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EFFECT OF RICE STRAW BURNING OR INCORPORATION, ORGANIC MANURING AND NITROGEN LEVEL ON WHEAT YIELD AND SOME NITROGEN FERTILIZATION EFFICIENCY ATTRIBUTES

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ABSTRACT: This investigation was carried out in an Extension field at Al-Ibrahimia district, Sharkia Governorate, during 2007/2008 and 2008/2009 seasons to find out the effect of rice straw burning or incorporation before sowing wheat as well as farmyard manure (FYM) addition (20 m^3/fad.) and N level (0, 40 and 80 kg N/fad.) on wheat growth and yield. The uptake of nitrogen and its apparent recovery and efficiency of utilization were also investigated, using Sakha 94 wheat cultivar.

Burning or incorporation of rice straw was without any significant effect on growth and yield attributes of wheat but however decreased significantly the grain yield/fad. Also, the grain and total wheat yields/fad were decreased significantly as compared with the check where rice residues were plowed down before sowing wheat. Organic manuring was without significant effect on wheat growth and yield except the plant height and the number of spikes/m^2. The increase of N level up to 80 kg N/ fad gave significant increase in all growth and yield attributes as well as N uptake, but decreased its apparent recovery. The response equation indicated the possibility of maximising the grain yield due to an average addition of 95.0 kg N/ fad. However, the grain yield could have been optimised due to a predicted addition of 92.0 kg N/fad. where this addition produced 4200 L.E./fad.

Key words: Rice straw burning, incorporation, farmyard manure, nitrogen fertilizer, nitrogen efficiency.

INTRODUCTION

In Egypt, rice growers have got used to burn rice straw as they believe in some gained benefits to their soil fertility or as a measure of controlling pest damage. In most cases, getting rid of rice straw, as residues of no value residues, is a target for an easy evacuation of the field and early seedbed preparation for the succeeding crop. Due to the very large rice cultivated area during the last two decadeds which reached more than 2 million faddan in 2008, burning rice straw has become one of the sources of air pollution.

Burning field crop residues is a common practice in some parts of the world, where this burning was reported to deplete soil fertility due to large losses up to 80% of N (Raison, 1979), 25% of P and 21% of K (Ponnamperuma, 1984), 4-60% of S (Lefroy *et al.*, 1994) and this practice was found to control insects and some soil born diseases (Gangwar *et al.*, 2006). Recycling of field crop plant residues, through their use after some treatments such as addition of nitrogen, is recommended (Pathak *et al.*, 2006). Incorporation of the preceding crops plant residues, as a practice of organic manuring, might help in partly solving defects of rice straw burning. Due to the wide C: N ratio of these residues, particularly of cereals, a temporary drop of the soil mineral N content was extensively reported (Tisdale and Nelson, 1975). Addition of N fertilizers under these conditions could possibly increase gained benefits through enriching soil N fertility from a rapid release of available nitrogen (Russel, 1973). In addition, several authors reported significant increase of grain yield/ fad due to the increase of N level up to 60, 80,90, 100 and 120 kg N/ fad as reported by Selim (1998), Shams El-Din and El-Habbak (1992), Amal *et al.* (2005), Abdul Galil *et al.* (1997) and Ashmawy and Abo-Warda (2002), respectively. The increase was attributed to the increase of plant height and number of spikes/m^2 due to increase of N level up to 40, 75.5, 100 and 120 kg N/ fad (Shaaban, 2006; Weber *et al.*, 2008; Abdul Galil *et al.*, 2008 and Mowafy, 2008, respectively). Some authors reported significant increase in the grain weight/spike, number of grains/spike and 1000-grain weight due to increase of N level up to 86.9, 100, 105 and 120 kg N/ fad

(Saleh, 2003; Abdul Galil *et al.*, 2008; Tawfelies and Tammam, 2005 and Mekail *et al.*, 2006, respectively).

Organic manuring was also reported to increase grain yield of wheat due to increase of organic manuring up to 20, 30 and 45 m^3/ fad (Abdel -Ati and Zaki, 2006; Attia and Dosuky, 1996 and Mowafy, 2002, respectively).

Therefore the present investigation aimed at finding the effect of burning rice straw or its incorporation before sowing wheat compared with a check where rice residues did not receive any treatment on growth and yield of wheat under organic manuring with FYM and the addition of different levels of mineral nitrogen. The uptake of nitrogen and its recovery as well as the efficiency and utilization of recovered and added nitrogen were also investigated using Sakha 94 wheat cultivar.

MATERIALS AND METHODS

This investigation was carried out in an Extension field at Al-Ibrahimia district, Sharkia Governorate, during 2007/2008 and 2008/2009 seasons to find out the effect of rice straw burning or incorporation before sowing wheat as well as FYM addition and N level on wheat growth and yield. The uptake of nitrogen and its apparent recovery and efficiency of utilization were also investigated, using Sakha 94 wheat cultivar.

Factors under Study

Rice straw treatments

- Burning rice straw before sowing wheat: Burning the preceding rice straw yield which amounted to 8.4 ton/ fad.
- Incorporation of rice straw: Rice straw was incorporated at a rate of 4.2 ton/fad before sowing wheat.
- Check rice straw treatment: The stubble of rice i.e. residues was plowed down as recommended before sowing wheat.

Organic manuring

- Addition of FYM: FYM was incorporated at a rate of 20 m^3/ fad before sowing wheat.
- Check FYM treatment: FYM was not added.

Nitrogen fertilization level effect

- Check without N fertilization.
- 40 kg N /fad.

- 80 kg N /fad.

One fifth of the two N fertilization levels was added as basal dose before sowing wheat in the form of ammonium sulphate (20.5 %). The rest of these two N levels was split partly added before the first and second irrigations as ammonium nitrate (33.5 % N).

Experimental Design

A split - split plot design of four replications was used, where the rice straw treatments were allocated in the main plots. Organic manuring and N fertilization levels were allocated in the first and second order sub plots, in respective order.

Recorded Data

Wheat yield attributes

A bordered 1.0 m length, previously labeled in the 3rd row after emergence (10 days after sowing) was harvested where the following yield attributes were recorded on 10 plants:

1. Plant height (cm).
2. Number of spikes/ m^2.
3. Grain number / spike.
4. Grain weight/ spike (gm).
5. Thousand grain weight (gm).

Wheat yield/ fad and harvest index

1. Grain yield/ fad (ardab/fad).
2. Straw yield/ fad (ton/fad).
3. Total yield/ fad (ton/fad).
4. Harvest index (%).

The grain, straw and total yields/ fad were cacluded using the yield obtained from 10 rows of 1 meter length (1.5 m^2).

Total N uptake and N efficiency attributes

At harvest, grain and straw samples were dried at 70°c where their contents from total N were determined according to Jackson (1967). Using these contents and the final grain and straw yields/ fad, the following N uptake and N fertilization efficiency attributes were calculated, according to Fageria *et al.*, (1997).

- Total N uptake (TNU) in kg N/ fad.
- Nitrogen apparent recovery efficiency (NARE).
- Nitrogen physiological efficiency (NPE).
- Nitrogen agrophysiological efficiency (NAPE).
- Nitrogen utilization efficiency (NUE).
- Nitrogen agronomic efficiency (NAE).

General Agronomic Practices

Wheat was sown in last week of November in the two seasons at a seeding rate of 70 kg/ fad. Sowing was made in rows 15 cm apart. Each 2nd order sub plot included 20 rows of 4 m length (12 m^2). Sowing was made after rice as a preceding crop in both seasons. Phosphorus as ordinary superphosphate (15.5 % P_2O_5) was band placed at a level of 15.5 kg P_2O_5/fad at the time of sowing. Flood irrigation was practiced in one month interval. Harvest was made during the last week of April.

Statistical Analysis

Data were statistically analyzed according to Snedecor and Cochran (1967). A combined analysis was undertaken for the data of the two seasons. Duncan Multiple range test was used to compare statistical significant differences. In interaction Tables capital and small letters were used to denote significant differences among rows and columns means, respectively.

The response of wheat yield and all of its attributes to N fertilization was found out. The response equations were calculated according to Snedecor and Cochran (1967) using the orthogonal polynomial Tables. The significancy of the linear and quadratic components of each of these equations was tested, then the response could be described as linear (first order) or quadratic (second order). The predicted maximum averages ($\hat{Y}_{max}$) which could have been obtained due to the addition of the predicted maximum N level (X_{max}) were calculated according to Neter *et al.* (1990). The predicted optimum grain yield ($\hat{Y}_{opt}$) obtained due to the addition of the predicted optimum N level (X_{opt}) and the profit obtained due to this addition were calculated according to Sukhatme (1941) as explained by Abdul Galil *et al.* (2003).

Soil Conditions

Data in Table 1 show some soil physical and chemical properties of the experimental field and rice straw and FYM nutrients contents in two seasons.

RESULTS AND DISCUSSION

Wheat Yield Attributes

Results in Table 2 show plant height, number of spikes/ m^2, grain weight/spike, 1000- grain weight and number of grains/ spike as affected by rice straw treatments, organic manuring and N fertilization levels and their interactions in the two seasons and their combined.

Table 1. Soil mechanical and chemical analyses of the experimental sites at 30 cm depth and farmyard manure and rice straw nutrient contents in two seasons

Properties	2007/2008	2008/2009
Texture	Silty loam	Silty loam
pH (1: 5, soil: water)	7.90	7.25
EC (dS m^{-1})	0.94	0.80
Total N (%)	0.15	0.16
Available P (mg kg^{-1})	17.41	7.16
Available K (mg kg^{-1})	40.80	37.85
Organic matter (%)	3.6	2.9
C/N ratio	15 : 1	11 : 1
Cations (mq/100g soil):		
K^{+}	0.10	0.09
Na^{+}	0.33	0.70
Ca^{++}	0.95	0.88
Mg^{++}	0.96	0.64
Anions (mq/100g soil):		
HCO_3^{-}	1.40	1.50
SO_4^{--}	0.13	0.27
CL^{-}	0.81	0.54
Farmyard manure:		
Total N (%)	0.52	0.52
Total P (mg kg^{-1})	91.88	158.36
Total K (mg kg^{-1})	1550	2293.13
Organic matter (%)	13.90	18.20
C/N ratio	17 : 1	22 : 1
Rice straw:		
Total N (%)	0.35	0.42
Total P (mg kg^{-1})	240.90	378.43
Total K (mg kg^{-1})	14790	13360
Organic matter (%)	43.6	32.4
C/N ratio	78 : 1	48 : 1

Table 2. Plant height, number of spikes/ m^2 as affected by rice straw treatments, organic manuring and nitrogen fertilization levels their interactions in the two seasons and their combined

Main effects and interactions	Plant height (cm)			Spikes/ m^2 (No)		
	2007/2008	2008/2009	Combined	2007/2008	2008/2009	Combined
<u>Rice straw treatments (S):</u>						
Check	102.58	99.80	101.19	365.59	401.08	383.33
Incorporation	97.47	98.35	97.91	342.50	369.71	356.10
Burning residues	102.29	98.66	100.48	359.31	400.88	380.09
F.test	N.S	NS	NS	N.S	N.S	N.S
<u>Organic manure (M):</u>						
Check	98.18	97.84	98.01	338.61	386.81	362.71
20 m^3 /fad.	103.39	100.03	101.71	372.98	394.31	383.64
F.test	*	**	**	N.S	N.S	**
<u>Nitrogen levels (N):</u>						
Check	80.03 c	73.79 c	76.91 c	223.08 c	236.38 c	229.73 c
40 Kg N/ fad.	106.32 b	107.86 b	107.09 b	388.75 b	406.63 b	397.69 b
80 Kg N/ fad.	115.99 a	115.16 a	115.58 a	455.56 a	528.67 a	492.11 a
F.test	**	**	**	**	**	**
Maximum response	36.02	42.07	39.05	234.01	391.74	312.88
Maximum N level						
(kg N/ fad)	83.3	70.9	77.09	87.0	linear	-
<u>Interactions:</u>						
S x M	N.S	**	NS	N.S	N.S	NS
S x N	*	NS	NS	N.S	N.S	NS
M x N	N.S	NS	* (2-a)	N.S	N.S	NS

*,** and NS indicate significancy at 0.05 and 0.01 levels and insignificancy of differences, in respective order.

Table 2. Cont.

Main effects and interactions	Grain weight/ spike (gm)			1000- grain weight (gm)			Number of grains/ spike		
	2007/2008	2008/2009	Combined	2007/2008	2008/2009	Combined	2007/2008	2008/2009	Combined
Rice straw treatments (S):									
Check	2.04	2.45	2.25	44.48	51.82	48.15	43.0	47.20	45.10
Incorporation	1.90	2.27	2.09	45.13	53.04	49.09	41.0	42.54	41.77
Burning residues	1.87	2.47	2.17	46.65	51.92	48.29	42.0	47.26	44.63
F.test	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
Organic manure (M):									
Check	1.91	2.42	2.17	45.44	52.14	48.79	41.0	45.94	43.47
20 m^3/fad.	1.97	2.38	2.18	45.41	52.37	48.89	43.0	45.40	44.20
F.test	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
Nitrogen levels (N):									
Check	1.47 b	1.40 c	1.44 c	44.81	49.26 b	47.04 b	31.0 c	28.36 c	29.68 c
40 Kg N/ fad.	2.08 a	2.72 b	2.40 b	45.52	54.74 a	50.13 a	45.0 b	49.92 b	47.46 b
80 Kg N/ fad.	2.27 a	3.08 a	2.68 a	45.93	52.76 a	49.35 a	50.0 a	58.73 a	54.37 a
F.test	**	**	**	N.S	**	**	**	**	**
Maximum response	-	1.69	1.69	-	-	-	19.01	30.61	24.81
Maximum N level (kg N/ fad)	-	75.0	-	-	-	-	82.2	87.6	84.92
Interactions:									
S x M	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	NS
S x N	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	NS
M x N	N.S	N.S	N.S	N.S	N.S	N.S	*	N.S	** (3-a)

*,** and NS indicate significancy at 0.05 and 0.01 levels and insignificancy of differences, in respective order.

Rice straw treatments effect

It is evident from Table 2 that the rice straw treatments were without significant effect on any of the wheat yield attributes in the two seasons and their combined analysis. However, some insignificant negative effects were observed due to rice straw incorporation and burning treatments.

Organic manuring effect

In both seasons and their combined, organic manured plants were significantly taller than the inorganic manured ones. The combined analysis detected significant increase in the number of spikes/ m^2 due to the addition of FYM, though this increase did not reach of significance level in both seasons Table 2. The grain weight/spike and its two main components i.e. number of grains/ spike and 1000- grain weight were not significantly affected by organic manuring Table 2. The present results are in accordance with those reported by Abd El-Bary and El-Bana (1994), Ahmed and Ali (2005) and Atta Allah and Mohameed (2003) as they got significant increase in plant height and the number of spikes/ m^2 due to the addition of organic matter to wheat.

Nitrogen fertilization level effect

Each increase in N level up to 80 kg N/ fad was followed by a significant increase in plant height and number of spikes/ m^2 Table 2. Similar significant effect was observed in the number and weight of grains/spike though the 1000-grain weight was not significantly increased beyond the addition of 40 kg N/fad in the second season and the combined where it failed to respond to this addition in first one Table 2. The response equations, indicated a diminishing increase in most of these yield attributes. The response to added N was greater in the second than in the first season. It was quite evident that the plant height could have been maximised due to predicted additions of 70.9 and 83.3 kg N/ fad, in the two seasons, respectively. The number of spikes/ m^2 could have been maximised due to predicted addition of 87.0 kg N/ fad in the first season but this increase was linear in the second one Table 2. Also, the number of grains/ spike could have been maximised due to predicted additions of 82.2 and 87.6 kg N/ fad in the two seasons, respectively. However, the 1000-grain weight failed to respond to the increase of N level in the first season and responded to only 40 kg N/fad in the second season. Therefore, the grain weight/spike responded to the increase of N up to a predicted level of only 75 kg N/ fad in the second season (Table 2).

These results clearly indicate that the maximum N level tried in this study i.e. 80 kg N/ fad was about to satisfy the needs of wheat plants in order to maximise most of the wheat yield attributes in Table 2. This could be attributed to the high soil organic matter content (Table 1).

Several authors reported significant increase in wheat plant height and number of spikes/ m^2 due to the increase of N level up to 40, 75.5, 100 and 120 kg N/ fad as reported by Shaaban (2006), Weber *et al.* (2008), Abdul Galil *et al.* (2008) and Mowafy (2008), respectively. Some authors reported significant increase in the grain weight/spike, number of grains/spike and 1000-grain weight due to increase of N level up to 86.9, 100, 105 and 120 kg N/ fad (Saleh, 2003; Tawfelies and Tammam, 2005 and Mekail *et al.*, 2006, respectively).

Interaction effect

According to the combined analysis, the interaction between organic manuring and N levels affected significantly plant height Table 2-a. and the number of grains/ spike Table (2-b).

It is evident from Table 2-a that the plant height was significantly increased with each increase in the N level but with different magnitudes at the two organic manuring levels. The response equations showed diminishing increase in plant height with the increase of N level but with lower magnitude in the organic manured plots than in the inorganic manured ones. In the former 71.9 kg N/fad were needed to maximise the plant height to 116.6 cm compared with 77.3 kg N/fad needed to maximise it to only 115.1 cm in the latter. This indicates that a lower N level was needed to maximise the plant height to a higher average in the manured than in the un-manured plots. These results further indicate that manuring and N fertilization played a complementally roles where they complemented their positive effects on plant height.

It is evident from Table 2-b that without FYM each increment of N produced a significant increase in the number of grains/spike. However, when FYM was added no significant increase in this was obtained beyond addition of 40 kg

N/ fad as indicated by the Duncan test. Also, the response equations show that the response of the number of grains/ spike to the increase of N level was linear without organic manuring but quadratic with FYM addition. Therefore, more number of grains/ spike was obtained due to the addition of 80 kg N/ fad in the un-manured than the manured plots. However, 65.5 kg N/ fad were enough to maximise this number in the manured plots.

These data are quite interesting as they refer to a complementally role between organic manuring and mineral N fertilization. The increase of N level might have had decreased the C : N ratio, and hence might have had released more available soil nitrogen. Therefore, lower level than the highest N level tried in this study

Table 2-a. Plant height (cm) as affected by the nitrogen fertilization level and organic manuring interaction (combined data)

Organic manuring level	N level (kg N/ fad) Check	40	80	Response equation $\hat{Y}=a + bx - cx^2$	$\hat{Y}_{max}$	Xmax
	C	B	A			
Check	73.70 b	105.33 b	114.99 b	$73.7 + 42.62x - 10.98 x^2$	115.1	77.3
	C	B	A			
20 m³/ fad.	80.13 a	109.43 a	116.16 a	$80.13 + 40.6x - 11.29 x^2$	116.6	71.9

Table 2-b. Number of grains/spike as affected by the nitrogen fertilization level and organic manuring interaction (combined data)

Organic manuring level	N level (kg N/ fad) Check	40	80	Response equation $\hat{Y}=a + bx - cx^2$	$\hat{Y}_{max}$	Xmax
	C	B	A			
Check	29.77 a	44.65 b	56.54 a	$29.77 + 16.38x$	Linear	Linear
	B	A	A			
20 m³/ fad.	29.77 a	49.94 a	52.36 b	$29.77 + 29.06x - 8.88 x^2$	53.54	65.5

was needed to maximise the number of grains/spike in the manured plots. Whereas, more N was needed to maximise this number in un-manured plots.

Wheat Yields/fad and Harvest Index

Table 3 shows grain, straw and total yields/ fad and harvest index as affected by rice straw treatments, organic manuring and N fertilization levels and their interactions in the two seasons and their combined.

Rice straw treatments effect

In the first season and the combined of both seasons, rice straw treatments had significant effect on grain and total yields/fad. It is evident from Table 3 that the incorporation of rice straw recorded the lowest grain and total yields/ fad with at par average total yield/fad with rice burning. According to the combined analysis, differences of grain and total yields/fad were significant among the three rice straw treatments, where the check treatment recorded the highest average followed by rice burning whereas the lowest average was recorded by rice straw incorporation.

These results clearly indicate that incorporation of rice straw might have had increased N immobilization and hence caused a temporary shortage of soil available nitrogen (Tisdale and Nelson, 1975). The results further indicate that burning rice straw decreased the grain yield/ fad where it recorded a lower average than rice straw incorporation. This was reflected in the combined analysis. It seems possible that burning rice straw was followed by gaseous losses of N and hence a possible decrease in soil available nitrogen (Raison, 1979).

Organic manuring effect

Organic manuring was without significant effect on grain, straw and total yields/ fad or on harvest index in both seasons and their combined Table 3. These results indicate the increase observed in plant height or in the number of spikes/m^2 due to organic manuring Table 2 was not reflected in grain or straw yield/ fad. These results are not in agreement with those reported by Attia and Dosuky (1996), Atia and Aly (1998) and Abdel -Ati and Zaki (2006), as they got significant increase in wheat grain yield/ fad due to organic manuring. This controversy could be attributed to possible differences in soil fertility of the present study with the others. Data in Table1 showed that

Table 3. Grain, straw, total yields and harvest index as affected by rice straw treatments, organic manuring and nitrogen fertilization levels their interactions in the two seasons and their combined

Main effects and interactions	Grain yield (ardab/fad.)			Straw yield (ton/ fad.)			Total yield (ton/fad.)			Harvest index %		
	2007/2008	2008/2009	Combined	2007/2008	2008/2009	Combined	2007/2008	2008/2009	Combined	2007/2008	2008/2009	Combined
Rice straw treatments (S):												
Check	17.43 a	16.76	17.20a	4.06	4.66	4.36	6.70 a	7.17	6.94 a	40.84	40.36	40.60
Incorporation	13.48 c	14.24	13.86c	3.26	4.05	3.65	5.28 b	6.19	5.73 b	39.90	35.95	37.94
Burning residues	15.74 b	15.57	15.66b	3.65	4.55	4.10	6.01 ab	6.88	6.45ab	40.07	35.70	37.88
F.test	*	N.S	**	N.S	N.S	N.S	*	N.S	*	N.S	N.S	N.S
Organic manure (M):												
Check	15.31	15.55	15.43	3.42	4.41	3.92	5.71	6.75	6.23	42.01	36.71	39.36
20 m^3 /fad.	15.79	15.51	15.65	3.90	4.42	4.16	6.29	6.75	6.52	38.52	37.96	38.24
F.test	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
Nitrogen levels (N):												
Check	8.57 c	7.56 c	8.07 c	1.81 c	1.74 c	1.77 c	3.09 c	2.88 c	2.99 c	42.68	42.92 a	42.80 a
40 Kg N/ fad.	17.12 b	17.23 b	17.18 b	4.16 b	5.14 b	4.65 b	6.72 b	7.72 b	7.22 b	39.207	35.04 b	37.12 b
80 Kg N/ fad.	20.97 a	21.78 a	21.38 a	5.01 a	6.37 a	5.69 a	8.18 a	9.64 a	8.91 a	38.92	34.04 b	36.48 b
F.test	**	**	**	**	**	**	**	**	**	N.S	**	**
Maximum response	12.64	14.61	13.63	3.20	4.64	3.92	5.13	6.80	4.47	-	-	-
Maximum N level (kg N/ fad)	92.8	95.6	94.2	82.7	82.6	82.6	86.8	86.3	86.6	-	-	-
Interactions:												
S x M	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
S x N	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
M x N	N.S	*	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

*,** and N.S indicate significancy at 0.05 and 0.01 levels and insignificancy of differences, in respective order.

soil of the experimental sites was very rich in soil organic matter. Therefore, added FYM was not badly needed by wheat plants probably due to a slow release of its content from available forms of plant nutrients particularly nitrogen.

Nitrogen fertilization level effect

In both seasons and their combined, each increase of N level up to 80 kg N/ fad was followed by a significant increase in each of grain, straw and total yield/ fad. However, the harvest index was decreased due to the first N increment but no further decrease was observed due to the second N increment (Table 3).

These results are rather expected as all the yield attributes were increased due to each increase in N level. The response equations of grain, straw and total yields/fad to the increase of N level indicated diminishing increases. This response was always higher in the second than in the first season. According to these equations, the grain yield could have been maximised due to predicted additions of 92.8 and 95.6 kg N/fad in the two seasons, respectively. This yield could be optimised to an average of 21.0 ardab/fad due to a predicted addition of 92.0 kg N/fad. This addition could produce a profit of 2400.0 L.E/fad. However, the straw and total yields/fad could have been maximised with lower additions of 82.7 and 82.6 kg N/fad for straw yield and 86.8 and 86.3 kg N/ fad for the total yield/ fad in the two seasons, respectively.

The present results clearly indicate that the highest N level (80 kg N/ fad) tried in this study was not enough to satisfy the N requirements of wheat plants in order to maximise their grain yields/ fad. This was also observed in grain yield attributes particularly the number of spikes/ m^2 which showed the need for 87.0 kg N/ fad to maximise this number in the first season. It seems evident that addition of N and the increase in its level of application might have had direct and indirect effects. The direct effect is enriching the soil fertility from available N whereas the indirect effect was in the role of added N in narrowing the soil C:N ratio and hence a possible release of previously immobilized nitrogen.

Interaction effect

None of the first order interactions affected significantly the grain, straw and total yield/ fad in both seasons and their combined Table 3. This clearly indicate the independence of the main effects of the these factors in affecting wheat yield. It was evident that N fertilization level played the major role in affecting the growth and hence the yield of wheat. Similar effects were observed in all yield attributes expect the plant height and the number of grains/ spike Table 2-a and 2-b which were affected by the interaction between N levels and organic manuring. However, these interactions were not reflected in the grain, straw and total yields/ fad as observed herein in (Table 3).

Nitrogen Uptake and N Fertilization Efficiency Attributes

Tables 4 and 5 show the total N uptake (TNU), nitrogen agrophysiological efficiency (NAPE), nitrogen apparent recovery (NARE), nitrogen utilization (NUE) and nitrogen agronomic efficiency (NAE) as affected by rice straw treatments, organic manuring and N fertilization levels and their interactions in the two seasons and their combined.

Rice straw treatments effect

The total N uptake was decreased due to incorporation rice straw as compared with the straw check treatment in the first season. The combined analysis confirmed this decrease but burning rice straw recorded as much total N uptake as the check N treatment. These results could be attributed to significant decrease of the total yield/ fad caused by incorporation of rice straw Table 3. Regarding the other N fertilization efficiency attributes, only the nitrogen agrophysiological efficiency (NAPE) was affected by rice straw treatments. It is evident from Table 4 that either the rice incorporation or the rice straw burning recorded at par higher NAPE averages than that recorded by the straw check treatment. This could be attributed to the higher N uptake by the straw check treatment as the NAPE expresses the weight of grain yield obtained per kg of recovered nitrogen.

Organic manuring effect

Organic manuring was without significant effect of the total N uptake or any other N fertilization efficiency attribute except the NAPE in the first season which was confirmed by the combined analysis Tables 4 and 5. Organic manured plants recorded lower NAPE average than inorganic manured ones. This could not be attributed to more N uptake by the formers than by the latters, as they had similar uptake averages. Therefore, organic un-manured plants were more efficient than manured ones in serving a unit kg of

Table 4. Total nitrogen uptake and nitrogen agrophysiological efficiency as affected by rice straw treatments, organic manuring and nitrogen fertilization levels their interactions in the two seasons and their combined

Main effects and interactions	Total nitrogen uptake (kg N/fad)			Nitrogen agrophysiological efficiency (kg/ kg N)		
	2007/2008	2008/2009	Combined	2007/2008	2008/2009	Combined
<u>Rice straw treatments (S):</u>						
Check	67.25 a	72.12	69.68 a	22.21	18.50 b	20.36 b
Incorporation	49.35 b	59.92	54.64 b	28.77	22.71 a	25.74 a
Burning residues	58.78 ab	66.93	62.86 a	26.20	22.07 a	24.13 a
F.test	**	N.S	**	N.S	*	**
<u>Organic manure (M):</u>						
Check	57.26	66.44	61.85	28.16	22.06	25.11
20 m^3 /fad.	59.67	66.20	62.93	23.26	20.12	21.71
F.test	N.S	N.S	N.S	**	N.S	**
<u>Nitrogen levels (N):</u>						
Check	28.89 c	28.21 c	28.55 c	-	-	-
40 Kg N/ fad.	64.51 b	73.90 b	69.21 b	40.14	32.54	36.34
80 Kg N/ fad.	81.98 a	96.86 a	89.42 a	37.04	30.74	33.89
F.test	**	**	**	N.S	N.S	N.S
<u>Interactions:</u>						
S x M	N.S	N.S	N.S	N.S	N.S	N.S
S x N	N.S	N.S	N.S	N.S	N.S	N.S
M x N	N.S	N.S	N.S	**	N.S	**

*,** and NS indicate significancy at 0.05 and 0.01 levels and insignificancy of differences, in respective order.

Table 5. Nitrogen apparent recovery, nitrogen utilization and nitrogen agronomic efficiencies as affected by rice straw treatments, organic manuring and nitrogen fertilization levels their interactions in the two seasons and their combined

Main effects and interactions	Nitrogen apparent recovery efficiency (%)			Nitrogen utilization efficiency (kg/ kg N)			Nitrogen agronomic efficiency (kg/ kg N)		
	2007/2008	2008/2009	Combined	2007/2008	2008/2009	Combined	2007/2008	2008/2009	Combined
<u>Rice straw treatments (S):</u>									
Check	60.18	69.58	64.88	54.43	70.83	62.63	21.77	19.28	20.53
Incorporation	35.94	62.27	49.11	44.35	64.41	54.38	14.76	21.19	17.97
Burning residues	55.28	68.24	61.76	55.52	62.85	59.19	21.27	22.50	21.88
F.test	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
<u>Organic manure (M):</u>									
Check	50.07	69.31	59.69	54.53	70.31	62.42	20.26	22.67	21.47
20 m^3/fad.	50.87	64.08	57.47	48.33	61.75	55.04	18.27	19.31	18.79
F.test	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
<u>Nitrogen levels (N):</u>									
Check	-	-	-	-	-	-	-	-	-
40 Kg N/ fad.	85.05 a	114.27 a	99.66 a	90.67 a	113.58 a	102.13 a	32.65 a	36.28 a	34.47 a
80 Kg N/ fad.	66.36 b	85.82 b	76.09 b	63.63 b	84.51 b	74.07 b	25.15 b	26.69 b	25.92 b
F.test	**	**	**	**	**	**	**	**	**
<u>Interactions:</u>									
S x M	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
S x N	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
M x N	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

*,** and NS indicate significancy at 0.05 and 0.01 levels and insignificancy of differences, in respective order.

recovered nitrogen in building grain yield/ fad. However, this efficiency was not reflected in the final grain yield/ fad as previously observed in Table (3).

Nitrogen fertilization level effect

In both seasons and their combined, each N increment up to the addition of 80 kg N/ fad resulted in a significant increase in the total N uptake. This increase was reflected in a significant decrease of the NARE, NUE and the NAE, Table 5. However, the NAPE was not significantly decreased (Table 4).

The increase of total N uptake due to the increase of N level is rather expected as the total yield/ fad was significantly increased due to the increase of N level Table 3. The decrease of NARE, could be attributed to the diminishing increase of total N uptake where the first N increment was more efficiently recovered by wheat plants than the second N increment. This in turn was reflected in a significant decrease in the NUE due to doubling the level of N to 80 kg N/ fad.

This explanation could, also, be served to discuss the decrease of NAE due to doubling the level of N fertilization, where the obtained grain yield from the second N increment was lower than that obtained from the first N increment where the increase was diminishing. It is quite interesting to discuss here the very high averages of N recovery from added N which surpassed 100% (114.3%) in the second season due to the addition of the first N increment. These results refer to other sources of available N which were recovered by wheat plants other than that recovered from added nitrogen. Under the present study the soil of the experimental site was very rich in organic matter. Also, added FYM was rich in total nitrogen Table 1. However, the C: N ratio of rice straw and rice residues were wide enough to tie up the available N through immobilization. Therefore, addition of the first N increment might have had decreased the C: N ratio and possibly increased the release of available nitrogen. This explanation is based on the significant decrease of total N uptake due to incorporation of rice straw Table 4, which refers to N immobilization due to the wide C: N ratio of rice straw.

Interaction effect

The first order interactions between factors under study were without significant effect of N uptake and all the nitrogen fertilization efficiency attributes except the NAPE (not presented).

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تأثير حرق أو دفن قش الأرز والتسميد العضوي ومستوي النيتروجين علي محصول القمح وبعض مؤشرات كفاءة التسميد النيتروجيني

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أجريت هذه الدراسة لموسمين (٢٠٠٧/٢٠٠٨- ٢٠٠٨/٢٠٠٩) بحقل إرشادي بمركز الإبراهيمية محافظة الشرقية بأرض طينية غنية بالمادة العضوية حيث تم دراسة تأثير حرق قش الأرز أو دفنه مقارنة بعدم إضافته، حيث تم حرث بقايا محصول الأرز وذلك قبل زراعة القمح. كذلك دراسة تأثير إضافة السماد البلدي (٢٠م^{٣}/فدان) ومستويان من النيتروجين (٤٠ و ٨٠ كجم ن/فدان) مقارنة بعدم الإضافة وذلك علي محصول القمح وبعض مؤشرات المحصول وكفاءة التسميد النيتروجيني واسترجاعه.

ويمكن تلخيص النتائج المتحصل عليها علي النحو التالي:

١- أدي دفن قش الأرز إلي انخفاض معنوي في محصول الحبوب والمحصول الكلي/فدان علي حين تحقق أعلي محصول عند حرث بقايا الأرز والذي تفوق علي محصول معاملة حرق قش الأرز. ولم يلاحظ ذلك علي أي من مؤشرات محصول الحبوب ومحصول القش/فدان.

٢- لم يكن لإضافة السماد العضوي تأثير معنوي علي محصول الحبوب ومحصول القش والمحصول الكلي/فدان رغم الزيادة المعنوية في طول النبات خلال الموسمين وزيادة عدد السنابل/ م^{٢} حسب التحليل التجميعي للموسمين.

٣- أدي زيادة معدل التسميد النيتروجيني حتي ٨٠ كجم ن/فدان إلي زيادة معنوية في جميع مؤشرات المحصول وكذلك محصول الحبوب والقش والكلي/فدان. وأوضحت معادلات الاستجابة أن هذه الزيادات كانت تناقصية وذلك يوضح إمكانية تعظيم محصول الحبوب/فدان بإضافة ٩٥ كجم ن/فدان. وكذلك إمكانية تعظيم العائد من عملية التسميد إلى ٤٢٠٠ جنيه/فدان وذلك بإضافة مستوى التسميد الأمثل ٩٢,٠ كجم ن/فدان.

٤- أدي دفن قش الأرز إلي انخفاض معنوي لكمية النيتروجين المسترجع والتي زادت معنويا بزيادة معدل التسميد النيتروجيني حتي ٨٠ كجم ن/فدان. وقد أدي ذلك إلي انخفاض كفاءة النيتروجين المسترجع وكذلك كفاءة استعمال النتروجين في بناء المحصول الكلي وكذلك انخفضت الكفاءة المحصولية والتي تعبر عن كمية محصول الحبوب المنتجة لكل وحدة نيتروجين مضاف.

٥- لم يلاحظ تأثير معنوي لتداخل الفعل بين عوامل الدراسة علي كل الصفات تحت الدراسة باستثناء طول النبات وعدد حبوب السنبلة، ولم يكن لذلك تأثير معنوي علي محصول الحبوب أو القش/فدان.