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# NUTRIENTS UPTAKE AS AFFECTED BY COMPOSTED RICE STRAW IN FLOODED RICE SOIL

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## ABSTRACT

A field experiment was conducted to study the uptake of N, P, K, Fe, Mn and Zn by rice fertilized with the combination of urea and composted rice straw. The highest yield of rice grains was recorded by the application of 2 tons composted rice straw plus 71.75kg N. fed$^{-1}$.The maximum 1000. grain weight obtained by the plot receiving no fertilizer. Utilization of 2 tons composted rice straw plus 51.75 kg N. Fed$^{-1}$ gave the highest value number of panicles. hill$^{-1}$. Results showed that the uptake of N, P, K, Fe, Mn and Zn increased when urea plus composted rice straw applied especially when 51.7 kg N. fed$^{-1}$ combined with two tons composted rice straw. Data showed also that N and P uptake by rice grain was higher than uptakeby rice straw but K, Fe, Mn and Zn uptake gave the opposite trend. The results of simple correlation coefficient ( r ) between grain yield (y) and each of total N uptake ( x1 ) , total P uptake ( x2 ) and total K uptake ( x3 ) showed that ( y ) was positively and significantly associated with x1, x2 and x3. Moreover the character most closely associated with grain yield ( y ) was the total N uptake ( x1 ) (r=0.99 ). Multiple linear regression showed that the prediction equation for grain yield (y) was formulated as follows: Grain yield = 291 + 38.7 total N uptake - 18 total P uptake + 7.7 total K uptake.
**Keyword**: rice, grain yield, rice straw, nutrient uptake.

## INTRODUCTION

Rice (Oryza sativa L.) is one of the most important cereal crops in the world as well as in Egypt. It ranks the second Crop after cotton regarding to exportation. It contributes more than 20 percent of the cereal consumption. Increasing productivity per unit land area is a native goal to meet the consistent demands from this crop. Increasing rice production can be achieved through optimizing the cultural practices, improving soil chemical, physical and biological conditions and good water management. Dei (1975) reported that straw and compost plus chemical fertilizer yielded more paddy than chemical fertilizer treatment alone. The presence of N and P fertilizer enhanced the benefits of straw application. During the first year of trial at vermicelli, Italy ,incorporating straw alone did not affect yield, but incorporated straw combined with fertilizers yielded 6.9 t/ha paddy compared with 5.5 t.ha$^{-1}$for the straw alone and no straw treatment. Straw alone produced no increase in mean yield, but in combination with N and P fertilizer it increased paddy yield from 5.7 to 8.6 t.ha$^{-1}$ (Russo,1976). (Barnes (1985) in India mentioned that the application of 132 Kg N/ha gave the highest grain yield while the 1000-grain weight, number of grains and Panicle$^{-1}$ were unaffected. Nutrients uptake patterns are curvilinear and resemble the growth curve. Nutrients accumulation is continuous through all phases of development, but highest demand occurs during the active tillering period, each essential nutrient plays a rather specific role in the plants physiological processes, and their absorption, accumulation and proper function depends on an adequate supply and balance of each essential element.

The present study was undertaken to determine the effects of composted rice straw and urea and their integration between them on the uptake of some nutrient elements such as N, P, K ,$Fe^{2+}$,$Mn^{2+}$ and $Zn^{2+}$ by rice plants and their contents in rice grains and straw.

## MATERIALS AND METHODS

A field experiment was conducted at the Rice Research and Training Center Farm using Sakha 101 rice variety (*Oryza sativa* L.) to achieve the study objectives. The experiment was conducted in clayey soil , some of its physical and chemical characteristics were determined according to the standard procedures as described by Cottenie *et al*. (1982) and Page *et al*.(1982) as shown inTable 1.

**Table 1: Some mechanical analyses of soil used**

| Properties | Value | Properties | Value |
|---|---|---|---|
| Total nitrogen , mg/kg | 560 | EC dS/m (soil paste) | 2.3 |
| Available P, mg/kg (0.5 M NaHCO3) | 15 | Available micronutrients ppm: (EDTA) | 6.1<br>1.1 |
| Available Ammonium (ppm) | 18.1 | Fe++ | 3.5 |
| Available Nitrate (ppm) | 15.1 | Zn ++ | |
| Available Potassium (ppm) | 308 | Mn ++ | |
| pH (1: 2.5 soil suspension) | 8.2 | | |

The Randomized complete block design with four replications was used, involving six treatments as follows: control, 69 kg N $fed.^{-1}$ (recommended), 2 ton of composted rice straw $fed.^{-1}$, 2 ton composted $fed.^{-1}$ + 17.25 Kg $N.fed^{-1}$, 2 ton composted $fed.^{-1}$ + 34.5 Kg $N.fed^{-1}$, 2 ton composted $fed.^{-1}$+ 51.75 Kg $N.fed^{-1}$ Grains and straw samples were oven dried at 70ºc for 48 hours then grounded to determine total nitrogen, phosphorus, potassium, iron, manganese and zinc according to Hafez and Jackson, (1967) and Mikkelsen (1981). The obtained date of the grain yield, grain N uptake, total N- uptake, grain P uptake and total P uptake were subjected to simple correlation and regression. The same data were also subjected to multiple linear regressions and stepwise according to this formula: $Y= a + b_1x_1 + b_2x_2 + b_3x_3$ according to Hammad (1995).

## RESULTS AND DISCUSSION

### 1.Yield and yield attributes:

### 1.1 Grain and straw yield:

Data in Table 2 show the effect of composted rice straw and urea treatments and their combinations on grain and straw yield of Sakha 101 rice variety during 2004 season. Data showed that, there is significant increase in yield under all the treatments over the control. The highest yield of rice grains was recorded by the application of 2 tons composted rice straw.fed$^{-1}$ plus 51.75 kg N.fed$^{-1}$ from urea (5469 kg. fed$^{-1}$ with increasing 83.3 % over the control) but the lowest grain yield was observed under the treatment, which received no fertilizer (2983 kg. fed$^{-1}$). The increase in grain yield with the combined use of both these sources is advantageous and substantial amount of inorganic N can be saved. This mainly could be attributed to that combined use of compost and chemical fertilizer increase nutrients availability for plant throughout their growth stages. There was an increasing effect from the application of compost when adequate mineral fertilizers available. The effect has been due to factors other than nutrient supply, it may be necessary to consider influence due to the behavior of N organically provides (Cooke, 1977) or the effects of bioreglators. These results are also in agreement with those obtained by Dei (1975).

Data showed that grain yield increased up to 2 tons composted rice straw. fed$^{-1}$ plus 51.75 kg N. fed$^{-1}$. Data reported that, 69 kg N. fed$^{-1}$ gave higher yield (4487 kg.fed$^{-1}$ with increasing 50.41% over the control) than 2 tons composted rice straw.fed$^{-1}$ alone (4294 kg.fed$^{-1}$.

Any addition from urea to composed rice straw gave higher grain yield than that observed with urea alone. The straw yield followed the same trend as that of rice grain.

**1.2. Grain weight:**

Data in Table 3 present the 1000 grains weight of Sakha 101 rice variety as affected by composted rice straw and urea and their integrations. Data reported that one thousand grains weight tended to decrease with increasing the fertilizer application. Data showed also that the maximum 1000-grain weight was obtained by the plot receiving no fertilizer (28.68 g). However, the plot receiving 2 tons composted rice straw plus 51.75 kg N.fed-1 produced minimum 1000 grains weight (27.12 g). This increasing in 1000 grains weight with control mainly due to decrease the number of seeds.panicle$^{-1}$ with control consequently increase the weight of seeds. These results are in according with those obtained by Barnes (1985).

**Table 2: Means of dry weight of rice grain and straw (kg.fed$^{-1}$) as affected by the application of composted rice straw and urea treatments at harvest in 2004 season.**

| Treatments | Grain | % increase or decrease | Straw | % increase or decrease |
|---|---|---|---|---|
| Control | 2983f | - | 3081f | - |
| 2TCRS. fed$^{-1}$ | 4294e | 43.93 | 5200e | 68.77 |
| 69 kg N.fed$^{-1}$ | 4487d | 50.41 | 5410d | 75.59 |
| 2TCRS + 17.25 kg N.fed$^{-1}$ | 4852c | 62.6 | 5730c | 85.97 |
| 2TCRS + 34.5 kg N.fed$^{-1}$ | 5137b | 72.2 | 6100b | 97.98 |
| 2TCRS + 51.75 kg N.fed$^{-1}$ | 5469a | 83.3 | 6700a | 117.64 |

**TCRS = Ton composted rice straw %=increase or decrease relative to the control**

Data indicated that there are no significant difference in 1000 grains weight between 2 tons composted rice straw alone (28.13 g) and 69 kg N. fed$^{-1}$ (28.17 g ).

**1.3. Number of panicles:**

Number of panicles.hill-1 of Sakha 101 rice variety as affected by the application of composted rice straw and urea and their integrations are presented in Table 3. Data showed highly significant increase in number of panicles.hill$^{-1}$ as fertilizer level increase from 0 kg N. fed$^{-1}$ (15) to 2 tons composted rice straw plus 51.75kg N.fed$^{-1}$ (31.5). Data showed also that integration of composted rice straw with urea gave higher number of panicle.hill$^{-1}$ than composted rice straw or urea alone. It could be concluded that the increase in number of panicle.hill$^{-1}$ resulted from increasing nitrogen may be due to stimulation effect branches. initiation which gave more panicle.hill-1. These results are in quite agreement with those reported by Hemalatha and Balasubramanian, (2000).

**1. 4. Panicle length:**

Data in Table 3 presente values of panicle length (cm) of Sakha 101 rice variety as affected by the application of composted rice straw and urea and their integrations. Data demonstrate that all treatments didn't vary significantly from the control. This might be due to the fact that panicle length is controlled genetically more than environmentally. The highest panicle length (22.96 cm) was recorded by the application of 2 tons composted rice straw plus 34.5 or 51.75 kg N. fed$^{-1}$ but the lowest (21.75) was observes under the treatment, which received no fertilizer. The order of panicle length was as follow: 2 tons composted rice straw (TCRS) plus 51.75 kg N. fed$^{-1}$ = 2 TCRS plus 34.5 kg N. fed$^{-1}$ > 2 TCRS plus 17.25 kg N. fed$^{-1}$ > 69 kg N. fed$^{-1}$ > 2 TCRS. fed$^{-1}$ > control. This increase of panicle length might be due to the favorable effect of N on rice plants and this encouraged the growth of rice plants and subsequently the excursion of panicle. These results are in agreement with those obtained by Abd-El –Rahman, (1999).

**Table 3: Yield attributes of rice variety Sakha101 as affected by the application of composted rice straw and urea treatments in 2004 season.**

| Treatment | 1000 grain weight (g) | No. of panicle. Hill$^{-1}$ | Panicle length (cm) | Filled grain (%) | Unfilled grain (%) |
|---|---|---|---|---|---|
| Control | 28.68a | 15e | 21.75a | 94a | 16a |
| 2TCRS .fed$^{-1}$ | 28.13b | 23.1d | 22.81a | 94a | 16a |
| 69 kg N.fed$^{-1}$ | 28.17b | 24.4d | 22.93a | 95a | 15a |
| 2TCRS + 17.25 kg N.fed$^{-1}$ | 27.87c | 27.2c | 22.95a | 94a | 16a |
| 2TCRS + 34.5 kg N.fed$^{-1}$ | 27.70d | 29.1b | 22.96a | 94a | 16a |
| 2TCRS + 51.75 kg N.fed$^{-1}$ | 27.12e | 31.5a | 22.96a | 95a | 15a |

**TCRS = Ton composted rice straw % = increase or decrease relative to the control. In the same column, means followed by the same letter are not significant by different according to DMRT (Duncan, 1955)**

**1. 5. Filled and unfilled grains percentage:**

Data in Table 3 presente filled and unfilled grains percentage as affected by the application of composted rice straw and urea and their integrations.

Results showed that no significant differences among all treatments. The highest filled grains percentage (95 %) was recorded when 2 tons composted rice straw plus 51.75 kg N. fed$^{-1}$ applied. The values of filled grain percentage showed the following order: 2TCRS+51.75kgN.fed$^{-1}$=69kgN.fed-1>2TCRS+34.5 kg N.fed-1 =2TCRS+17.25kg N. fed$^{-1}$ =2TCRS. fed$^{-1}$ =control. The increase in filled grain percentage mainly due to the increase of the available N, P, K and other nutrients. The results confirm the findings of Kalita and Sharnah(1992)

**2- Nutrients uptake by rice plants:**

**2.1. Nitrogen and Phosphorus uptake by rice plants:**

Nitrogen and Phosphorus uptake (kg.fed$^{-1}$) by rice plants (rice straw and grains) at harvest as affected by composted rice straw and urea and their combinations are shown in Figs. 1 and 2, respectively. Data showed that total N and P- uptake were lower with unfertilized plot but 2 tons composted rice sraw.fed$^{-1}$ plus 51.75 kg N.fed$^{-1}$ gave the highest value (92.20% and 66.90 % respectively over the control) at harvest. This could be attributed to that this treatment increased the amount of available nitrogen and Phosphorus consequently increased N and P-uptake beside the higher production of the dry matter. Also, the addition of the compost accelerated the development of active rice roots that carry out nutrient absorption (IRRI,1984). These results are in agreement with those obtained by Seng *et al* (1999) and Manish *et al* (2003). Data showed also that increasing N level applied with composted rice straw increased N and P-uptake. This might be due to increasing the amount of available N and P thereby increased N and P uptake. It is important to notice that rice grain gave N and P uptake higher than rice straw. This mainly due to the translocation of N and P from straw to grains.

**2.2. Potassium uptake by rice plants:**

Potassium uptake by rice plant at harvest as affected by the application of composted rice straw and urea treatments and their combinations are shown in Fig. 3. Data showed that all treatments increased total K-uptake over the control. It is important to notice that addition nitrogen to composted rice straw increased the amount of total K-uptake. Data showed also that the combination of 2 tons composted rice straw.fed$^{-1}$ plus 51.75 kg. N. fed$^{-1}$ increased total K-uptake at harvest. This mainly due to the increase in K availability during season beside the increase of the dry matter. These results are in harmony with those obtained by Beye (1974) and Seki *et al*. (1989). Data reported also that K-uptake in rice straw was higher than K-uptake in rice grain. This mainly due to the higher potassium content of rice straw than rice grain.

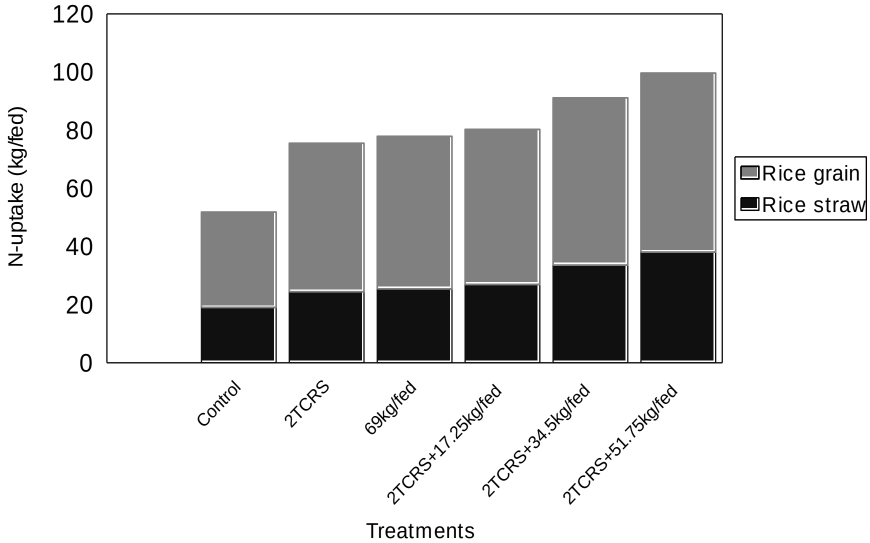


**Fig. 1: Nitrogen uptake by rice plant(kg.fed$^{-1}$) as affected by the application of composted rice straw and nitrogen treatments at 115 days after transplanting in 2004 season.**

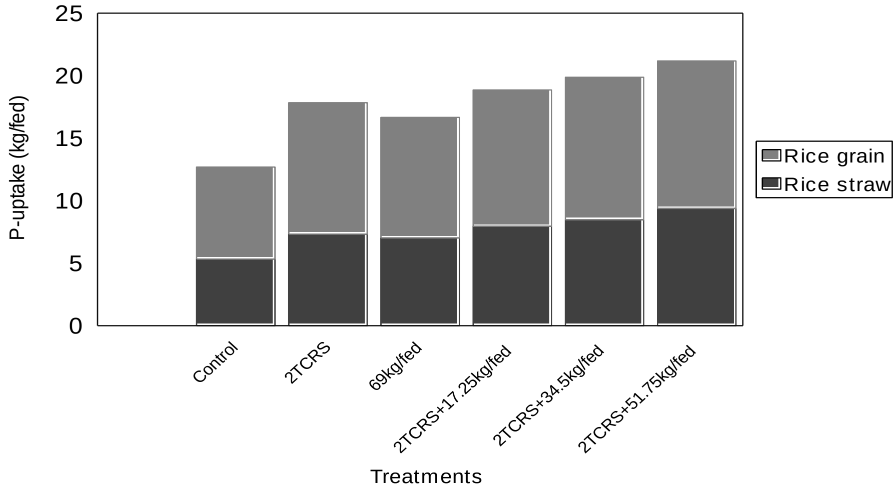


**Fig. 2: Phosphorus uptake by rice plant (kg.fed$^{-1}$) as affected by the application of composted rice straw and nitrogen treatments at 115 days after transplanting in 2004 season.**

**2.3. Micronutrients uptake by rice plants:**

Data in Figs. 4, 5 and 6 demonstrate that all treatments increased Fe, Mn and Zn-uptake compared with control. The percentage of increase in total Fe,Mn and Zn-uptake were 76.71, 83.14 and 83.54% ,respectively comparing with the control. Data indicated also that,Fe, Mn and Zn-uptake by rice straw is higher than uptake by rice grain. This may be due to remaining most of the micronutrients in the rice straw. (Doberman and Fairhurst, 2000).

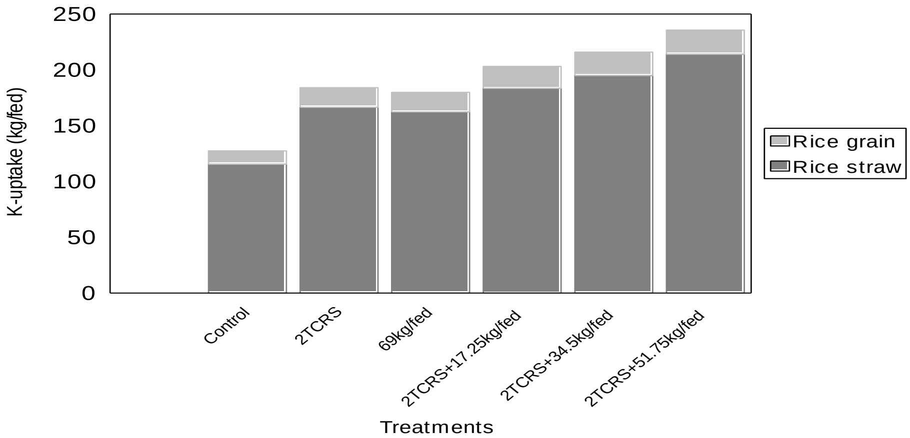


**Fig. 3: Potassium uptake by rice plant (kg.fed$^{-1}$) as affected by the application of composted rice straw and nitrogen treatments at 115 days after transplanting in 2004 season.**

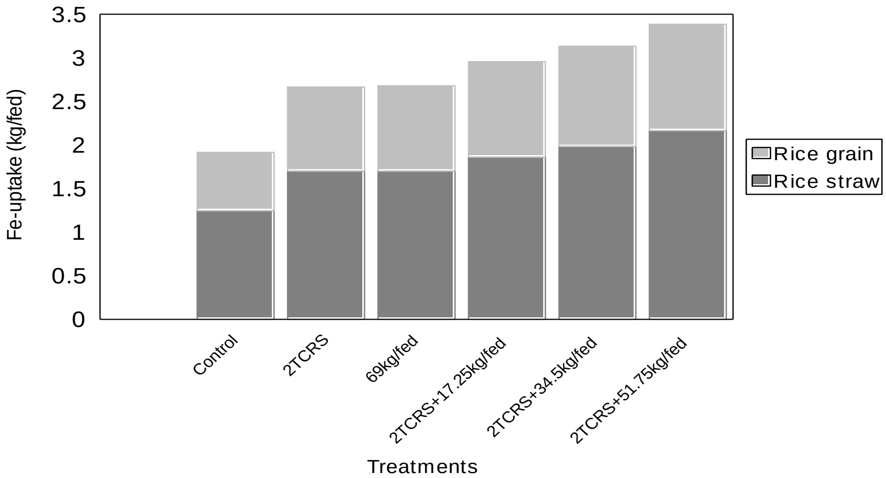


**Fig. 4: Iron uptake by rice plant (kg.fed$^{-1}$) as affected by the application of composted rice straw and nitrogen treatments at 115 days after transplanting in 2004 season.**

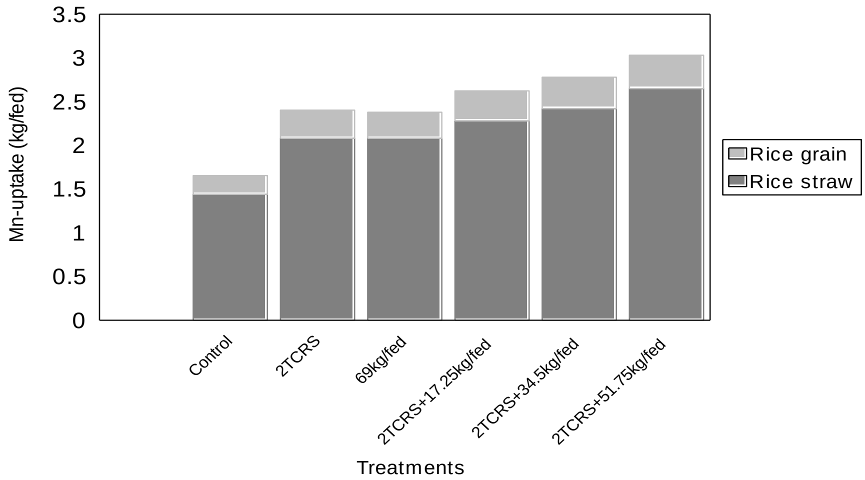


**Fig. 5: Manganese uptake by rice plant (kg.fed$^{-1}$) as affected by the application of composted rice straw and nitrogen treatments at 115 days after transplanting in 2004 season.**

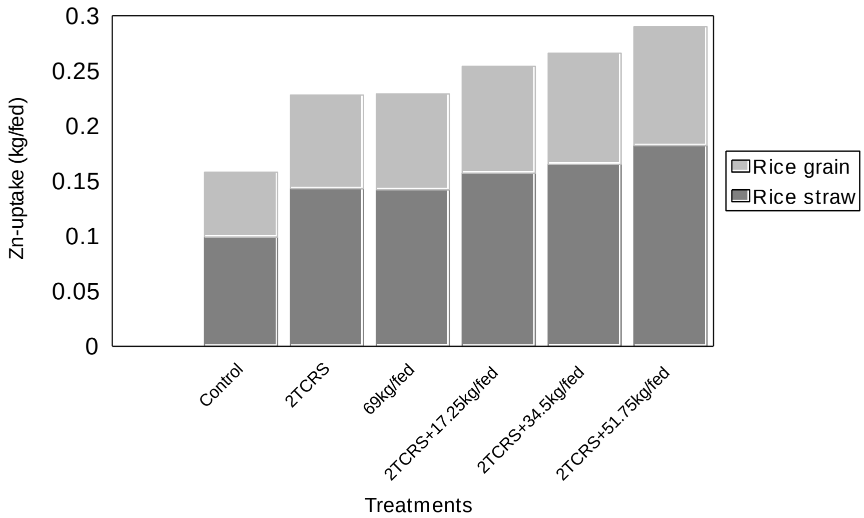


**Fig. 6: Zinc uptake by rice plant (kg.fed-1) as affected by the application of composted rice straw and nitrogen treatments at 115 days after transplanting in 2004 season.**

**3.1. Correlation between some results:**

While multiple linear regressions from the following formula illustrated that total nitrogen uptake had a significantly role in predicting the

grain yield (y) (R2=98.9% and the adj. R2=97.2), therefore, the expected equation to predict the grain yield is as follows: The regression equation is
Y = 291 + 38.7 x1 - 18 x2 + 7.7 x3
Where y=Grain yield (kg.fed-1), X 1= Total N-uptake ($kg.fed^{-1}$)
X2 = Total P-uptake (kg.fed-1), X3= Total K-uptake ($kg.fed^{-1}$)
Stepwise Regression. In addition stepwise linear regression revealed that the most closely variable related to y (grain yield) are total nitrogen uptake, so the prediction equation for grain yield is
Y=301.7+53.1 total nitrogen uptake with R2=98.81

**3.2. Polynomial regression**

As illustrated in Fig. 7 the simple regression equation for predicting grain yield (g/pot) (y) was computed from the following equation:
Y = -3.82960 + 0.441753X - 1.85E-05X**2 R-Sq = 98.8 %
)Where X=total N-uptake.
Finally, it is worthily to mention that from Table 2 that total N uptake had significant effect on grain yield.

**Table 4: Correlation (Pearson) between some results affecting grain yield of rice plant in 2004 season**

| | Grain(kg.fed-1) | Total N- uptake (kg.fed-1) | Total P-uptake (kg.fed-1) |
|---|---|---|---|
| Total N- uptake (kg.fed-1) | 0.994** | - | - |
| Total P-uptake (kg.fed-1) | 0.980** | 0.982** | - |
| Total K-uptake (kg.fed-1) | 0.991** | 0.994** | 0.995** |

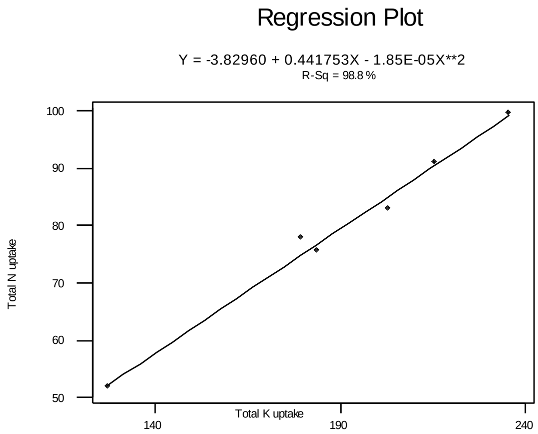


Fig 7: Simple regression coefficient between grain yield and total N-uptake as affected by different treatments in 2004 season.

## Conclusion

Nutrients uptake by rice plants at 2 ton composted rice straw plus 51.75 kg N.fed$^{-1}$ were higher than that the other treatments. Rice grains gave N and P-uptake higher than rice straw but opposite trend was found with K, Fe, Mn and Zn. Stepwise linear regression revealed that the prediction equation for y (grain yield) is:

Y=301.7+53.1 total nitrogen uptake with R2=98.81

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**امتصاص العناصر وتأثرها بمكمورة قش الأرز فى أراضى الأرز المغمورة**

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****مركز البحوث والتدريب فى الأرز- سخا- كفرالشيخ**

أجريت تجربة حقلية في موسم ٢٠٠٤ في مزرعة مركز البحوث والتدريب في الأرز – كفر الشيخ مستخدماً صنف الأرز سخا ١٠١ وذلك بهدف دراسة تأثير بعض الأسمدة العضوية (مكمورة قش الأرز ) والأسمدة الكيماوية ( اليوريا ) على امتصاص بعض العناصر المختلفة مثل النيتروجين والفوسفور والبوتاسيوم والحديد والمنجنيز والزنك ومحتوى كلا منهم فى قش وحبوب الأرز. أوضحت النتائج ان اعلى قيم لمحصول الحبوب وعددالسنابل فى الجورة وجد مع استخدام ٢طن كومبوست + ٥١. ٥ كجم نيتروجين/فدان. واعلى قيم لوزن الالف حبه وجد مع معاملة الكنترول. كما أوضحت النتائج أن أعلى قيمة للنيتروجين والفوسفور والبوتاسيوم والحديد والمنجنيز والزنك الممتص بواسطة قش وحبوب الأرز ظهرت عند استخدام ٢طن كمبوست +٥١,٧٥ كجم نيتروجين . فدان $^{-1}$.

كمية النيتروجين والفوسفور الممتص بواسطة حبوب الأرز كانت أعلى من الممتص بواسطة قش الأرز ولكن العكس وجد مع كلا من البوتاسيوم والحديد والمنجنيز والزنك. وجد من المعادلات الخطية أن اكثر العوامل ارتباطا بالمحصول هو كمية النيتروجين الكلى الممتص ويتضح ذلك من المعادلة آلاتية:

**Grain yield = 291 + 38.7 total N uptake - 18 total P uptake + 7.7 total K uptake.**

**قام بتحكيم البحث**

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|---|---|
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