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SAVING IRRIGATION WATER AND REDUCING MINERAL FERTILIZATION FOR WHEAT USING RICE STRAW COMPOST

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ABSTRACT

Tow field experiments were carried out at Sakha Agricultural Research Station. Kafr El-Sheikh Government, during two successive seasons of 2010 / 11 and 2011 / 12. The objectives of this research where: (i) increasing wheat yield, (ii) decreasing the applied mineral fertilizer, and (iii) saving irrigation water. Experiments were arranged in split plot design with four replicates .The main plots were assigned to three irrigation intervals, irrigation every (20 (I_1), 25 (I_2) and 30 days (I_3). The sub plots were assigned to three fertilization treatments of F_1 (application of the recommended dose of mineral NPK fertilizer, 75, 30 and 48 unit / fed. for N, P and K, respectively). F_2 (5 ton / fed. rice straw compost augmented with organic activator +75 % of the recommended mineral fert. (56, 22.5 and 36 unit /fed.NPK). F_3 (10 ton /fed. rice straw compost augmented with organic activator + 50% of the recommended mineral fert. 37.5, 15 and 24 for N, P and K, respectively)

The results can be summarized as follows:

1- Irrigation treatment I_3 was the best treatment since it save water irrigation of about 10.8% (286 m^3) and had no significant decrease in wheat grain yield compared to the traditional irrigation treatment (I_2).
2- The highest wheat yield value of 3963.4 kg /fed. Was obtained with I_2 F_3 treatment, while the lowest one was with I_1 F_2 .
3- The highest straw yield was obtained by I_2 F_3 treatment which gave 5.35 ton/fed.
4- The highest protein percentage 11.31 % was obtained by I_2 F_3.
5- The highest irrigation water productivity (WIP) of 1.40 kg/m^3 was obtained with I_3 F_3 treatment.
6- Water productivity values for I_1, I_2 and I_3 were 1.27, 2.07 and 2.4 kg/m^3, respectively indicating a superiority of I_3 regime over the others.
7- The highest total organic carbon, organic matter, aggregation parameters and the lowest soil bulk density (1.161 kg/m^3), which means the improvements of the soil structure and nutrient uptake, were obtained I_2F_3 treatment.
8- Therefore, irrigation wheat crop every 30 days with 10 ton rice straw + 50% recommended mineral fertilizer could be recommended for the management of wheat crop under the condition of the studied area.

Keywords: Saving irrigation water, wheat yield, rice straw compost, water productivity.

INTRODUCTION

The importance of water resources management is due to the increase of the population and water demand especially in the Middle East North Africa, which are classified as arid and semi-arid regions. These are threatened by water crisis in the future. Egypt is classified among the regions that are facing high – water shortage. This is mainly due to the combination of persistent drought and the increase of water demand effects, especially in the irrigation sector.

Water resources in Egypt are limited and restrict crop production in the newly reclaimed lands because of current intensive agricultural production. Agriculture in Egypt relies heavily on irrigation. The agriculture sector consumes more than 84% of available water resources (EL-Beltagy and Abo – Hadeed, 2008).

Abd El-Hameed and Omar (2006) concluded that, increasing N level up to 105 kg N/fed. Significantly increased each of spike length, number of spikelet's / spike, number of grains /spike, 1000 – grain weight and grain yield / fed. Mahmoud *et al.,* (2006) recorded that grain and straw yields for wheat plants as well as crude protein content were increased due to increasing nitrogen level from 20 to 40, 60, 80, and 100 kg N/fed. Matter *et al.,* (2007) reported that grain yield of wheat cultivar (Sakha – 93) was increased by using organic fertilizer. The highest wheat grain yield was obtained with treatment consisted of 1.2: 0.66: 1.5: 2.5 ton/fed. from farmyard manure, chicken manure, town refuse and sewage sludge, respectively . Increasing wheat productivity is national target in Egypt to fill the gap between wheat consumption and production. Water stress affects physiological processes, growth and yield of wheat plant. El – Far and Teama (1999) studied the effect of irrigation intervals (21, 31 and 41 days) on the productivity of some bread and durum wheat cultivars. The results reveled that, the highest number of spikes /m2 (514.17), 1000 – grain weight (54.059 g) and grain yield (27.64 ard / fed.) were obtained from irrigation every 31 days. The highest straw yield (6.11 ton/fed.) was obtained from irrigation every 21 days. Sharaan *et al.,* (2000) studied the response of wheat cultivars (Sids -1, Sakha-8, Sakha-69, Giza-164 and Giza 167) grown under three water regimes to some environmental influences. They found that skipping one irrigation either at heading or at drought –ripe stage decreased all studied traits except biological and straw yields.

Normal irrigation produced the highest averages of different traits followed by those resulted from skipping one irrigation at drought ripe stage, mean while, the lowest values were obtained from skipping one irrigation at heading stage . Ashmawy and Abo –Warda (2002) showed that Giza -168 wheat cv. Significantly surpassed Sids-1 and Gemmeize-9 cultivars in each of grain yield/fed., number of spikes/m2, number of grains/spike and 1000grain wight . Abd El-Hameed (2005) concluded that, wheat Giza-168 cultivar gave higher values of number of grain/spike, 1000-grain weight, grain and straw yields/fed. than Sakha-93 one . Abd El-Hameed and Omar (2006) concluded that, increasing N levels up to 105 kg N/fed. significantly increased each of spike length, number of spikelet's/spike, number of grains/spike, 1000-grain weight and grain yield/fed.

Soil organic matter content in the arid regions is considered as one of the main problems in maintaining soil fertility.

The objectives of the present study are: increasing wheat yield, saving irrigation water, reducing mineral fertilization, improving some soil properties, soil fertility and decreasing the environmental pollution by using the straw rice compost as organic fertilizer and appropriated irrigation interval.

MATERIALS AND METHODS

Site:

Two field experiments were conducted during two growing seasons 2010/ 11 and 2011/12 at Sakha Agricultural Research Station Farm, Kafer El – Sheikh Governorate. The experiments site is located near to the main open drain and was served by tile drainage established since 1989. The tile drainage system consists of subsurface, 10 cm inner diameter, PVC pipes spas at 20 m a part and buried at 1.65 m depth. The site represents the circumstances and conditions of Middle North Nile Delta region and allocated at 31°-07' N Latitude, 30°-57'E Longitude with an elevation of about 6 meters above sea level**.** Agro meteorological data of Sakha station**,** during the two season of study, are presented in Table (1). Some physical and chemical properties of the experimental soil are presented in Table (2)

Soil texture of the experimental site was clayey and contained 46.5 % clay, 29.8 % silt and 23.7 % sand. The average of electrical conductivity of the irrigation water was 0.48 dSm^{-1}.

Experimental layout:

Wheat MISR – 2 (*Triticum aestivum* L) was sown in 18 and 20 December, in 2010 and 2011, respectively. Dates of harvesting were May, 20, 2011 and May, 22, 2012.

All agronomic practices were the same as recommended for the studied area, expect the irrigation interval and the fertilization treatments under study. The plot area was 90 $m^{2,}$ the distance between ridges was 70 cm. The compost materials were incorporated into soil surface, 15 days before planting.

Table (1_a): Mean of some meteorological data for Kafr El-sheikh area during the two growing seasons of wheat crop*

Month	Season 2010/2011							Season 2011/2012						
	Air Temp.C°		Relative humidity, %		wind speed, km/ day	Ep, mm/day	rain, mm/ month	Air Temp. C°		Relative humidity, %		wind speed, km/ day	Ep, mm/ day	rain, mm/ month
	maxi.	min.	max	min				max	min	max	min			
Nov.	26.8	11.0	82.0	54.2	63	2.9	------	24.0	10.5	86.7	53	66	2.69	-
Dec.	22.0	8.3	85.0	55.7	58.3	1.9	90.0	20.2	6.4	86.0	61.1	47.8	0.18	-
Jan.	20.3	5.8	84.2	54.0	42.5	2.11	-------	18.1	8.4	77.5	60.2	63.2	0.21	70.0
Feb.	23.4	7.4	87.0	54.0	64.0	2.7	22.5	17.5	9.5	75.6	62.0	71.5	0.3	87.0
Mar-	21.8	6.8	86.3	49.5	77.4	2.5	14.0	20.5	12.3	77.1	59.8	94.3	0.45	32.0
Apr-	26.5	10.0	85.0	47.7	83.7	4.7	----	27.1	17.0	73.53	53.5	89.7	5.15	--
May-	29.0	13.0	76.7	38.0	102.0	5.6	-----	30.8	20.7	75.7	50.0	100.1	5.7	---

Source: meteorological station at Sakha 31°07 latitude, 30°57 longitude elevation 6 m.

Table (1): Some soil physical and chemical properties of the experimental site

A-

Soil Depth, cm	Hydro physical properties			
	Available water %	PWP %	Field Capacity %	Bulk density kg m^{-3}
0 – 15	21.74	24.36	46.10	1.18
15 – 30	18.60	21.80	40.60	1.19
30 – 45	17.95	21.15	39.10	1.23
45 - 60	17.82	20.88	38.70	1.25

B-

Soil Depth, cm	Chemical properties														
	SAR	Ec, dS m^{-1}	pH	Available nutrients, ppm			Organic Matter gk g^{-1}	Infiltration rate, cm/h	DTPA – extracted element mg kg^{-1} (ppm)						
				N	P	K			Ni	Pb	Cd	Fe	Cu	Mn	Zn
0-15	7.22	1.91	8.09	15.81	23.92	307	3.19	0.46	0.27	1.24	0.03	49.31	1.14	34.21	4.31
15-30	7.01	1.98	8.01												
30-45	8.11	2.06	8.00												
45-60	8.36	2.61	7.95												

The experiment was arranged in split plot design with four replicates. The main plots were assigned to three irrigation intervals i.e. (20 (I_1), 25 (I_2) and 30 days (I_3). While the sub treatments (F_1, F_2 and F_3) were assigned to compost application rates. F_1 was the recommended dose of the mineral nutrients (100% NPK + 0(RSC) rice straw compost) . F_2 was 5 ton/fed. organic fertilizer (rice straw compost (RSC) + 75 % of the recommended dose of the mineral nutrients . F_3 was 10 ton/fed of organic fertilizer rice straw compost +50% of the recommended NPK dose of the mineral nutrients. The treatments of mineral fertilizer were applied at rates of 75, 30 and 48 unit/ fed. For N, P_2O_5 and K_2O, respectively. The used mineral fertilizers were $(NH_4)_2SO_4$ (20%N), ordinary super phosphate (15.5 % P_2O_5) and K_2SO_4 (48%.k_2O). The used compost in this study was prepared from the rice straw and some of its properties are given in Table (2).

Table 2: The characteristics of rice straw compost

Bulk density kg m^{-3}	Moisture content %	EC, dS/m	Organic carbon %	PH (1:2.5)	Total N %	C/N ratio	Fulvic acid	Humic acid	Micro – elements (ppm)			
									Fe	Zn	Mn	Cu
							g/ kg					
0.480	25.66	4.08	24.02	7.22	1.912	12.66	19.60	39.92	462	231	182	7.8

- **Irrigation water applied (Wa) :**

Water applied (Wa) was calculated according to, Giriapa (1983):

$$Wa = Iw + Re + S$$

Where: Iw = irrigation water, Re = effective rainfall, S = amount of soil moisture contributing to consumptive use either from stored moisture in root zone and / or that from shallow water table. Value of S was neglected because of the ground water table remained at a depth of a about 2 m below the surface according to observation wells installed in the field, so the upward flow into the soil profile was negligible.

Submerged flow orifice with fixed dimension was used to convey and measure the irrigation water applied, as the following equation (Michael, 1978)

$$Q = CA\sqrt{2gh}$$

Where:

Q = Discharge through orifice (cm^3 sec^{-1})

C = Coefficient of discharges (0.61)

A = Cross sectional area of orifice cm^2

g = Acceleration due to gravity, cm/sec^2 ($980 cm/sec^2$)

h = Pressure head, over the orifice center, cm

Consumptive use (Cu):

Water consumptive use was calculated using the following equation (Hansen *et al.,* 1979).

$$Cu = \sum_{i=1}^{i=4} Di \text{ x } Dbi \text{ x } \frac{PW2 - PW1}{100}$$

Cu = Water consumptive use (cm) in the effective root zone (60cm) .

D_i = Soil layer depth (15cm each)

D_{bi} = Soil bulk density, (g/cm^3) for this depth

PW_1 = Soil moisture percentage before irrigation (on mass basis, %) .

PW_2 = Soil moisture percentage, 48 hours after irrigation (on mass basis, %)

i = Number of soil layers (each 15 cm depth)

- **Water use efficiency (WUE):**

It was calculated according to (Ali *et al.,* 2007)

WUE = GY / ET

Where: WP (kg / m^3), GY is grain yield (kg / fed.). And ET total water on sumption of the growing season (m^3 / fed.)

- **Productivity of irrigation water (PW) :**

Was calculated as (Ali *et al.,* 2007)

PW = GY/I

Where I is irrigation water applied (m^3 / fed.).

Grain samples from each plot were analyzed for protein and oil percent by standard A.O.A.C. (1990) methods.

Yield and yield quality:

After harvesting the grain and straw yield of wheat were determined at the end of each season, disturbed and undisturbed soil samples were collected using cores under each treatment. Organic carbon and organic matter were determined according to Walkleyand Black rapid titration method as described by Page *et al.* (1982). Bulk density was determined using the core method by weighing the undisturbed soil samples of a volume of 250 cm^3 (Klute, 1986). Soil aggregate in the undisturbed soil samples, wet sieving technique was carried out using a set of sieves having 2.00, 1.00, 0.50and 0.25 mm screen opining according to Klute (1986).

Mean weight diameter (MWD) values was calculated by the following equation according to Baver *et al.* (1972).

$$MWD = \sum_{i=1}^{n} Wi \text{ x } i$$

Where Wi is the proportion of the total sample mass in the corresponding size fraction. Xi is the mean diameter of each size fraction (mm).

The structure coefficient (SC) values were calculated as follows: (El-Shafei and Ragab, 1975).

$$SC = \frac{\% \text{ aggregates} > 0.25 \text{ mm diameter}}{\% \text{ aggregates} < 0.25 \text{ mm diameter}}$$

The obtained data were statistically analyzed according to Gomez and Gomez, 1984.

RESULTS AND DISCUSSION

- **Irrigation water applied (Wa) :**

Water applied (Wa) to wheat consists of two items. These are (1) irrigation water (IW) and (2) rainfall (RF). As shown in Table (3) the total number of irrigations events were 7, 6 and 5 for I_1, I_2 and I_3 respectively, including sowing irrigation.

Amounts of irrigation water applied (Wa) through the two seasons for different treatments, are tabulated in Table (3). Mean values of applied water (means of 2 seasons) are 3321.0. 2939.5 and 2654.1 m^3 / fed. For I_1, I_2 and I_3 treatments, respectively. Irrigation water for I_3 treatment was the lowest and the amount for I_1 treatment was the highest. These data indicate that using I_3 irrigation treatment saved water by about 10.8% (286 $m^3 fed^{-1}$) compared to irrigation treatment I_2, while I_1 treatment consumed excess water by 12.97% (381.5 m^3/fed.) relative to the conventional irrigation I_2.

- **Water consumptive use (Cu) :**

The obtained results in Table (4) show that seasonal Cu values were greatly affected by irrigation intervals, where Cu values decreased with increasing the irrigation intervals. Seasonal average values of Cu during the two seasons were 63.7, 43.0 and 35.0 cm for I_1, I_2 and I_3 treatments, respectively. The values of Cu during the two seasons were 34.0 cm and 65.2 cm, respectively for the driest (F1I3) and wettest (F_3I_1) treatments. These results indicate that consumptive use decreased as the available soil moisture decreased in the root zone. These results are in agreement with those obtained by EL – Tantawy *et al.,* (2007).

The effect of applied fertilizer on Cu data show slightly clear evidence of fertilizer treatment on value of this trait under fixed irrigation interval.

Values of Cu were 46.1, 47.2 and 47.2 cm during the two seasons which addressed to F_1, F_2 and F_3, respectively. Values of Cu increased with increasing addition of rice straw compost due to the highest moisture condition. These results are in a good agreement with those given by Kanany *et al.,* (2004).

Table (3): Date of irrigation events and irrigation water applied (m^3/fed.) for wheat crop under different treatments during the two seasons of 2010 and 2011.

Data	Irrigation treatment			Data	Irrigation treatment			Mean of two seasons		
	20 days	25 days	30 days		20 days	25 days	30 days	20 days	25 days	30 days
20/12/2010	600.6	600.6	600.6	22/12/2011	601.0	600.0	601.0	600.8	600.3	600.8
10/1/2011	380.6	___	___	12/1/2012	369.6	___	___	375.1	__	__
15/1/	___	420.0	___	17/1/	___	370.4	___	__	395.2	__
20/1/	___	___	415.0	22/1/	___	___	405.8	__	__	410.4
30/1/	375.4	___	___	2/2/	336.0	___	___	355.7	__	__
10/2/	___	362.0	___	12/2/	___	388.6	___	__	375.3	__
20/2/	352.7	___	436.4	22/2/	347.0	___	400.2	349.85	__	418.3
5/3/	___	377.1	___	7/3/	___	332.3	___	__	354.7	__
10/3/	440.2	___	___	12/3/	469.0	___	___	454.6	__	__
20/3/	___	___	390.6	22/3/	___	___	359.6	__	__	375.1
30/3/	421.1	470.4	___	2/4/	330.3	324.2	___	375.2	397.3	__
20/4/	311.6	___	349.0	22/4/	314.4	___	304.7	313.0	__	326.35
25/4/	___	331.6	___	27/4/	___	309.0	___	__	320.3	__
Irrig.no.	7	6	5	Irrig.no	7	6	5	7	6	5
Irrigation water applied	2882.2	2561.7	2191.6	Irrigation water applied	2767.0	2324.5	2071.3	2824.6	2443.1	2157.7
Effective rainfall	397.5	397.5	397.5	Effective rainfall	595.3	595.3	595.3	496.4	496.4	496.4
Water applied	3279.7	2959.2	2589.1	Water applied	3362.3	2919.8	2666.6	3321.0	2939.5	2654.1

- **Grain yield:**

Effect of irrigation interval:

Regarding the main effect of irrigation intervals, grain yield was the highest under I_2 water regime as compared with the other two regimes. This was occurred in both seasons. The mean grain yield for the two seasons obtained by I_1, I_2 and I_3 water regimes are 3374.2, 3716.0 and 3526.0 kg/fed., respectively (Table 5). The increase caused by the I_2 regime in relation to I_1 regime was 9.8% and the increase over I_3 regime was 5.4%. The greater yield given by the I_2 regime over the other water regimes was occurred with off fertilizer treatments. With F_1 mean yields (over the two seasons) were 3340.5, 3662.2 and 3469.7 kg/ fed. for the I_1, I_2 and I_3 irrigation treatment, respectively. The superiority of I_2 regime over the I_1 regime was 8.78% and the increase over I_3 regime was 5.26% with the F_2 treatment the mean yields were 3311.2, 3522.3 and 3409.7 kg/fed. for I_1, I_2 and I_3, respectively. The superiority of the I_2 regime were 6.4% and 3.3% over I_1 and I_2, respectively. With the F_3, the mean yields were 3470.8, 3963.4 and 3698.6 kg/fed. for I_1, I_2

and I_3 water regimes of 12.43% and the increase over I_3 regime, respectively, with a superiority 14.2 and 7.2% over I_1 and I_3 regime.

- **Effect of fertilizer :**

Grain yield was greater with f_3 treatment than the other fertilizer treatments. This occurred under each of the irrigation intervals regimes since the interaction between the fertilizer treatment and irrigation intervals was significant (Table 5). Mean yields for the two seasons due to fertilization treatments of F_1, F_2 and F_3 were 3490.8, 3414.4 and 3710.0 kg/fed., respectively. Thus the F_3 treatment gave the highest yield. The percentage of increase in yield given by this treatment was 5.93 % and 7.98% as compared with F_1 and F_2 treatments, respectively.

The highest grain yield was obtained by I_2 F_3 treatment which gave 3963.4 kg/fed. The lowest yield was obtained by the I_1 F_2 treatment which gave 3311.2 kg/ fed.

It worth to mention that the obtained yield of treatment I_3 F_3 (3698.6 kg/fed.) was about the same yield of treatment I_2F_1 (3662.2kg/fed.), which represent the recommended mineral fertilization for the studied area under the traditional irrigation, i.e the control treatment. In other hand, yield of treatment I_3F_3 was slightly less than treatment I_2F_3, which had the highest yield (Table 5), by 9.2 %. Therefore, treatment I_3F_3 could be considered the best treatment and could be recommended for the management of wheat crop under the condition of the studied area, since this treatment saved water by 10.8 % (286m^3) and had no significant decrease in grain yield compared to that I_2 F_3 which had the highest yield.

- **Straw yield, (ton/fed)**

As shown in Table (6), straw yield was the highest under I_2 water regime as compared with the other two regimes. This occurred in both seasons. The mean straw yield for the two seasons obtained by $I_{1,}$ I_2 and I_3 water regimes are 4.63, 5.11 and 4.96 ton/fed., respectively. (Table 6). Regarding the effect of fertilizer treatments, straw yield was greater with F_3 treatment than the other two fertilizer treatments .This occurred under each of the irrigation intervals regimes since the interaction between the fertilizer treatments and irrigation intervals was significant (Table 6). Mean straw yields for the two seasons due to fertilization treatments of F_1, F_2 and F_3 were 4.86, 4.71 and 5.12 ton/ fed., respectively. The highest straw yield was obtained by I_2 F_3 treatment which gave 5.35 ton/fed. The lowest straw yield was obtained by the I_1 F_2 treatment which gave 4.42 ton/fed. These results are in harmony with those obtained by EL-Beshbeshy (2000) who found that the combined effect of both compost and mineral fertilizers was very obvious in increasing both straw and grain yields of wheat.

Similar results were obtained by El-Sayed *et al.* (2005) and Laila *et al.*(2005).

- **Protein percentage:**

As shown in Table (7), the effect of irrigation intervals regimes on protein percentage had the highest value with 25 days interval as compared with the two other irrigation intervals. Mean protein percentages of the two seasons due to I_1, I_2 and I_3 water regimes were 8.53, 9.53 and 8.89%, respectively.

Table (4): Average values of seasonal consumptive use in (cm) during the two growing season 2010/11 and 2011/12 .

Irrigation interval / Fertilization treatments	I_1 (20 days)	I_2 (25 days)	I_3 (30 days)	Mean
F_1	62.3	42.0	34.0	46.1
F_2	63.6	43.0	35.0	47.2
F_3	65.2	44.0	36.0	48.4
Mean	63.7	43.0	35.0	47.2

Table (5) : Average value of grain yield of wheat (kg/fed.) as affected by irrigation interval and fertilizer treatments in combined analysis of 2010/11and 2011/12 seasons.

Ferit. treatments / Irrig. Treatments.	100 % NPK F_1 RSC (0 ton/fed.)	75 % NPK F_2 RSC (5 ton/fed.)	50 % NPK F_3 RSC (10 ton/fed.)	Mean
I_1 (20 days)	3340.5	3311.2	3470.8	3374.2
I_2 (25 days)	3662.2	3522.3	3963.4	3716.0
I_3 (30 days)	3469.7	3409.7	3698.6	3526.0
Mean	3490.8	3414.4	3710.7	
L. S .D 5 %	0.067			
L .S .D 1 %	0.051			

Table (6): Average values of straw yield (ton/fed.) of wheat as effected by irrigation interval and fertilizer treatment in combined analysis of 2010/11 and 2011/12 seasons.

Fert. treatments / Irrig . intervals	100 % NPK F_1 RSC (0 ton/fed.)	75 % NPK F_2 RSC (5 ton/fed.)	50 % NPK F_3 RSC (10 ton/fed.)	Mean
I_1 (20 days)	4.63	4.42	4.83	4.63
I_2 (25 days)	5.08	4.91	5.35	5.11
I_3 (30 days)	4.88	4.80	5.19	4.96
Mean	4.86	4.71	5.12	
L .S .D 5 %	0.099			
L .S .D 1 %	0.057			

Under all fertilizer treatments, of irrigation interval (I_2) was higher than those of I_1 or I_3 irrigation intervals. With F_1 fertilization treatment means of protein percentage were 7.9, 8.30 and 8.46 % for I_1, I_2 and I_3 water regime, respectively. Increasing irrigation intervals increased the protein percentage with the superiority of I_3 water regime. With F_2 the means of protein percentage were 8.40, 9.00 and 8.86 % for I_1, I_2 and I_3, respectively. Superiority of I_2over I_1 was 6.67%, and it was 1.56 % over I_3. With F_3 means of protein percentage were 9.30, 11.31 and 9.36 % for each of the 3 irrigation intervals I_1, I_2 and I_3, respectively. The superiority of the I_2 over I_1 was 17.77 %, and it was 17.25 % over I_3.

Concerning the effect of rice straw compost, the protein percentage was the greatest with F_3. The means of protein percentage (over the two seasons) due to F_1, F_2 and F_3 were 8.22, 8.75 and 9.99 %, respectively. Thus the 10 ton rice straw compost + 50 % mineral NPK F_3 gave greater percentage of protein in comparison with the other two fertilization treatments. The percentage of increase in protein percentage was given by F_3 over F_2 and F_1 were 12.42 % and 17.71 %, respectively. The highest protein percent 11.31 % was obtained by I_2 F_3. The lowest 7.90 % was obtained by I_1 F_1. These results are in agreement with those obtained by Khalil *et al.* (2000) and Khalil et al, (2004)

Table (7): Average values of protein percentage of wheat as effected by irrigation interval and fertilizer treatment in combined analysis of 2010/11 and 2011/12 seasons.

RSC + NPK		I_1 (20 days)	I_2 (25 days)	I_3 (30 days)	Mean
F_1	0 + 100 % NPK	7.90 c	8.30 c	8.46 c	8.22
F_2	5 ton + 75 % NPK	8.40 b	9.00 a	8.86 b	8.75
F_3	10 ton + 50% NPK	9.30 a	11.31 a	9.36 a	9.99
Mean		8.53	9.53	8.89	
In rows L. S. D 5 %		0.155			
In rows L. S. D 1 %		0.217			

- **Water use efficiency (WUE) :**

Regarding the effect of water regimes (Table 8) the WUE was the highest with the I_3 as compared with the other treatments. The mean of WUE (over the two seasons) due to I_1, I_2 and I_3 water regimes were 1.3, 2.1and 2.4 kg/m^3, respectively. The increase due to I_3 regime in relation to I_2 regime was 18.72 % and the increase over I_1 was 50.16 %. Under condition of F_1 treatment mean WUE values for I_1, I_2 and I_3 were 1.27, 2.07 and 2.42 kg/m^3, respectively indicating a superiority of I_3 regime over the others.

It gave an increase of 18.72 and 50.16 % relative to I_2 and I_1 regimes, respectively. With F_2, the pattern was similar to that with F_1 and the mean value of WUE were 1.23, 1.95 and 2.31 kg/m^3 for the I_1, I_2 and I_3, respectively, this increase due to I_3 over I_2 and I_1 of 16.90 and 46.56 %, respectively. With F_3 mean values of WUE were 1.26, 2.14 and 2.84 kg/m^3 for I_1, I_2 and I_3 water regimes, indicating that I_3 gave an increases in WUE of 24.57 % and 44.65 % over I_2 and I_1, respectively. The highest WUE obtained by I_3 F_3 treatment was 2.84 kg/m^3. The lowest WP was obtained by the I_1 F_2 treatment which gave 1.24 kg/m^3 .The results indicate that increasing the irrigation intervals as well as the addition of rice straw compost enhanced the WUE of wheat crop under these conditions of the studied area.

- **Productivity of irrigation water(PIW)**

As shown in Table (8), PIW values were the highest with I_3 as compared with the other two treatments. This was particularly true under conditions of I_3. The average of PIW (over the two seasons) due to I_1, I_2 and I_3 water regimes were 1.02, 1.26 and 1.33 kg/m^3 respectively. The increase due to I_3 regime over I_1 and I_2 were 23.31 %, and 5.26%, respectively. Concerning the effect of fertilization treatment, PIW values were the highest with F_3. The average values of PIW (over the two seasons) due to F_1, F_2 and F_3 were 1.19, 1.16 and 1.27 kg/m^3, respectively.

The increase due to F_3 treatment over F_1 and F2 were 6.30 % and 8.66 %, respectively. The highest PIW value was obtained by the I_3F_3 treatment which gave 1.40 kg/m^3. While the lowest one was obtained by I_1F_2 treatment which gave 1.00 kg/m^3 of irrigation water applied

Table (8) Average values of grain yield (kg/fed.), consumptive use (CU) cm/fed., water applied (Wa), water use efficiency (WUE) and productivity of irrigation water (PIW) (average of two seasons 2010/11 and 2011/12)

Irrigation treatment	Fertilization treatment	Grain yield (Kg/Fed.)	Wa (m^3/Fed.)	CU (m^3/Fed.)	WUE (Kg/m^3)	PIW (kg/m^3)
I_1	F_1	3340.5	3321	2616.6	1.3	1.01
	F_2	3311.2	3321	2671.2	1.2	1.00
	F_3	3470.8	3321	2738.4	1.3	1.05
Mean		3374.2		2675.4	1.3	1.02
I_2	F_1	3662.2	2940	1764	2.1	1.24
	F_2	3522.3	2940	1806	2.0	1.20
	F_3	3963.4	2940	1848	2.1	1.35
Mean		3717.3		1806	2.1	1.26
I_3	F_1	3469.7	2654	1428	2.4	1.31
	F_2	3409.7	2654	1470	2.3	1.28
	F_3	3698.6	2654	1512	2.4	1.40
Mean		3526.0		1470	2.4	1.33

Total organic carbon and organic matter:

Data in Table (9) indicate that the application of composted materials increased each organic C and organic matter in soil compared to the mineral fertilization after both seasons.

Also, the data showed that organic C and organic matter (OM) were increased progressively with increasing the application rates of composted materials.

Regarding the effect of fertilizer treatments, organic carbon and organic matter were greater with F_3 treatment than with the other two fertilizer treatments. This occurred under each of the irrigation intervals regimes since the interaction between the fertilizer treatment and irrigation intervals was significant (Table 9). Mean organic carbon and organic matter (g kg^{-1}) for the two seasons due to fertilization treatments of F_1, F_2 and F_3 were 5.71, 7.54, 9.79, 9.85, 13.00 and 16.89 (g kg^{-1})respectively. The highest organic .C and OM contents were obtained with (I_2F_2) treatment which amounted to 10.22 and 17.62 (g kg^{-1}), respectively. Meanwhile, the lowest values of soil organic C and OM were obtained with (I_1F_1) treatment which amounted to 5.62 and 9.69 (g kg^{-1}), respectively.

In general, this increment in total organic carbon and organic matter means the improvement of the structural status, water retention, plant available water, root penetration and nutrient uptake, where they consequently reflected on improved yield of wheat crop.

Buckman and brady (1969) pointed out that the organic matter played an important role for desirable soil structure by developing micro- aggregates which increased the soil porosity. The results are in agreement with those reported by Khalifa *et al.* (2000), Hamoud (2001). Nasser(2001), El-Zaher *et al.*(2004); Ali, *et al.*(2001) and Nasser (2007).

Table (9): Average values of total organic carbon and organic matter ($g\ kg^{-1}$) of two seasons 2010/11 and 2011/12.

Irrigation treatment	Fertilization treatment	Total organic carbon ($g\ kg^{-1}$)	Organic matter ($g\ kg^{-1}$)	Bulk density (BD), (g/cm^3)
I_1	F_1	5.62 b	9.69 b	1.189 a
	F_2	7.31 c	12.60 c	1.178 a
	F_3	9.53 c	16.43 c	1.170 a
Mean		7.49	12.91	1.179
I_2	F_1	5.81 a	10.02 a	1.186 a
	F_2	7.79 a	13.43 a	1.167 b
	F_3	10.22 a	17.62 a	1.161 b
Mean		7.94	13.69	1.171
I_3	F_1	5.70 b	9.83 b	1.188 a
	F_2	7.52 b	12.96 b	1.170 b
	F_3	9.64 b	16.62 b	1.167 a
Mean		7.62	13.14	1.175
The whole mean		7.68	13.25	1.175

Bulk density (BD):

Regarding the alterations of bulk density as affected by the application rate of composted materials, and irrigation treatment, data presented in Table (9) revealed that the application of rice straw compost significantly decreased soil bulk density (BD) compared to the mineral fertilization after harvesting wheat crop. Mean bulk density for the two seasons due to fertilization treatments of F_1, F_2 and F_3 were 1.188, 1.172 and 1.166 kg/m^3, respectively.

Thus the F_3 treatment gave the lowest value of bulk density. The highest value of soil bulk density was recorded by I_1F_1 treatment which gave 1.189 g/cm^3. Meanwhile, the lowest value of soil bulk density was obtained by I_2 F_3 treatment which gave 1.161 kg/cm^3. Regarding the main effect of irrigation intervals on soil bulk density was the highest under I_1 water regime as compared with the other two regimes. This occurred in both seasons . The mean soil bulk density after the two seasons was obtained by I_1, I_2 and I_3 water regimes treatment were 1.179, 1.171 and 1.175 g/cm^3 respectively. Also, soil bulk density was the lowest under I_2 water regime as compared with the other two regimes. The decrease of the density can be ascribed to an increase in volume of micro pore spaces as well as decreasing particle density in soil amended with organic materials.

Aggregation

Regarding, the effect of different rates of composted applications, the data showed that, values of aggregation parameters were increased with increasing rates of composted application (Table 10). Moreover, the values of these parameters at rate of addition 10 ton/Fed. compost + 50% NPK) F_3, were it was higher than those obtained from the other two fertilizer treatments (F_1 and F_2) .This occurred under each of the irrigation intervals.

As shown in Table (10), values of aggregation parameters were the highest with I_2 as compared with the other two treatments, which amounted to 48.046%, 0.251, 0.501 (mm), 36.877 % and 0.926, respectively, for total W.S.A, AI, M.W.D ., opt. size and S.C. This occurred in both seasons. Meanwhile, the lowest values of aggregation parameters were obtained from I_1 which gave 43.581 %, 0.216, 0.431 (mm), 30.199 % and 0.739, respectively. Also, The highest values of aggregation parameters were obtained by the I_2 F_3 treatment which gave 43.303 %, 0.251, 0.526(mm), 39.143 % and 0.973 for the five above mentioned parameters, respectively.

Boyle *et al.* (1989) discussed the effects of organic matter on soil aggregation. They stated that organic amendments increased soil organic matter (humic substances and polysaccharides) which binds soil particles together into aggregates where larger or wide pore size distribution favors the downward flow of water in soil.

In general, these increments in total organic carbon, organic matter, aggregation parameters and decreased soil bulk density means improvement of the construction and nutrient uptake, while they consequently reflected on improveing yield of wheat crop.

Similar results were obtained by Bazzoffi *et al.*(2000) ; Khalifia *et al.*(2000) ; Hamoud (2001) and Nasser (2001).

Table(10):Effect of irrigation intervals and fertilizer treatments on aggregation parameters of the tested soil after wheat crop.

Irri. Treat.	Fertilizer treat.	Distribution of W.S.A.(%)				T.W.S.A. (%)	AI	MWD (mm)	Opt. size % (2-0.5 mm)	SC
		>2 mm	2-1 mm	1-.5 mm	0.5-.25 mm					
I_1	F_1	1.705	10.355	18.965	10.874	41.899	0.212	0.424	29.320	0.720
	F_2	1.399	10.950	18.290	11.040	41.679	0.207	0.413	29.240	0.715
	F_3	1.899	11.598	24.060	9.608	47.165	0.228	0.456	32.036	0.783
Mean		1.668	10.968	20.438	10.507	43.581	0.216	0.431	30.199	1.739
I_2	F_1	1.893	12.149	23.682	9.945	47.669	0.246	0.492	35.831	1.911
	F_2	1.899	11.598	24.060	9.608	47.165	0.243	0.486	35.658	0.893
	F_3	1.254	16.855	21.288	9.906	49.303	0.263	0.526	39.143	0.973
Mean		1.682	13.534	23.010	9.820	48.046	0.251	0.501	36.877	0.926
I_3	F_1	1.612	11.505	22.871	8.761	44.749	0.229	0.458	34.376	0.783
	F_2	1.582	10.845	18.831	11.398	42.656	0.213	0.426	29.676	0.744
	F_3	1.735	17.335	18.435	10.523	48.028	0.263	0.525	35.770	0.924
Mean		1.676	13.228	20.047	10.227	45.144	0.235	0.470	33.274	0.817

AI=Aggregation index MWD = Mean weight diameter opt. size =optimum size of water stable aggregates

SC= structure coefficient TWSA = Total of water stable aggregates

CONCLUSION

The results of our work indicated that the highest grain and straw yield for wheat planted in both growing seasons of 2010/11 and 2011/12 was obtained when the plants were irrigated every 30 days with 10 ton rice straw compost +50 % recommended mineral fertilizer, could be recommended for the management of wheat crop under the condition of the studied area

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توفير مياه الرى والحد من الاسمده المعدنيه للقمح باستخدام كمبوست قش الارز

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اجريت هذه الدراسه بمزرعه محطه البحوث الزراعيه بسخا – محافظه كفر الشيخ عامى ٢٠١٠ / ١١ و ٢٠١١/ ١٢ بهدف زياده محصول القمح وتقليل الاسمده المعدنيه وتوفير مياه الرى وخفض التلوث البيئى - استخدم محصول القمح صنف (مصر ٢) كما استخدم تصميم القطع المنشقه مره واحده فى اربع مكررات حيث خصصت القطع الرئيسيه لمعاملات فترات الرى حيث كانت (I_1) الرى كل ٢٠ يوم و (I_2) الرى كل ٢٥ يوم و (I_3) الرى كل ٣٠ يوم

والقطع تحت رئيسيه معاملات التسميد حيث كان (F_1) التسميد المعدنى (بالمعدل الموصى به) و F_2 ٧٥% من معدل التسميد الموصى به + ٥ طن كمبوست قش الارز – (F_3) ٥٠ % من معدل التمسيه المعدنى الموصى به + ١٠ طن كمبوست قش الارز

ويمكن تلخصي النتائج كالاتى :

١- معامله الرى كل ٣٠ يوم مع اضافه ٥٠ % من الاسمده المعدينه الموصى بها + ١٠ طن كمبوست قش الارز هى افضل معامله وفرت ٢٨٦ م^3 (١٠.٨ %) من مياه الرى مع نقص غير معنوى فى محصول حبوب القمح (٦.٩٣ %) مقارنه بمعامله الرى كل ٢٥ يوم (I_2)تحت نفس معامله التسميد .

٢- اعلى انتاج لمحصول القمح كان (٣٩٦٣.٤ كجم / فدان) وامكن الحصول عليه من معامله الرى كل ٢٥ يوم و ٥٠ % من السماد المعدنى الموصى به + ١٠ طن كمبوست قش الارز (I_2 F_3).

٣- اعلى محصول للتبن كان ٣،٥ ٥ طن/ للفدان تحصل علية من المعاملة (I_2 F_3)

٤- ايضا كانت اعلى نسبة بروتين كانت ١١.٣١% تحصل عليها لنفس المعاملة

٥- اعلى انتاجيه للماء ١.٤٠ كجم/م^3 من مياه الرى المضاف و 2.84كجم/م^3 ماء مستهلك بواسطه المحصول وامكن الحصول عليه من معامله الرى كل ٣٠ يوم نغ اضافه ٥٠ % من السماد المعدنى الموصى به + ١٠ طن كمبوست قش الارز .

٦- زيادة كمية الكربون العضوى والمادة العضوية وانخفاض الكثافة الظاهرية ادى الى تحسن بناء التربة وزيادة امتصاص العناصر وكانت اقل قيمة للكثافة الظاهرية ١.١٦١ جم/سم^3 كانت للمعاملة (I_2 F_3)

٧- رى القمح كل ٣٠ يوم وتسميد ب ٥٠ % من السماد الموصى به +١٠ طن كمبوست قش الارز المعامله (I_3F_3) يمكن التوصيه بها لاداره محصول القمح تحت ظروف منطقه الدراسه .

قام بتحكيم البحث

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