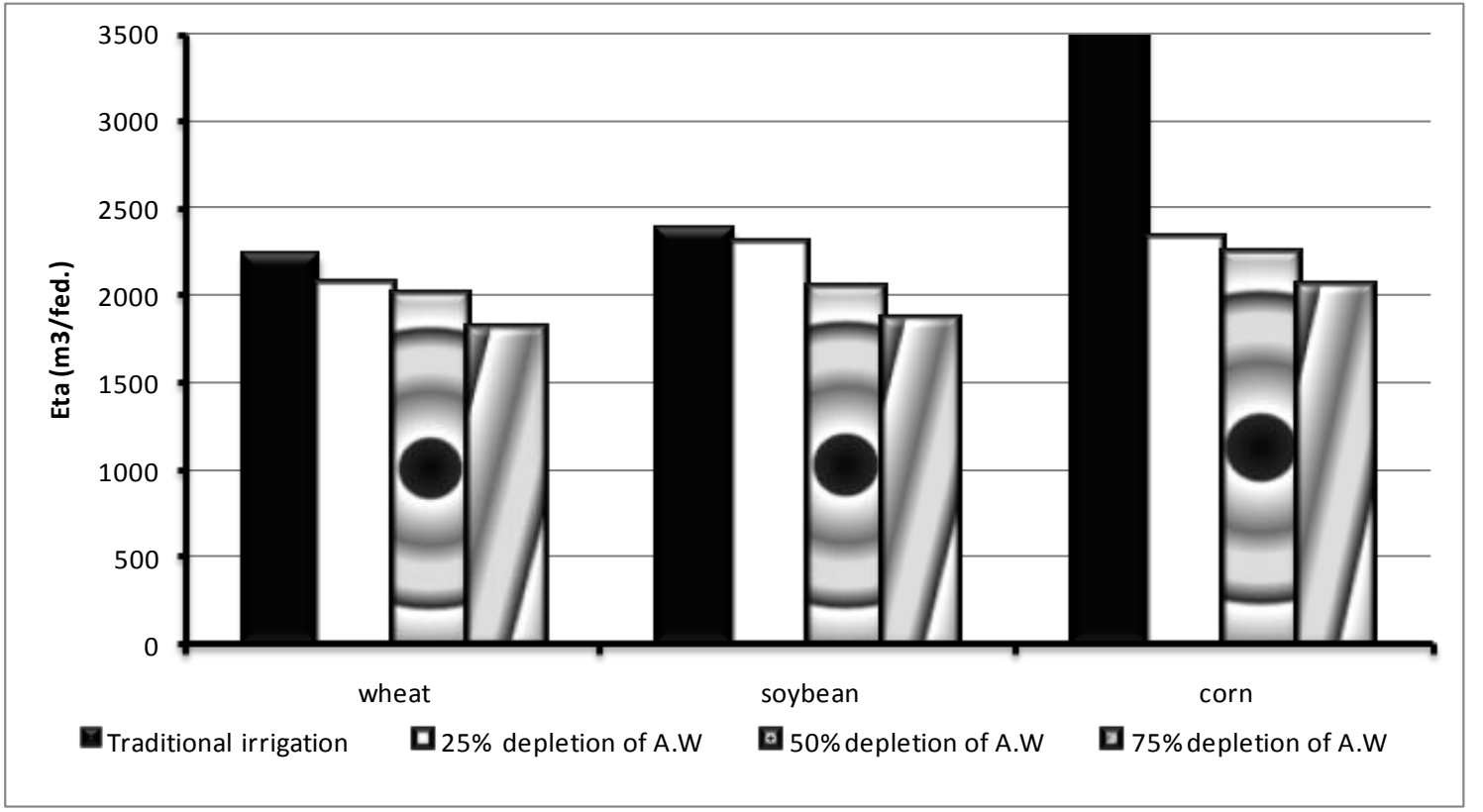

Fig. (1): Seasonal actual evapatranspiration ET_a (m^3 / fed) For wheat , Soybean and corn crops as affected by irrigation regime during the tow studied seasons

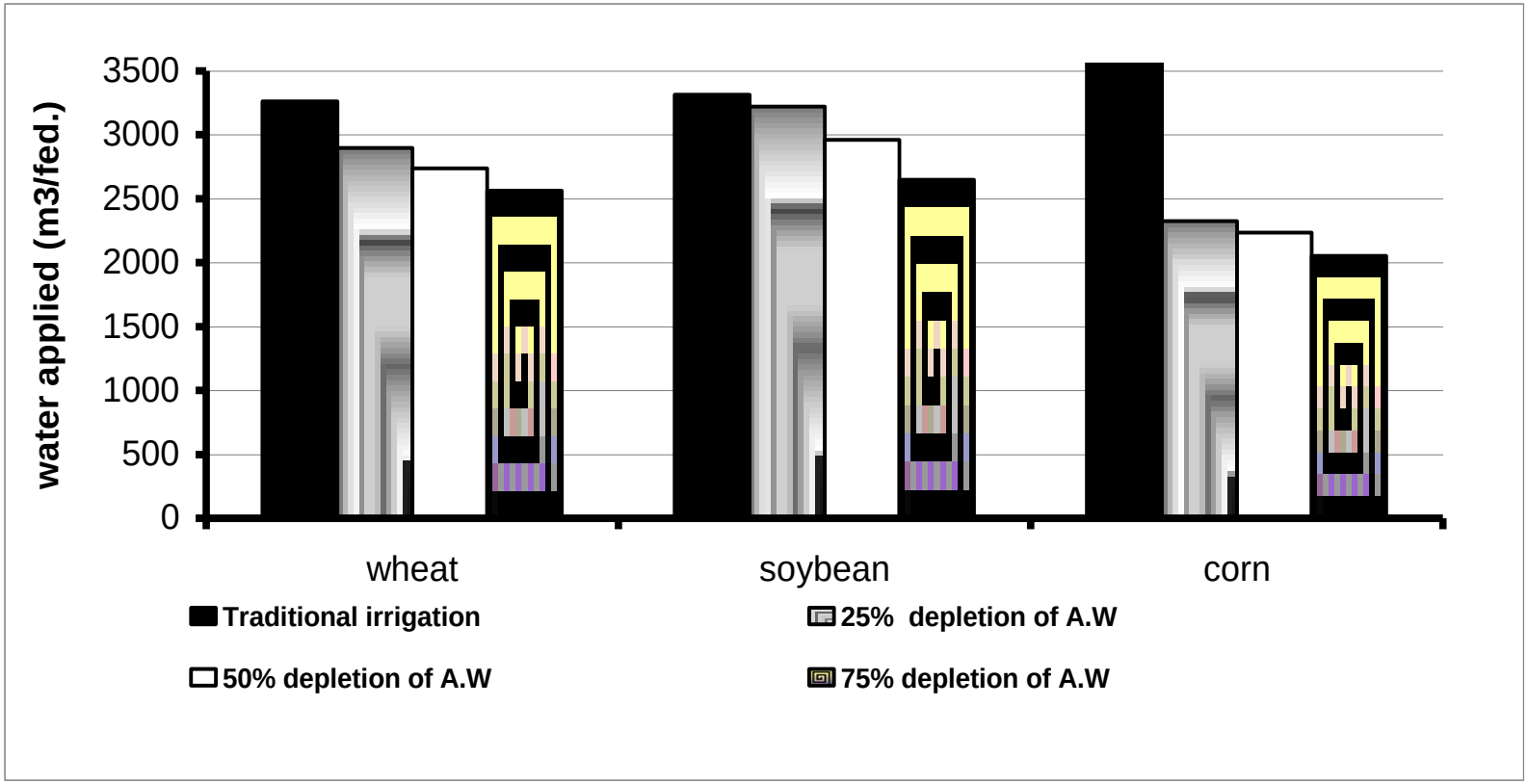

Fig. (2) : Average quantity of water applied (m^3/ fed.) for wheat , soybean and corn crop as affected by irrigation regime during the tow studied seasons