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AVAILABILITY OF SOME NUTRIENTS AND RICE YIELD AS AFFECTED BY RICE STRAW FERTILIZATION UNDER CONTINUOUS FLOODING AND SATURATION.

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ABSTRACT

A field experiment was conducted during the two successive summer seasons of 2009 and 2010 in using clayey soil at the farm of Rice Research and Training Center, Sakha District, Kafer El-Sheikh Governorate, Egypt, to investigate the effect of rice straw incorporation in the soil under continuous flooding and continuous saturation on availability of some nutrients in the soil (ammonium, nitrate, phosphorus and potassium) and rice yield. Utilization of 165 kg N ha^{-1} gave the highest values of rice grain yield but without any significant differences with 5 tons rice straw ha^{-1} + 110 kg N ha^{-1}. The largest amounts of nutrients (NH_4^+ and P) availability were found with continuous flooding. While, the highest values of NO_3^- and K availability were found under continuous saturation. The continuous flooding treatment gave more grain yield as compared with continuous saturation treatment.

Keywords: Rice, Rice Straw fertilization, Nutrients Availability

INTRODUCTION

It is important to understand the unique properties of flooded soils in order to manage soil, fertilizer, and moisture regimes and to maximize rice production in a given environment. Alternate flooding gave much lower dry weight and nitrogen uptake than continuous flooding. Recovery of ^{15}N-labelled urea in the plant was lower and loss higher under alternate flooding (Sharif-Zia and Waring, 1987). Singh *et al*. (2001) stated that the integrated use of organic manures and chemical fertilizer will augment the efficiency of both substantially to maintaining a high level of productivity and rice production. Hence in order to bring the soil well supplied with all the essential plant nutrient and also to maintaining it in good health, it is necessary to use organic supplies in conjunction with fertilizer.

The application of the organic fertilizers such as the farmyard manure, straw and green manure, could increase the soil organic matter contents which serve several advantages like conservation and slow release of nutrients, improve of soil physical conditions and preservation of soil moisture. These advantages lead to increasing the fertility and productivity of the soil (Doberman and Fairhruse, 2000).

Understanding the chemical changes that accompany flooding or alternate wetting and drying of the soil are important for determining the suitability of nutrients for rice production. Flooding the soil sets in motion a series of chemical and biochemical changes profoundly affect the availability and losses of nutrients and the generation of the substances that can interfere with nutrients uptake. Where possible, nutrient sources such plant residues should be used in combination with minerals fertilizer to satisfy part of rice crop's requirement for nutrients and to sustain soil quality in the long run. Wetting and drying causes unequal swelling and compression of entrapped air which could cause aggregates to disintegrate and expose new surfaces to the bulk solution and enhance extractable some nutrient elements.

Decomposition of rice straw occurs anaerobically when crop residues are incorporated into flooded rice soils during land preparation for the following crop. There are many long term benefits associated with residues incorporation including soil fertility improvement. The incorporation of rice residues and continuous flooding has become common in tropical areas through nitrification of rice cropping practices (Cassman and Pingali, 1995). Pervious studies have shown that the incorporation of rice straw can negatively affected rice yield through N immobilization (Rao and Mikkelsen1976) or N availability (Cassman *et al*. 1997). Other studies have shown positive residual effects on rice yield after straw incorporation (Cassman *et al*. 1997) other studies have found similar increase in rice soils when straw incorporation is practiced (Wassmann *et al*. 1996).

The objectives of the present study were to determine the effects of mineral nitrogen fertilizer and rice straw under continuous flooding and continuous saturation on:

1- Ammonium, nitrate, phosphorus and potassium availability in the soil.

2- Rice grain and straw yield and its attributes.

MATERIALS AND METHODS

A field experiment was conducted at the experimental farm of Rice Research and Training Center (RRTC), Sakha District, Kafr El Sheikh Governorate, Egypt during 2009 and 2010 rice seasons to fulfill the objectives of the present work as follows:

Soil: it was clayey in texture. The main analytical values were: clay 55.75 and 55.27 % , silt 31.68 and 32.02 %, sand 12.57 and 12.35 %, pH 8.25 and 8.21, EC: 2.30 and 3.15 dSm^{-1} (soil paste), Organic matter 1.60 and 1.51%, total nitrogen 0.065 and 0.052%, available ammonium 19.35 and 20.58 ppm, available nitrate 14.30 and12.42 ppm, available phosphorus 18.80 and 14.20 ppm, available potassium 320 and 350 ppm, the soluble ions meq L^{-1} (soil paste) were Na^{+} 12.30 and14.10, Ca^{++} 5.40 and 10.04, Mg^{++} 2.10 and 7.42, HCO_3^{-} 3.90 and 9.40, Cl^{-}15.10 and 19.34, SO_4^{2-} 2.20 and 3.22 in the first and second seasons, respectively. The composition of used rice straw were 0.5%N, 0.08 % P, 1.5% K and 40%C.

Studied crop: Rice (*Oryza sativa,* L.) variety Sakha 105.

Experimental laid out: Experiment was laid out in a strip - plot design with four replications. The main plots were devoted to the two irrigation treatments,

1- Continuous flooding throughout the season (CF).

2- Continuous saturation throughout the season (CS).

Irrigation was done using 6 ($\pm$1) cm water head through the flooding times. Meanwhile the sub plots were occupied by the four treatments:

1- Control (T_1).
2- 5 tons rice straw ha^{-1} (T_2).
3- 5 tons rice straw ha^{-1} + 110 kg N ha^{-1} (T_3).
4- 165 kg N ha^{-1} (T_4).

Rice straw was chopped well for enhanced it's decomposition. All amount of rice straw was applied as a basal application and incorporated into the soil surface, during plots preparation. Nitrogen fertilizer was added as urea form (46.5% N). Two third of N was applied as basal application, and the other third was top dressed at 35 days after transplanting (DAT). All plots received identical cultural treatments in terms of ploughing, cultivation, seed rate, sowing method, P, K and Zn fertilizers, and disease control.

Soil samples: they were taken at 30, 60 and 90 days after transplanting (DAT), All samples were subjected to determination of available NH_4^+, NO_3^-, P and K according to the methods of Cottenie *et al.* (1982).

Plant samples: At maturity, five representative hills of the plants at each plot were separately sampled to determine number of panicles $hill^{-1}$, panicle weight g, panicle length cm, 1000-grain weight, number of filled grain $panicle^{-1}$, number of unfilled grain $panicle^{-1}$ and sterility %. At harvest, grain and straw yields of rice were estimated from 10 m^2 and grain yield was expressed as t ha^{-1} at 14% moisture content.

Statistical analysis: Data were subjected to statistical analysis, using ANOVA as described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Ammonium availability

Table 1 and Figure 1, present the concentration of NH_4^+ in the soil at 30, 60 and 90 DAT as affected by fertilizer treatments under continuous flooding and continuous saturation. Data indicate that all treatments under continuous flooding gave the highest availability of NH_4^+ compared to the same treatments under continuous saturation. The highest value of available NH_4^+ was found when 5 tons rice straw ha^{-1} + 110 kg N ha^{-1} were added. This may be due to that incorporation rice straw reduced the N losses beside stimulated both heterotrophic and phototrophic N fixation in flooded soil (IRRI, 1984) and also lower N immobilization after incorporating straw in anaerobic system compared with aerobic system which increase inorganic N and also microbial N was replenished by N contained in root exudates and decomposing root debris (Inubushi and Watanabe, 1996)

The highest values of available NH_4^+ were found at 30 DAT then declined to the minimum by 90 DAT. This decrease may be due to the absorption by rice plants and the losses by different ways. These findings are in agreement with those reported by Savnt and De Datta 1982, Kotb *et al*. 1997, and Gewaily 2006.

Table 1: NH_4^+ concentration ppm in the soil at 30, 60 and 90 days after transplanting (DAT) as affected by fertilizer treatments under continuous flooding and continuous saturation in 2009 and 2010 seasons.

Treatment	30 DAT		60 DAT		90 DAT	
	2009	**2010**	**2009**	**2010**	**2009**	**2010**
Irrigation (I)						
Continuous flooding	46.93	52.87	40.12	44.86	21.95	25.43
Continuous saturation	41.23	48.13	30.98	34.14	20.59	23.62
F test	*	*	**	*	*	*
Fertilizer treatments (T)						
Control	33.68	40.92	25.68	29.13	19.98	22.52
5 t Rice straw ha^{-1}	37.06	42.86	30.84	34.62	20.07	23.40
5 t Rice straw + 110 kg N ha^{-1}	54.92	60.26	44.52	46.99	22.45	26.02
165 kg N ha^{-1}	50.66	57.94	41.16	47.26	22.56	26.16
L.S.D.0.05	0.36	0.43	0.55	1.68	0.44	0.54
Interaction I x T	**	**	*	**	NS	NS

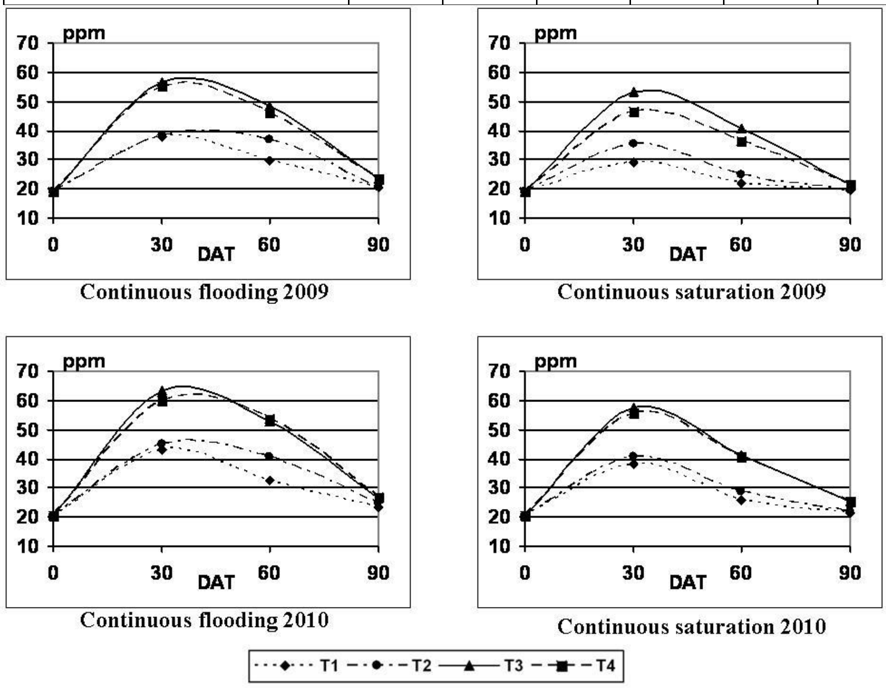

Fig.1: NH_4^+ concentration ppm in the soil at 30, 60 and 90 days after transplanting (DAT) as affected by the interaction between fertilizer and irrigation treatments in 2009 and 2010.

Nitrate concentration

Table 2 and Figure 2 represent the concentration of NO_3^- in the soil as affected by different fertilizer treatments under continuous flooding and continuous saturation. Data show that the highest values of NO_3^- concentration were found with continuous saturation treatment. This increase in NO_3^- concentration may be due to that higher amount of oxygen under continuous saturation condition that lead to more nitrification producing plenty of NO_3^-. Utilization of 165 kg N ha^{-1} under continuous flooding and continuous saturation gave the maximum NO_3^- concentration compared to other treatments. This decrease in NO_3^- concentration with using rice straw may be due to that application of rice straw enhanced NO_3^- immobilization beside the reduction of NO_3^- to NH_4^+ by microorganism. Similar results were found with IRRI 1984.

Table 2: NO_3 concentration ppm in the soil at 30, 60 and 90 days after transplanting (DAT) as affected by fertilizer treatments under continuous flooding and continuous saturation in 2009 and 2010 seasons.

Treatment	30 DAT		60 DAT		90 DAT	
	2009	2010	2009	2010	2009	2010
Irrigation (I)						
Continuous flooding	11.13	12.95	8.11	9.93	8.43	11.65
Continuous saturation	15.71	19.22	12.67	15.67	8.71	11.57
F test	**	*	**	*	NS	NS
Fertilizer treatments (T)						
Control	9.54	11.98	7.33	9.58	7.80	10.39
5 t Rice straw ha^{-1}	11.46	14.60	8.37	10.49	7.83	10.60
5 t Rice straw + 110 kg N ha^{-1}	16.13	18.04	12.40	15.40	9.12	12.48
165 kg N ha^{-1}	16.55	19.74	13.46	15.74	9.52	12.98
L.S.D.0.05	0.42	0.40	0.30	0.44	0.34	0.49
Interaction I x T	**	**	**	**	*	NS

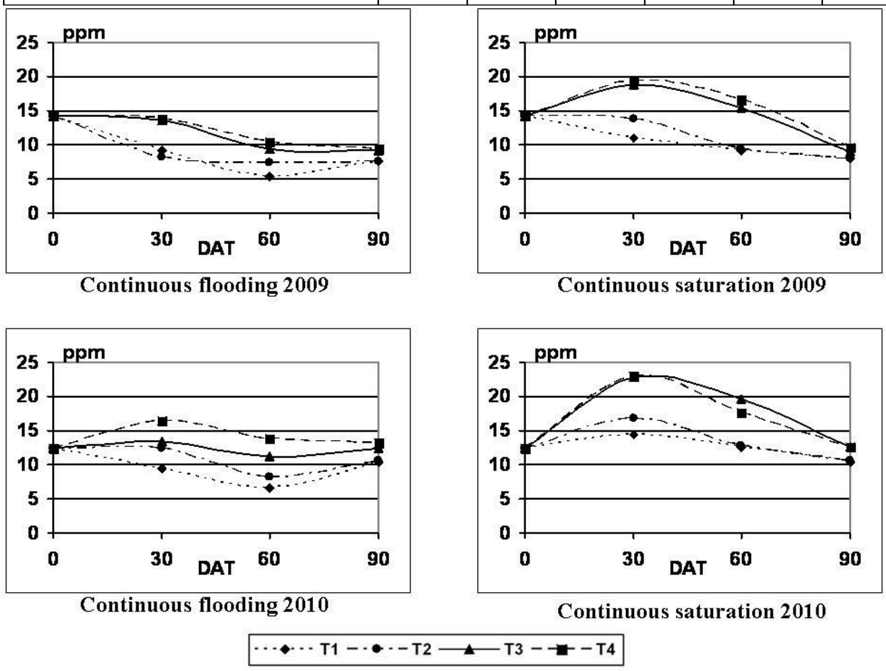

Fig. 2: NO_3 concentration ppm in the soil at 30, 60 and 90 days after transplanting (DAT) as affected by the interaction between fertilizer and irrigation treatments in 2009 and 2010.

The largest amount of NO_3^- concentration was obtained at 30 DAT then decreased to the minimum at 60 DAT, followed by a slight increase under continuous flooding but under continuous saturation treatment the highest amount of NO_3^- concentration was found at 30 DAT, then decreased afterward. The decreased of NO_3^- and increased again under continuous flooding, mainly due to the improving the aeration in the soil layers at 90 DAT and therefore nitrification process take place. These results are in agreement with obtained by Kotb *et al*. 1997 and Gewaily 2006.

Phosphorus availability

Phosphorus availability values as affected by incorporated rice straw and nitrogen fertilizer under continuous flooding and continuous saturation presented in Table 3 and Figure 3. Generally P concentration was higher under continuous flooding than that of continuous saturation. The increases in P concentration due to flooding is attributed mainly to the reduction of iron, manganese and aluminum increase their solubility with flooding and changing the condition from oxidized (before flooding) to reduced (after flooding)(De Datta, 1983) and desorption of P held by Fe^{+3} oxides and release of occluded P (Doberman and Fairhruse,2000)

Data indicate that P availability increased up to 30 DAT then decreased afterward. This mainly due to the absorption of plant beside subsequent reprecipition and resorption by soil minerals caused a decline in P (Ponnamperuma, 1972). Generally, addition of rice straw increased the P availability. Soil phosphorus availability increased form 18.80 and 14.20 ppm before flooding to 63.41 and 51.63 ppm at 30 DAT with using 5 tons rice straw ha^{-1} + 110 kg N ha^{-1} in 2009 and 2010 seasons, respectively under continuous flooding (Fig. 3)

Table 3: P concentration ppm in the soil at 30, 60 and 90 days after transplanting (DAT) as affected by fertilizer treatments under continuous flooding and continuous saturation in 2009 and 2010 seasons.

Treatment	30 DAT		60 DAT		90 DAT	
	2009	2010	2009	2010	2009	2010
Irrigation (I)						
Continuous flooding	56.68	48.33	34.16	36.45	19.15	24.89
Continuous saturation	44.02	37.21	26.95	29.29	17.56	23.57
F test	*	*	**	*	*	**
Fertilizer treatments (T)						
Control	40.74	39.60	24.61	28.11	14.94	24.58
5 t Rice straw ha^{-1}	48.91	41.05	29.32	31.58	18.02	26.01
5 t Rice straw + 110 kg N ha^{-1}	56.45	44.51	36.68	41.32	21.47	24.62
165 kg N ha^{-1}	55.30	45.91	31.61	30.48	18.99	21.63
L.S.D.0.05	0.56	0.43	0.41	0.48	0.50	0.34
Interaction I x T	**	**	*	**	**	**

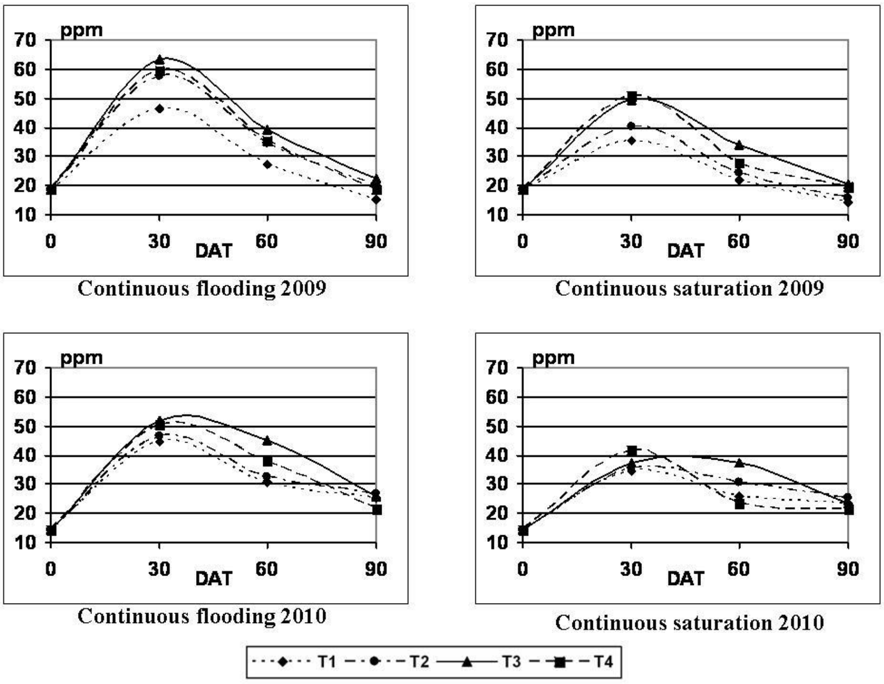

Fig. 3: P concentration ppm in the soil at 30, 60 and 90 days after transplanting (DAT) as affected by the interaction between fertilizer and irrigation treatments in 2009 and 2010.

Potassium availability

Effect of incorporated rice straw and nitrogen fertilizer treatments under continuous flooding and continuous saturation presented in Table 4 and Figure 4. Data show that all treatments under continuous flooding and continuous saturation increased the availability of K up to 30 DAT then decrease to the minimum at 60 DAT, followed by a slight increase at 90 DAT. It is clear that all treatments under continuous saturation gave the largest amounts of K availability compared to the treatments under continuous flooding. This mainly due to the effects of leaching on K losses. Hammad (1995) stated that the availability of K decreased with continuous flooding and development of plant growth. This result is mainly attributed to leaching loss and nutrient uptake. These results could be confirmed those obtained by Gewaily 2006

The highest values of K availability were obtained with using 5 tons rice straw ha^{-1} + 110 kg N ha^{-1}. This could be come from the reason that soil solution K is higher in the straw treatments. The other reason could be higher increase in the soil solution Fe_2^+ and Mn_2^+ caused by rice straw which release K from exchange complexes (Ponnamperuma 1972). These results are in harmony with those obtained by Li *et al* 2000.

Table 4: K concentration ppm in the soil at 30, 60 and 90 days after transplanting (DAT) as affected by fertilizer treatments under continuous flooding and continuous saturation in 2009 and 2010 seasons.

Treatment	30 DAT		60 DAT		90 DAT	
	2009	2010	2009	2010	2009	2010
Irrigation (I)						
Continuous flooding	372.16	382.41	352.15	363.06	367.91	368.74
Continuous saturation	387.58	390.86	374.23	368.22	381.24	376.30
F test	**	**	*	NS	*	*
Fertilizer treatments (T)						
Control	358.86	379.14	350.16	350.48	354.22	353.57
5 t Rice straw ha^{-1}	385.38	389.70	370.88	368.55	381.23	379.45
5 t Rice straw + 110 kg N ha^{-1}	404.17	397.64	381.60	377.57	398.16	386.97
165 kg N ha^{-1}	371.07	380.052.	350.13	365.96	364.69	370.09
L.S.D.0.05	3.87	84	3.33	4.01	3.24	2.60
Interaction I x T	**	*	**	*	**	**

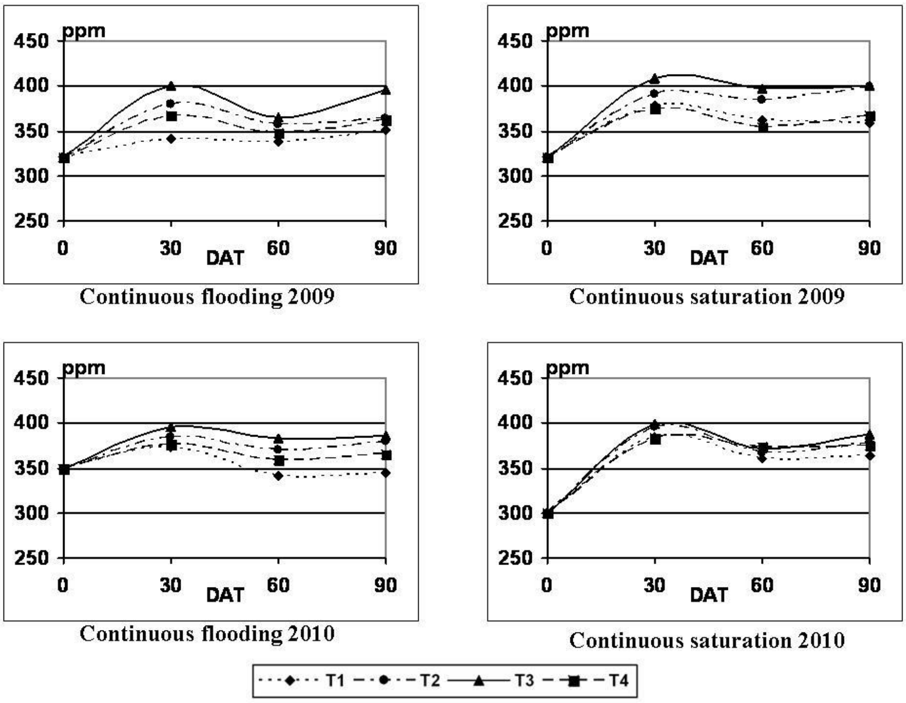

Fig. 4: K concentration ppm in the soil at 30, 60 and 90 days after transplanting (DAT) as affected by the interaction between fertilizer and irrigation treatments in 2009 and 2010.

Yield attributes:

Data in Table 5 and 6 show that in both seasons no significant differences between the irrigation treatments on panicle weight, panicle length, 1000 grain weight, filled grain panicle^{-1} and sterility %. While there was significant difference between irrigation treatments on number of panicle hill^{-1} . The highest values of number of panicle hill^{-1} (22.38 and 23.09 in the 2009 and 2010 seasons, respectively.) were obtained with continuous flooding. These results were in harmony with those obtained by El-Refaee *et al*. 2007.

Data also indicate that yield attributes were significantly affected by fertilizer treatments. Treatment of 165 kg N ha^{-1} produced the highest number of panicle hill^{-1}, panicle weight, number of filled grain panicle^{-1} in both seasons. Application of 5 tons rice straw ha^{-1} + 110 kg N ha^{-1} gave the longest panicles (21.71 and 22.20 cm) in both seasons. The heaviest 1000 grain weight was recorded with 5 tons rice straw ha^{-1} + 110 kg N ha^{-1} during 2009 season and with 5 tons rice straw ha^{-1} during 2010 season. While the lighter 1000 grain weight was obtained with control. Data also showed that in both seasons the highest values of sterility percentage were obtained with control, while application of 5 tons rice straw ha^{-1} + 110 kg N ha^{-1} gave the lowest percentage.

Table 5: Number of panicles hill^{-1}, Panicle weight and panicle length cm as affected by fertilizer treatments under continuous flooding and continuous saturation in 2009 and 2010 seasons.

Treatment	Panicle hill^{-1}		Panicle weight		Panicle length	
	2009	2010	2009	2010	2009	2010
Irrigation (I)						
Continuous flooding	22.38	23.09	3.82	3.87	21.00	21.56
Continuous saturation	20.06	21.84	3.64	3.77	20.67	21.24
F test	*	*	NS	NS	NS	NS
Fertilizer treatments (T)						
Control	14.30	14.69	3.40	3.40	19.87	20.07
5 t Rice straw ha^{-1}	21.68	22.46	3.29	3.29	20.41	21.43
5 t Rice straw + 110 kg N ha^{-1}	24.15	26.34	4.12	4.13	21.71	22.20
165 kg N ha^{-1}	24.76	26.37	4.13	4.47	21.40	21.90
L.S.D.0.05	0.81	0.70	0.26	0.27	0.48	0.51
Interaction I x T	**	**	**	NS	NS	*

Table 6 : 1000 grain weight g, number of filled and sterility% as affected by fertilizer treatments under continuous flooding and continuous saturation in 2009 and 2010 seasons.

Treatment	1000 grain weight		No. filled grain panicle^{-1}		Sterility %	
	2009	2010	2009	2010	2009	2010
Irrigation (I)						
Continuous flooding	28.18	28.03	116.50	117.76	5.18	5.07
Continuous saturation	28.11	28.42	115.00	118.25	5.66	5.42
F test	NS	NS	NS	NS	NS	NS
Fertilizer treatments (T)						
Control	27.35	27.67	97.20	100.38	7.07	6.55
5 t Rice straw ha^{-1}	28.24	28.50	109.60	111.13	5.32	5.25
5 t Rice straw + 110 kg N ha^{-1}	28.66	28.46	125.30	128.66	4.06	4.14
165 kg N ha^{-1}	28.32	28.27	130.90	131.85	5.19	5.01
L.S.D.0.05	0.73	0.63	6.74	3.52	1.33	0.72
Interaction I x T	NS	NS	NS	**	*	*

Concerning the effect of the interaction between irrigation and fertilizer treatments on yield attributes of rice in Tables 7 and 8 reveal that there was general increase in panicle hil^{-1} values with treating of 165 kg N ha^{-1} without any significant differences with 5 tons rice straw ha^{-1} + 110 kg N ha^{-1} under both of irrigation treatments. Panicle length, panicle weight and number of filled grain panicle^{-1} recorded the maximum values with treating of 165 kg N ha^{-1} under continuous flooding.

Data also showed that the highest percentage of sterility was obtained with control under continuous flooding. While the lowest percentage of sterility was obtained with 5 tons rice straw ha^{-1} + 110 kg N ha^{-1} under continuous saturation.

Table 7: Panicle weight (g) in 2009 season, panicle length (cm)and number of filled panicle^{-1} in 2010 season as affected by the interaction between fertilizer and irrigation treatments.

Fertilizer treatment	Panicle weight 2009		Panicle length 2010		No. filled grain panicle^{-1} 2010	
	CF	CS	CF	CS	CF	CS
Control	3.76	3.03	20.14	19.99	103.80	96.96
5 t Rice straw ha^{-1}	3.24	3.34	21.06	21.82	106.32	115.94
5 t Rice straw + 110 kg N ha^{-1}	4.01	4.23	22.43	21.97	129.58	125.99
165 kg N ha^{-1}	4.28	3.98	22.60	21.20	131.33	134.12
L.S.D.0.05	0.50		0.67		4.89	

CF = continuous flooding and CS = continuous saturation

Table 8: Number of panicle weight g and sterility % as affected by the interaction between fertilizer and irrigation treatments during 2009 and 2010 seasons.

Fertilizer treatment	No. panicle hill^{-1}		Sterility %	
	CF	CS	CF	CS
	2009 season			
Control	15.40	13.99	7.49	6.66
5 t Rice straw ha^{-1}	24.17	20.74	3.92	6.72
5 t Rice straw + 110 kg N ha^{-1}	26.68	25.98	4.00	3.76
165 kg N ha^{-1}	26.11	26.63	5.30	5.48
L.S.D.0.05	0.90		1.86	
	2010 season			
Control	14.80	13.80	6.88	6.21
5 t Rice straw ha^{-1}	23.48	19.87	4.58	5.91
5 t Rice straw + 110 kg N ha^{-1}	24.90	23.40	4.09	4.00
165 kg N ha^{-1}	25.35	24.17	4.72	5.54
L.S.D.0.05	1.04		1.37	

CF = continuous flooding and CS = continuous saturation

Rice yield

As shown in Table 9, no significant differences between irrigation treatments on grain yield. The continuous flooding method produced more grain yield (7.38 and 6.79% in 2009 and 2010 seasons, respectively) as compared with continuous saturation method. El-Refaee 2006 reported that continuous flooding almost gave a grain yield similar to that of continuous saturation. Although continuous saturation induced 3-5% reductions in grain yield. Insignificant increase in grain yield under continuous flooding may be due to the higher amount of availability N and P that help plant to absorb sufficient amount of them which lead to higher yield.

It is interest to notice that there was a significant increase in grain yield caused by using 165 kg N ha^{-1} but without any significant differences with using 5 tons rice straw ha^{-1} + 110 kg N ha^{-1}. This mean that 55 kg N ha^{-1} can be saved by using 5 tons rice straw ha^{-1}. Also using 5 tons rice straw ha^{-1} performed higher grain yield (25.61 and 23.33% in 2009 and 2010 seasons, respectively) than control under either continuous flooding or continuous saturation in both seasons.

Irrigation methods by fertilizer treatments had a highly significant effect on grin yield. Under continuous flooding, using 165 kg N ha^{-1} produced the highest grain yield (10.96 and10.98 t ha^{-1} in the first and second seasons, respectively.). On other hand, in both seasons under continuous saturation treatment, control gave the lowest grain yield (Table 10).

In both seasons no significant differences between irrigation methods on straw yield was detected (Table 9). On the other hand, there are significant differences among fertilizer treatments on straw yield. The highest straw yield was obtained with 5 tons rice straw ha^{-1}+110 kg N ha^{-1} without any significant differences with using 165 kg N ha^{-1}. This findings are in agreement with those reported by Lakpale *et al*. 1999.

It is worth while to notice that, in the first season higher straw yield (12.84 t ha^{-1}) was obtained when 5 tons rice straw ha^{-1}+ 110 kg N ha^{-1} was applied under continuous saturation treatment. In the second season, applied 165 kg N ha^{-1} gave the highest straw yield under continuous flooding without any significant differences with using 5 tons rice straw ha^{-1}+110 kg N ha^{-1} under continuous saturation treatment. In both seasons control gave the lowest straw yield under continuous saturation method (Table 10).

Table 9: Grain and straw yield t ha-1 and Harvest index (HI) as affected by fertilizer treatments under continuous flooding and continuous saturation in 2009 and 2010 seasons.

Treatment	Grain		Straw		HI	
	2009	2010	2009	2010	2009	2010
Irrigation (I)						
Continuous flooding	8.87	8.96	10.53	10.86	0.463	0.452
Continuous saturation	8.26	8.39	10.42	10.58	0.442	0.442
F test	NS	NS	NS	NS	NS	NS
Fertilizer treatments (T)						
Control	5.66	5.91	7.03	7.29	0.464	0.448
5 t Rice straw ha^{-1}	7.11	7.29	10.20	10.42	0.411	0.407
5 t Rice straw + 110 kg N ha^{-1}	10.63	10.66	12.48	12.72	0.460	0.458
165 kg N ha^{-1}	10.88	10.80	12.18	12.43	0.472	0.464
L.S.D.0.05	0.44	0.46	0.48	0.44	0.014	0.013
Interaction I x T	*	**	**	**	**	**

As shown in Table 9 in both seasons no significant differences between irrigation methods on harvest index (HI). This findings are in agreement with those reported by El Refaee 2006. On other hand, there are significant differences among fertilizer treatments on harvest index (HI). The highest values of HI was achieved by using 165 kg N ha^{-1} without any significant differences with 5 tons rice straw ha^{-1}+110 kg N ha^{-1}, while using 5 tons rice straw ha^{-1} alone gave the lowest values of HI in both seasons.

Table 10: Grain and straw yield t ha^{-1} and Harvest index (HI) as affected by the interaction between fertilizer and irrigation treatments in 2009 and 2010 seasons.

Fertilizer treatment	Grain t ha^{-1}		Straw t ha^{-1}		HI	
	CF	CS	CF	CS	CF	CS
	2009 season					
Control	6.13	5.20	7.68	6.38	0.444	0.449
5 t Rice straw ha^{-1}	7.52	6.70	9.96	10.44	0.430	0.391
5 t Rice straw + 110 kg N ha^{-1}	10.88	10.37	12.33	12.64	0.469	0.451
165 kg N ha^{-1}	10.96	10.80	12.16	12.21	0.474	0.469
L.S.D.0.05	0.55		0.78		0.022	
	2010 season					
Control	6.30	5.52	7.81	6.77	0.446	0.449
5 t Rice straw ha^{-1}	7.76	6.81	10.25	10.59	0.431	0.391
5 t Rice straw + 110 kg N ha^{-1}	10.84	10.48	12.83	12.61	0.458	0.454
165 kg N ha^{-1}	10.98	10.62	12.53	12.33	0.467	0.463
L.S.D.0.05	0.43		0.75		0.019	

CF = continuous flooding and CS = continuous saturation

Irrigation methods by fertilizer treatments had a highly significant effect on harvest index. Under continuous flooding, applied 165 kg N ha^{-1} produced the highest harvest index (0.474 and0.467 in the first and second seasons, respectively.). On other hand, in both seasons applied of 5 tons rice straw ha^{-1} alone gave the lowest harvest index under continuous saturation method, (Table 10).

Conclusion

It could be concluded that, statistically, keeping the soil at saturation condition produced grain yield at par with the treatment of continuous flooding with only 7.09 % reduction in grain yield. Application of 5 tons rice straw ha^{-1}+110 kg N ha^{-1} N ha^{-1} gave similar grain yield with the treatment of 165 kg N ha^{-1}. Application of 5 tons rice straw ha^{-1}+110 kg N ha^{-1} increased the nutrients availability more than the other fertilizer treatments under continuous either flooding or saturation.

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تـأثر صـلاحية بعض العناصر الغذائيـة ومحصـول الأرز بالتسميد بقـش الأرز تحـت ظروف الغمر والتشبع المستمر.

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*** مركز البحوث والتدريب في الارز- معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية, مصر.**

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أجريت تجربة حقلية بمزرعة مركز البحوث والتدريب في الأرز, سخا, كفرالشيخ فى موسمى زراعة الأرز 2009 و 2010 لدراسة تأثير التسميد النتروجينى و خلط قش الأرز بالتربة تحت ظروف الغمر المستمر والتشبع المستمر على صلاحية بعض العناصر الغذائية وعلى محصول الأرز وقد وجد أن استخدام 165كجم نتروجين للهكتار اعطى اعلى محصول حبوب وبدون اى فروق معنوية مع استخدام 5 طن قش أرز للهكتار+ 110 كجم نتروجين للهكتار . أيضا وجد ان أعلى قيم للعناصر الغذائية (الامونيوم –الفوسفور) وجدت تحت ظروف الغمر المستمر. بينما وجد ان أعلى صلاحية للنترات والبوتاسيوم قد وجدت تحت التشبع المستمر و أيضا أعطى الغمر المستمر محصول حبوب أعلى بالمقارنة بالتشبع المستمر بدون وجود فروق معنوية

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