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IMPACT OF COMPOSTED RICE STRAW AND UREA FERTILIZER ON YIELD, YIELD ATTRIBUTES AND N UPTAKE OF SAKHA 106 RICE CULTIVAR IN FLOODED RICE SOIL

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ABSTRACT

Nitrogen requirements of rice crop are met from both soil and fertilizers. Because of acute N deficiency in most rice soils, fertilizer N must be applied to meet the crop demand. A field experiment was carried out at Rice Research and Training center (RRTC), Sakha, Kafr El-Sheikh, Egypt during two summer seasons 2011 and 2012 to study the yield and yield component of Sakha 106 rice cultivars as well as nitrogen uptake in rice grains and soil organic matter percentage as affected by integrated use of composted rice straw and urea fertilizers. The treatments derived from the combination of 4 N fertilizer rates (0, 55, 110 and 165 Kg N/ha) and 3 composted rice straw rates (0, 5 and 7 tons composted rice straw/ha).

The obtained results revealed that, panicle weight, number of panicles, and 1000 grain weight and number of filled grains per panicle increased and reached the maximum values when the treatment of 165 Kg N/ha plus 5 tons composted rice straw/ha was applied but the opposite trend was observed with unfilled grains.

From the results under this study, it could be concluded that the application of 165 Kg N/ha plus 5 tons composted rice straw/ha produced the highest grain yield but the application of 165 Kg N/ha plus 7 tons gave the highest straw yields without any significant difference with the treatment of 110 Kg N/ha plus 7 tons composted rice straw for both of rice grain and straw yield.

The obtained data indicated also, that N uptake in rice grain of Sakha 106 was increased when the treatment of 165 Kg N/ha plus 5 tons composted rice straw was applied but N uptake by straw yield increased when the treatments of 165 Kg N/ha plus 7 tons composted rice straw was applied. The percentage of soil organic matter was increased with the addition composted rice straw.

Multiple linear regressions showed that the prediction equation for grain yield was formulated as follows:-

Grain yield = 1.33 + 0.0794 Nitrogen Uptake (2011)
(R^2=97.8% and the adj. R^2=97.6%)

Grain yield = 1.55 + 0.0798 Nitrogen uptake (2012)
(R^2=99.0% and the adj. R^2=98.9%)

INTRODUCTION

The need of rice plants to nitrogen (N) fertilizer is a well Known fact all over the rice producing countries. Rice crop removes large amount of N for its growth and grain production. Most of the rice soils of the world are deficient in N. Nitrogen fertilization aims at a high economic return of the investment through optimized crop yield and quality. Urea is the major N fertilizer used for optimum crop yields all over the world. Crop residue is a vital natural resource for conserving and sustaining soil productivity. It is the primary substrate for replenishment of soil organic matter (SOM). Crop residue supplies essential plant nutrients (Waltars *et al.*, 1992). Compost is a resource of the organic matter which resulted from exploiting wastes through the controlled bioconversion process, compost is considered as a method for recycling and re-utilization of crop residues (Bernal et al., 1998). Incorporation of rice straw and addition of straw ash supplemented with fertilizer application significantly increased the crop yield over the control (Singha, 2003). Application of rice straw in addition with chemical fertilizers recorded significant increases in total nutrient uptake (Tanchroen *et al.*, 2003). A number of field studies have been done on the use of rice straw as a part of integrated nutrient management strategies in many parts of the world. The time course of N uptake is closely related to plant growth, but variation occurs among early and late maturing varieties, depending on environmental factors. Excess N absorption during reproductive stage may produce non-productive tillers. The time between panicle initiation and heading is a period of high nitrogen demand (Mikkelsen et al., 1995) Integrated organic and inorganic fertilizers will help for increasing soil organic matter. The present work was designed to evaluate the response of rice cultivar Sakha 106 to integration of composted rice straw plus different rates of nitrogen as urea on:

1) Rice yield and its attributes
2) Uptake of nitrogen
3) Soil organic matter (SOM)

MATERIALS AND METHODS

A field experiment was conducted at the farm of Rice Research and Training center (RRTC), Sakha, Kafr El-Sheikh, Egypt during two summer seasons 2011 and 2012 to study the effect of mineral nitrogen fertilizer and composted rice straw and their integrations on yield and yield attributes of rice cultivars Sakha 106 beside nitrogen uptake and percentage of soil organic matter (SOM). The experiment was conducted in clay soil, some of its physical and chemical characteristics are determined according to the standard procedures as described by *Page (1982)* in Table1. Analysis of composted rice straw was determined according to *Cottine (1982)*

A randomized complete block with three replications was used involved 12 treatments derived from the combination of 4 N fertilizers rates (0, 55, 110 and 165 Kg N/ha) and 3 composted rice straw rates (0, 5 and 7 tons/ha). The compost was incorporated in dry soil, while nitrogen was added in two split; 2/3 of the amount was added as a basal before transplanting and the remind amount was added 5 days before panicle initiation stage. The phosphorus in form of calcium superphosphate (15.5 % P_2O_5) was added in one dose before transplanting during land preparation. Twenty five days old seedlings were transplanted at 20 x 20 cm between hills and rows. The plot size was 12 cm^2. The other culture practices for rice cultivation were applied according to the recommendation of Rice Research and Training center (RRTC). At harvest, 10 main panicles were randomly taken from each plot to determine the number of panicle/hill, number of filled and unfilled grain/panicle, panicle weight and 1000 grain weight. In each plot 10 m^2 of area was manually harvested. Grain yield was recorded and adjusted to 14 % moisture content. Grain and straw yield were converted to ton/ha. Nitrogen uptake was determined through nitrogen content of rice grain and weight of grains. Soil organic matter percentage was determined according to *Jackson (1967)*. All statically analysis was conducted according to *Gomez and Gomez (1953)*.

The same data were also subjected to multiple linear regressions and stepwise regression was done. Partial coefficient of determination (R2) was estimated for each component to evaluate the relative contribution and to construct the prediction model for the grain yield according to this Formula: Y= a + b1x1 + b2x2 + b3x3 + b4x4 according to *Snedecor and Cochran, (1982)*.

Table 1: Some chemical analyses of soil used under study in 2011 and 2012 summer seasons

Soil chemical properties	Before planting	
	2011	2012
Clay%	55	55.5
Silt %	32.4	32.32
Sand %	12.6	12.27
Texture	clayey	clayey
Organic matter%	1.39	1.42
pH(1:2.5)	8.20	8.35
Ec (ds.m^{-1})	3.33	3.12
Total N (ppm)	518.0	477.0
Available P (ppm)	15.09	14.0
Anions(meq.L^{-1})		
$CO_3^{=}$	--	--
HCO_3^-	5.56	5.30
Cl^-	9.00	8.50
SO_4^{--}	18.33	17.40
Cations(meq.L^{-1})		
Ca	10.01	11.70
Mg	5.00	3.50
Na	1.88	1.60
K	16.00	14.40
Available Micronutrients (ppm)		
Fe	4.55	5.30
Mn	3.10	3.70
Zn	0.75	0.70

Table 2: Chemical analysis of composted rice straw (CRS) in 2011 and 2012 seasons

Analysis compost	C%	N%	C:N Ratio	% P	% K	Fe	Mn	Zn
						(ppm)		
Season 2011	53.00	1.80	29.44	0.62	2.00	524.34	244.30	52.06
Season 2012	50.00	1.75	28.57	0.59	1.83	580.22	290.30	68.10

RESULTS AND DISCUSSION

1- Yield and its attributes

Data presented in Tables 3 and 4 show the effect of composted rice straw and urea treatments and its integration on panicle weight, number of panicle/m^2, number of filled and unfilled grains/panicle, one thousand grain weight, grain and straw yield of Sakha 106 rice cultivars during 2011 and 2012 seasons.

Data show that, a significant increase of most studied character under all tested treatments compared with the control. Data indicated that the integration between 165 Kg N/ha plus 5 ton composted rice straw /ha recorded the highest significantly values compared with urea or composted rice straw alone for panicle weight, number of panicle/m^2, number of filled grains, 1000 grain weight, grain and straw yield in both seasons except for number of unfilled grains/panicle.

Table 3: Panicle weight (g) and number of panicle/m^2 of Sakha 106 rice cultivar as affected by application organic and inorganic fertilizers

Treatments	panicle weight (g)		Number of panicle	
	2011	2012	2011	2012
Control	2.84f	2.70c	383.80b	441.30b
55 Kg N/ha	3.00e	3.14abc	405.00ab	449.70b
110 Kg N/ha	3.09cd	3.15abc	417.50ab	467.50b
165 Kg N/ha	3.20bc	3.24ab	438.80 ab	482.50ab
5 tons CRS	2.96de	2.94bc	398.80 b	446.30 b
7 tons CRS	3.10cd	3.13abc	403.80 b	455.00 b
55 Kg N/ha +5 tons CRS	3.21c	3.16abc	418.80 ab	475.00a b
55 Kg N/ha + 7 tons CRS	3.28c	3.20abc	420.00 ab	485.00 a
110 Kg N/ha + 5 tons CRS	3.30c	3.27ab	425.00 a	495.00 a
110 Kg N/ha + 7tons CRS	3.32bc	3.35ab	432.50 a	500.00 a
165 Kg N/ha + 5 tons CRS	3.47a	3.58a	450.00 a	520.00 a
165 Kg N/ha + 7 tons CRS	3.39ab	3.44ab	441.30 a	515.00 a

Table 4: 1000-grain weight, number of filled grains/panicle and number of unfilled grains /panicle of Sakha 106 rice cultivar as affected by application of organic and inorganic fertilizers

Treatments	1000 grain weight (g)		Number of filled grains/ panicle		Number of unfilled grains /panicle	
	2011	2012	2011	2012	2011	2012
Control	25.98a	26.33c	81.36 k	85.45g	8.32a	12.74a
55 Kg N/ha	26.85a	27.05bc	87.12 j	99.55 ef	8.66a	8.22cde
110 Kg N/ha	27.48 a	27.95ab	96.25 g	106.50cde	8.76a	8.42bcd
165 Kg N/ha	27.20 a	27.45 ab	101.02 e	109.75 bcd	8.95	8.70 bc
5 tons CRS	26.63 a	27.20 ab	90.65 i	95.00f	8.22a	9.37 b
7 tons CRS	27.90 a	28.19 a	94.00h	101.60e ef	8.16a	7.96cde
55 Kg N/ha+5 tons CRS	27.52 a	27.67 ab	98.25 f	103.65de	8.57a	8.40bcd
55 Kg N/ha+7 tons CRS	27.64 a	28.01 ab	100.99 e	105.50 cde	8.78a	8.31 cd
110Kg N/ha+5 tons CRS	27. 54a	27.79 ab	102.45 d	109.65 bc	8.10a	7.21 e
110 Kg N/ha+7tons CRS	27.80 a	28.07 ab	105.65 c	111.40 abc	8.52a	7.42 de
165 Kg N/ha+5 tons CRS	27.98 a	28.17 a	111.75 a	118.85 a	8.40a	7.34 de
165 Kg N/ha+7 tons CRS	27.53a	27.42 ab	107.25 b	115.45 ab	8.48a	7.38 de

Tables 3 and 4 show that yield and yield components of Sakha 106 rice cultivar was significantly improvement due to the use of tested treatment of integration between composted rice straw and urea. These results may be due to decomposition of compost which increase the availability of nutrients during growth stages and might produce a lot of tillers which resulted in increasing the number of panicles and improve grain filling and so increasing weight of grains which lead to increase in grain and straw yield. On the contrast, the unfertilized treatments recorded the lowest values of all traits except number of unfilled grain/panicle. These results are in harmony with those obtained by *Hammad et al (2006)*. The 1000 grain weight values was recorded at 165 Kg N/ha plus 5 ton composted rice straw, while the lowest 1000 grains weight was obtained when no fertilizer was added.

Data in Table 5 show that utilization of 165 Kg N /ha plus 5 ton composted rice straw gave the highest values of rice grain (9.60 and 10.13 t/ha) in 2011 and 2012 seasons respectively. It is worthwhile to mention that the highest values of rice straw yield was found when the treatments of 165 Kg N/ha plus 7 tons CRS /ha (11.56 and 12.07 t/ha) was applied. These findings could be explained as result of the reason that increasing fertilizer levels help to increase vegetative growth.

Table 5: Grain and straw yields (t/ha) of Sakha 106 rice cultivar as affected by application organic and inorganic fertilizers

Treatments	Grain yield t/ha		Straw yield t/ha	
	2011	2012	2011	2012
Control	5.45 f	5.91 f	6.62 d	7.17 d
55 Kg N/ha	6.59 e	7.03 d	8.00 c	8.88 c
110 Kg N/ha	7.57 c	8.28 b	8.93 c	9.91 b
165 Kg N/ha	8.84 b	9.60 a	10.30 b	11.38 a
5 tons CRS	6.41 e	6.98 de	8.67 c	9.54 b
7 tons CRS	6.97 d	7.36 d	9.70 bc	10.34 b
55 Kg N/ha +5 tons CRS	7.83 cd	8.08 c	10.28 b	10.68 b
55 Kg N/ha + 7 tons CRS	8.21 c	8.73 b	10.75 ab	11.24 ab
110 Kg N/ha + 5 tons CRS	8.88 b	9.59 ab	10.98 ab	11.41 ab
110 Kg N/ha + 7tons CRS	9.29 a	9.95 a	11.18 ab	11.50 ab
165 Kg N/ha + 5 tons CRS	9.60 a	10.13 a	11.35 a	11.63 ab
165 Kg N/ha + 7 tons CRS	9.44 a	9.96 a	11.56 a	12.07a

It is important to note that, there is no significant difference in rice grain yield between the treatment of 165 Kg N/ha and 165 Kg N/ha plus either 5 or 7 ton CRS/ha or 110 Kg N/ha plus either 5 or 7 ton CRS/ha in 2012 season but it is important to add CRS to increase soil organic matter (SOM) to sustain the soil.

2- Nitrogen uptake in rice

Data in Table 6 show that the effect of composted rice straw and urea alone or in combination with nitrogen on nitrogen uptake. Data revealed that nitrogen uptake by grain and straw were gradually increased by application of high dose of urea (165 Kg N /ha) or high and medium dose of urea (110 Kg N/ha) plus composted rice straw. The lowest values of nitrogen uptake in grain and straw resulted from unfertilized treatment followed by the treatment of 5 tons composted rice straw but the highest N uptake was obtained by application of 165 Kg N/ha plus either 5 or 7 tons composted rice straw. These findings might be attributed to increasing N availability which in turn increased N absorption and translocation, consequently increased grain and straw N uptake. These findings are in harmony with those obtained by *Singha, (2003).*

Table 6: N uptake in grain and straw yields (Kg/ha) of Sakha 106 rice cultivar as affected by application organic and inorganic fertilizer

Treatments	N uptake in grain Kg/ha		N uptake in straw Kg/ha	
	2011	2012	2011	2012
Control	51.30 e	53.66 f	31.20 g	35.18 f
55 Kg N/ha	63.80 d	68.76 e	40.70 f	42.48 e
110 Kg N/ha	79.90 c	81.95 cd	48.1 def	53.34 d
165 Kg N/ha	97.90 ab	98.92 b	56.8 b-e	65.71 bc
5 tons CRS	66.10 d	69.97 e	46.70 ef	53.77 d
7 tons CRS	73.50 cd	75.16 de	54.4cde	60.77 c
55 Kg N/ha +5 tons CRS	80.10 c	82.84 c	58.80 a-e	63.09 bc
55 Kg N/ha + 7 tons CRS	86.60 bc	88.40 c	61.20 a	65.19 bc
110 Kg N/ha + 5 tons CRS	94.70 ab	100.68 ab	64.30 abc	69.62 b
110 Kg N/ha + 7tons CRS	98.90 ab	108.16 a	67.40 abc	66.38 bc
165 Kg N/ha + 5 tons CRS	104.60a	107.91 a	69.70 ab	70.10 b
165 Kg N/ha + 7 tons CRS	98.90 ab	104.15 ab	71.40 a	77.52 a

It is important to notice that the N uptake at harvest was significantly increased with raising the nitrogen dose. It could be concluded that composted rice straw release additional amount of N required for rice plants which caused a marked increase in N uptake.

3- Soil organic matter (SOM %)

Soil organic matter percentage as affected by compost application, mineral nitrogen as urea and its integration are presented in Fig 1. Data showed that Soil organic matter percentage increased by application of compost either applied alone or in combinations with different levels of mineral nitrogen compared the control.

The results in both seasons revealed that, Soil organic matter percentage gave the lowest values as observed at unfertilized treatment and urea only while, the utilization of composted rice straw only or in combination with urea increase the soil organic matter percentage compared with the initial values 1.39 and 1.42 % in 2011 1nd 2012 seasons as shown in Table 1. This may be due to the integrated application of inorganic fertilizer may meet the demand of mineral nutrition by microbes but can not provide carbon, which is a major constituent of microbe cell but integration of organic and inorganic provide mineral nutrition as well as carbon. These results agreed with the findings of *sarwar et al (2003)* who found that the combination of compost and chemical fertilizers proved further helpful in increasing the organic matter levels in soil.

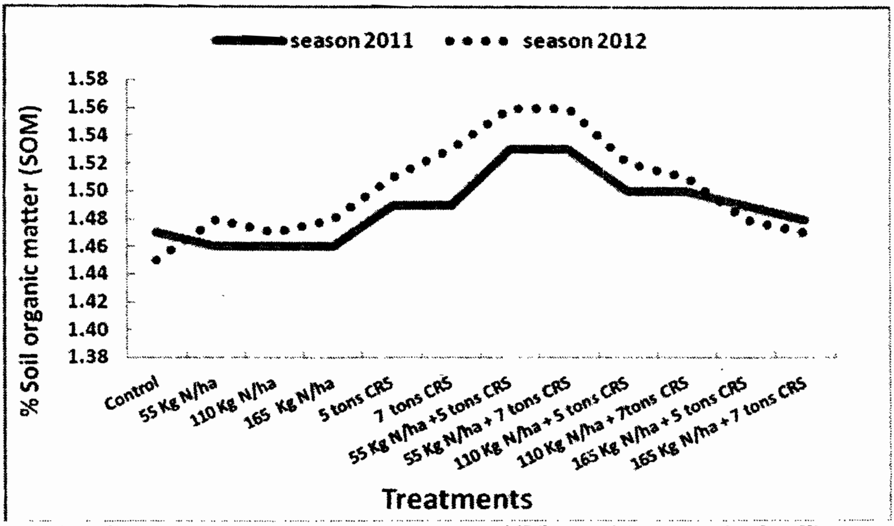

Fig 1: Effect of composted rice straw (CRS) and inorganic fertilizers on soil organic matter %

4- Simple regression coefficient between grain yield and total N uptake as affected by the different treatments in 2011 and 2012 season.

Multiple linear regressions from the following formula illustrated that total nitrogen uptake had a significant role in predicting the grain yield. Therefore, the expected equation to predict the grain yield is as follows: The regression equation is

Grain yield = 1.33 + 0.0794 Nitrogen Uptake (2011)
(R2=97.8% and the adj. R2=97.6%)

Grain yield = 1.55 + 0.0798 Nitrogen uptake (2012)
(R2=99.0% and the adj. R2=98.9%)

Finally, it is worthily to mention from Fig. 2 and 3 that total N uptake had significantly effect on grain yield.

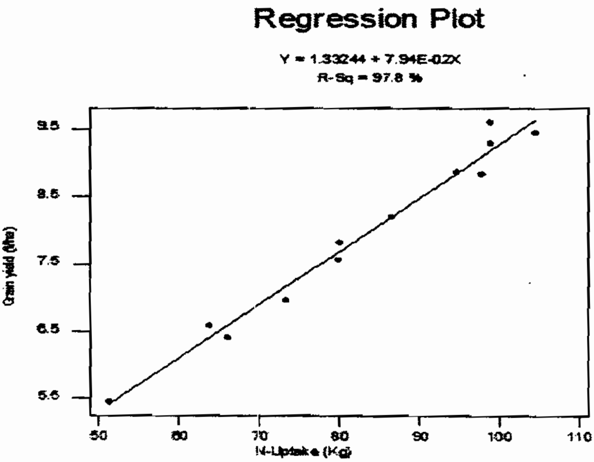

Fig 2 : Simple regression coefficient between grain yield and total N uptake as affected by the different treatments in 2011 season.

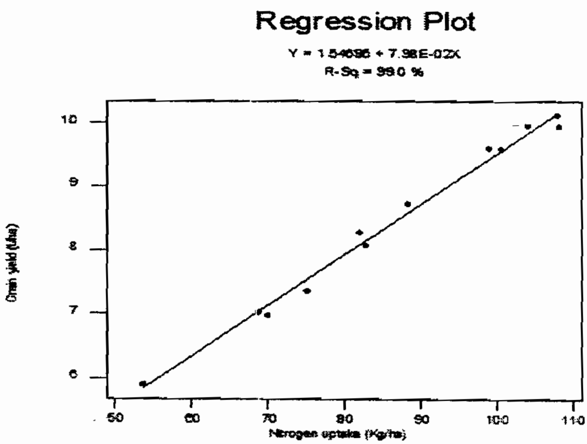

Fig 3 . Simple regression coefficient between grain yield and total N uptake as affected by the different treatments in 2012 season.

REFERENCES

Bernal, M.P; J. Cegara; A. Roig; M.A. Sanchez- Monedero and C.paredes 1998. Composting of organic wastes as astrategy as for production high quality organic fertilizers. 18th International Conference on Mangement Strategies for Organic waste Use in Agriculture. Rennes, France, 26-29.

Cottenie, A.M. Verloo. L. Kierkens, G.velghe and R. Camerlynch..1982. Chemical Analysis of plants and soils. Laboratory of Analytical Agro. Chemistry state university, Ghent. Belgium.

Gomes, A.K, and A.A Gomes.1984.Statistical procedures of Agricultural Research.2 and ed. Jahn Wiley Sons, New York.

Hammad.S.A.:K.H El-Hamdi; S.A Ghanem and E.S. Naeem. 2006. Efficacy of composted rice straw in integration with urea in rice production and their effect on effect on soil organic matter.J.Agric. Sci. Mansoura. Univ. 31 (6): 4001-4006.

Jackson, M. L. 1967. Soil Chemical Analysis Prentice Hall of Indica, New Delhi, PP. 144- 197. Jat

Mikkelsen, D.S.; G.R. Jayawera and D.E. Rolston.1995. Nitrogen fertilization practices of lowland rice culture. Davis, California, Chap. 6. (C. F. Fertilization In The Environment).

Page, A. L., R.H. Miller and D.R. Keeney.1982. Methods of soil Analysis – part 2. Amer. Sco. Agric. Inc. Madison.

Sarwar.G.N, Hussain, F. Mujeeb, H. Schmeisky and G.Hassan. 2003. Biocompost application for the improvement of soil characteristics and dry matter yield of loium perenne (Grass). Asian J. plant Sci., 2 (2): 237-241.

Singha.D.D.2003. Management of crop residues in summer rice and its effect on the soil properties and crop yield. Crop-Ress. Hisar. 25 (1): 191-193.

Snedecor, G. W. and W.G. Cochran 1982. Statistical Methods 7th ED. Second printing. The Iowa stat Univ. Press, Ames, Iowa, U.S.A.

Tranchoraen S. ; J. Chanchareonsook; C. Suwannarat and C.Panichjakul 2003. Combined effect of rice straw and chemical fertilizer on yield and nutrient uptake of khaopaq Haum suphanburi rice grown in paddy calcareous, Lop Buri soil series Plant and Agriculture Extension and Communication , 251-257.

Walters, D.T., M.S. Aulakh and J.W. Donran. 1992. Effects of soil aeration, legume residue and soil texture on transformations of macro and micronutrients in soils. Soil. Sci. 153: 100- 107.

تأثير استخدام مكمورة قش الارز وسماد اليوريا علي محصول و مكونات صنف الارز سخا ١٠٦

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* مركز البحوث والتدريب فى الأرز- سخا- كفرالشيخ
** معهد الاراضي والمياة
**مركز البحوث والتدريب فى الأرز- سخا- كفرالشيخ

أجريت تجربة حقلية في موسم ٢٠١١ و٢٠١٢ في مزرعة مركز البحوث والتدريب في الأرز -كفر الشيخ مستخدما صنف الأرز سخا ١٠٦ وذلك بهدف دراسة تأثير بعض الأسمدة العضوية (مكمورة قش الأرز) والأسمدة الكيماوية (اليوريا) على محصول ومكونات هذا الصنف بالاضافه لدراسة العلاقة بين محصول الحبوب وكمية النيتروجين الممتصة وكذا اثر استخدام تلك الاسمدة علي المادة العضوية بالتربة. اوضحت النتائج ان اعلي قيم لكلا من وزن السنبلة ووزن الالف حبة وعدد الحبوب الممتلئه وكذلك محصول الحبوب ظهرت عند استخدام ٥طن كمبوست +١٦٥ كجم نيتروجين.هكتار^-١ بينما استخدام المعاملة ٧طن كمبوست +١٦٥ كجم نيتروجين . هكتار^-١ اعطي اعلي قيمة لمحصول القش. اوضحت النتائج ايضا ان استخدام الكمبوست ادي الي زيادة المادة العضوية . كما وجد من المعادلات الخطية أن اكثر العوامل ارتباطا بالمحصول هو كمية النيتروجين الكلى الممتص ويتضح ذلك من المعادلة آلاتية:

Grain yield = 1.33 + 0.0794 Nitrogen Uptake (2011)
(R2=97.8% and the adj. R2=97.6%)

Grain yield = 1.55 + 0.0798 Nitrogen uptake (2012)
(R2=99.0% and the adj. R2=98.9%)

قام بتحكيم البحث

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