J. Agric. Sci. Mansoura Univ., 33 (1): 829 - 834, 2008

USE OF SOME ORGANIC MATERIALS AS A FOLIAR APPLICATIONS IN RICE PRODUCTION AND REDUCTION OF MINERAL N-FERTILIZERS

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ABSTRACT

Two field experiments were conducted at Sakha Agriculture Research Station in two successive seasons of 2005 and 2006 to evaluate the effect of some organic compounds as a foliar applications (2000 ppm citric acid and 10% methanol) separately or together with adding three nitrogen rates to the soil (30, 45 and 60 kg N fed^{-1}) on rice production and reduction of mineral N-fertilizers.

The obtained data generally showed that the addition of such organic compounds with 60 or 45 kg N fed.$^{-1}$ produced significantly higher yield and yield components.

Also data indicated that using these organic compounds with 45 kg N fed.$^{-1}$ significant increased N, P and K content in rice plants.

The percentage of protein content in rice grains increased by using these organic compounds. Using these organic compounds leads to decreased of mineral N-fertilizer applications about 25% thus reducing pollution of the environment.

Keywords: Rice, nitrogen, fertilization, organic compounds (citric acid and methanol).

INTRODUCTION

The shortage and high costs of chemical fertilizer and the pollution factor have been focused attention on biofertilizer and organic materials (Addiscott *et al.,* 1991).

Parasad and Rokima (1991) found an integrated effect of organic, inorganic and biofertilizers on the available N, P and K contents of the soil and increased the N and P contents.

Abd El-Magid *et al*. (2004) concluded that the application of organic compounds is suggested as a sustainable way of increasing crop yields which would reduce the use of chemical fertilizers and improve soil fertility.

Nonumura and Benson (1992) reported that one of the important effects of methanol as a precursor of CO_2 is to increase water use efficiency under intense sunlight conditions, due to the increased turgidity which leads to a reduction in the transpiration and the availability of carbon from methanol in the vicinity of the leaf enhances the photosynthesis rate. Their results should that the use of methanol could significantly increase yield.

Nofal *et al.* (1990) and Genaidy *et al.* (1995) found good responses in growth and yield of some main filed crop plants as a result of foliar application of some organic acids such as ascorbic and citric. Mansour *et al.* (1988) and Hammada and El-Hakimi (2000) indicate that the foliar application of some organic acids were more effective on carbohydrate constituent. Gerik and Faver (1994) using aqueous solutions of methanol 10, 20 and 30% at square stage or start of flowering, found that methanol increased stomal conductance to CO_2 improved transpiration rate and enhanced CO_2 assimilation by 10% in biomass accumulations. Leaf area and fruit weight increased by 10% over the control. Abu El-Fotoh (1998) found that use of

Azolla as organic materials with urea fertilizer (as a source of mineral N-fertilizer) could help to increase the efficiencies of the different N-sources including the soil native-N, minimizing the rice production costs, saving the environment from the high chemical N-doses and accordingly producing a satisfactory and good rice yield. The aim of the present investigation was to study the effect of some organic materials (citric acid and methanol) on rice production and reducing of mineral N-fertilizers.

MATERIALS AND METHODS

Two field experiments were conduced at Sakha Agriculture Research Station during two successive seasons of 2005 and 2006 to evaluate the effect of some organic compounds (citric acid and methanol) as a foliar application with three rates of nitrogen fertilizer (60 kg N fed.$^{-1}$ recommended dose, 45 and 30 kg N fed.$^{-1}$) rice variety used was Giza 178.

The experiments were carried out in completely randomized block design with four replicates. The experimental treatments were conducted as follow:

1. 60 kg N fed.$^{-1}$ (recommended dose) = control.
2. 60 kg N fed. $^{-1}$ + citric acid.
3. 60 kg N fed.$^{-1}$ + methanol.
4. 60 kg N fed.$^{-1}$ + citric acid + methanol.
5. 45 g N fed.$^{-1}$
6. 45 kg N fed.$^{-1}$ + citric acid.
7. 45 g N fed.$^{-1}$ + methanol.
8. 45 kg N fed.$^{-1}$ + citric acid + methanol.
9. 30 kg N fed.$^{-1}$ + citric acid.
10. 30 kg N fed.$^{-1}$ + methanol.
11. 30 kg N fed.$^{-1}$ + citric acid + methanol.

Mixed surface soil (0-30 cm) samples were taken before planting for mechanical and chemical analysis from both experimental sites (data are shown in Table 1). Soil properties were determined according to Page (1982) and Jackson (1967).

The rice grains were shown in the nursery on 20th and 23rd of May in first and second season respectively, after soaking in water for 24 hours. Twenty eight-day-old rice seedling were transplanted in hills (three single plants per each hill) spaced at 20 x 20 cm among hills and rows. Plot size was 4 m x 5 m = 20 m^2.

Table 1: Some physical and chemical properties of the experimental soil.

Soil character / Seasons	Mechanical analysis			Texture	pH 1: 2.5	E.C dSm^{-1}	Total N %	Available (ppm)	
	Clay	Silt	Sand					P	K
First season (2005)	59.12	26.61	14.27	Clay	7.89	2.28	0.089	5.9	375
Second season (2006)	58.87	27.39	13.74	Clay	7.86	2.24	0.091	5.7	384

The usual and common agronomical practices were adopted as recommended by ministry of Agriculture. Each plot received basal dose equivalent to 100 kg of super phosphate (15.5% P_2O_5) and 20 kg zinc sulphate per feddan before transplanting while the nitrogen fertilizer (urea 46.5%) was applied into two equal doses. The first was added at the of transplanting and the second was added from 40 days after the transplanting at the maximum tillering stage.

The organic compounds (methanol 10% and citric acid 2000 ppm) were foliar applied twice, namely, at 30 and 50 days after transplanting.

Samples of rice Y-leaf (most recently fully matured leaf) were taken at 40 and 70 days after transplanting which corresponded maximum tillering and heading growth stages, respectively. Also samples of rice grain yield were taken for analysis after harvesting.

- Protein percentage in rice grain was calculated by multiplying its N percentage by the factor 5.95 as outlined by Juliano (1985).
- Total nitrogen content was determined by using micro kjeldahl method as descried by Jackson (1967).
- Phosphorus percentage and potassium percentage were determined according to Jackson (1967).
- Grain weight (gm): Thousand rice grains were picked at random and weighted.

The data were analyzed by the least significant differences (L.S.D.) method according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Rice yield and some yield components as affected by organic materials applications in 2005 and 2006 seasons are recorded in Table 2. The data showed that the application of citric acid and methanol as a foliar had a significant positive effect on grain, straw yield and 1000 grain weight. The highest increases values of grain yield were 21.3 and 21.1% over control which obtained with (45 N fed.$^{-1}$ + methanol + citric acid) treatment in both seasons, respectively. While the straw yield increases were 24.4 and 21.4% over control which obtained with (60 kg N fed.$^{-1}$ + methanol + citric acid) treatment in both seasons respectively. Also, data in Table 2 cleared that the application of methanol and citric acid as a foliar with 45 kg N fed.$^{-1}$ significantly increased the 1000 grain weight over the control treatment by 13.8 and 14.3% in both seasons respectively. This results means the foliar application of methanol and citric acid with 45 kg N fed.$^{-1}$ leads to increasing in rice production with minimizing costs and saving the environment from the high chemical N-dose (saving about 25% of urea-N fertilizer). These results are in agreement with those obtained by Rosenani and Shulan (1992) and Hammada and El-Hakimi (2000).

The results presented in Table 3a and 3b cleared that the application of methanol and citric acid as a foliar with 45 kg N fed.$^{-1}$ significantly increased of the P and K % concentration in rice plants at tillering and heading stages growth of rice plants. While the highest values of N concentration in rice plants at tillering and heading stages were 4.35 and 4.18% and 4.33 and 4.17% in both seasons, respectively obtained with (60 kg N fed.$^{-1}$ + methanol + citric acid) treatment. The present results are similar with that shown by Hammad *et al*. (1997) and Abu El-Fotoh (1998).

Table 2: Rice yield and some yield components as affected by nitrogen rates and foliar applications of methanol and citric acid.

Seasons	2005			2006		
Character / Treatments	Grain yield (ton fed.$^{-1}$)	Straw yield (ton fed.$^{-1}$)	1000 grain weight (g)	Grain yield (ton fed.$^{-1}$)	Straw yield (ton fed.$^{-1}$)	1000 grain weight (g)
60 kg N fed.$^{-1}$ (control)	3.61	5.12	21.68	3.79	5.09	22.03
60 kg N fed.$^{-1}$ + metha.	4.15	5.64	22.98	4.23	5.52	23.47
60 kg N fed.$^{-1}$ + citr.	4.12	5.95	22.87	4.25	5.79	24.14
60 kg N fed.$^{-1}$ + meth. + citr.	4.34	6.37	24.63	4.56	6.18	25.12
45 kg N fed.$^{-1}$	3.24	4.98	20.58	3.36	4.96	20.49
45 kg N fed.$^{-1}$ + metha.	4.12	5.26	23.57	4.31	5.19	23.52
45 kg N fed.$^{-1}$ + citr.	4.08	5.86	23.64	4.24	5.38	23.61
45 kg N fed.$^{-1}$ + meth. + citr.	4.38	6.28	24.68	4.59	5.84	25.18
30 kg N fed.$^{-1}$ + meth.	3.31	5.11	20.76	3.19	5.03	21.22
30 kg N fed.$^{-1}$ + citric	3.27	4.98	20.63	3.17	4.87	20.88
30 kg N fed.$^{-1}$ + metha. + citr.	3.33	5.14	21.04	3.23	5.06	21.74
L.S.D. at 5%	0.13	0.21	0.98	0.12	0.23	0.95

Y-leaf: most recently fully matured leaf.

Table 3a: N, P and K concentration (%) in rice plants at tillering and heading stages as affected by nitrogen rates and foliar applications of methanol and citric acid in the first season 2005.

Character	N%		P%		K%	
Treatments	Y-leaf at tillering	Y-leaf at heading	Y-leaf at tillering	Y-leaf at heading	Y-leaf at tillering	Y-leaf at heading
60 kg N fed.$^{-1}$ (control)	4.07	3.86	0.152	0.149	1.98	1.94
60 kg N fed.$^{-1}$ + metha.	4.13	3.92	0.164	0.161	2.11	1.97
60 kg N fed.$^{-1}$ + citr.	4.12	3.98	0.168	0.163	2.09	1.99
60 kg N fed.$^{-1}$ + meth. + citr.	4.35	4.18	0.177	0.166	2.06	1.96
45 kg N fed.$^{-1}$ (control)	3.83	3.54	0.160	0.151	1.98	1.95
45 kg N fed.$^{-1}$ + metha.	4.11	3.88	0.163	0.152	1.99	1.86
45 kg N fed.$^{-1}$ + citr.	4.09	3.91	0.162	0.153	2.13	1.98
45 kg N fed.$^{-1}$ + meth. + citr.	4.29	4.13	0.4178	0.169	2.14	1.97
30 kg N fed.$^{-1}$ + meth.	3.65	3.45	0.168	0.159	2.11	1.89
30 kg N fed.$^{-1}$ + citric	3.71	3.38	0.166	0.153	2.08	1.93
30 kg N fed.$^{-1}$ + metha. + citr.	3.89	3.53	0.169	0.161	2.04	1.96
L.S.D. at 5%	0.09	0.14	0.011	0.012	0.10	0.06

Y-leaf: most recently fully matured leaf.

Table 3b: N, P and K concentration (%) in rice plants at tillering and heading stages as affected by nitrogen rates and foliar applications of methanol and citric acid in the second season 2006.

Character	N%		P%		K%	
Treatments	Y-leaf at tillering	Y-leaf at heading	Y-leaf at tillering	Y-leaf at heading	Y-leaf at tillering	Y-leaf at heading
60 kg N fed.$^{-1}$ (control)	4.09	3.92	0.153	0.139	2.01	1.98
60 kg N fed.$^{-1}$ + metha.	4.15	3.93	0.164	0.158	2.13	1.96
60 kg N fed.$^{-1}$ + citr.	4.14	3.97	0.167	0.163	2.15	1.99
60 kg N fed.$^{-1}$ + meth. + citr.	4.33	4.17	0.178	0.164	2.17	2.03
45 kg N fed.$^{-1}$	3.91	3.62	0.161	0.159	1.97	1.94
45 kg N fed.$^{-1}$ + metha.	4.21	4.16	0.164	0.159	2.03	1.89
45 kg N fed.$^{-1}$ + citr.	4.22	4.13	0.165	0.157	2.11	1.95
45 kg N fed.$^{-1}$ + meth. + citr.	4.28	4.12	0.179	0.168	2.18	2.09
30 kg N fed.$^{-1}$ + meth.	3.71	3.65	0.162	0.159	2.12	1.89
30 kg N fed.$^{-1}$ + citric	3.80	3.48	0.159	0.153	2.11	2.00
30 kg N fed.$^{-1}$ + metha. + citr.	3.91	3.53	0.163	0.158	2.13	2.00
L.S.D. at 5%	0.08	0.13	0.012	0.013	0.09	0.05

Y-leaf: most recently fully matured leaf.

The obtained results in Table (4) showed that the nitrogen concentration % and protein content % in rice grains as affected by organic materials applications. The treatment of (45 kg N fed.$^{-1}$ + methanol + citric acid) recorded the highest N-concentration and protein content %. The values were 1.45 and 8.63% and 1.47 and 8.75% in both seasons, respectively. These results were confirmed by the results of Shealan *et al.* (1987) and Abd El-Magid *et al.* (2004).

Table 4: Nitrogen concentration and protein content (%) in rice grains as affected by nitrogen rates and foliar applications of methanol and citric acid.

Seasons	2005		2006	
Character / Treatments	N %	Protein content %	N %	Protein content %
60 kg N fed.$^{-1}$ (control)	1.29	7.68	1.30	7.74
60 kg N fed.$^{-1}$ + metha.	1.35	8.03	1.34	7.97
60 kg N fed.$^{-1}$ + citr.	1.34	7.97	1.35	8.03
60 kg N fed.$^{-1}$ + meth. + citr.	1.43	8.51	1.44	8.57
45 kg N fed.$^{-1}$	1.27	7.56	1.28	7.62
45 kg N fed.$^{-1}$ + metha.	1.33	7.91	1.36	8.09
45 kg N fed.$^{-1}$ + citr.	1.34	7.97	1.35	8.03
45 kg N fed.$^{-1}$ + meth. + citr.	1.45	8.63	1.47	8.75
30 kg N fed.$^{-1}$ + meth.	1.28	7.62	1.31	7.79
30 kg N fed.$^{-1}$ + citric	1.27	7.56	1.28	7.62
30 kg N fed.$^{-1}$ + metha. + citr.	1.28	7.62	1.29	7.68
L.S.D. at 5%	0.02		0.02	

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استخدام بعض المواد العضوية رشا فى إنتاج محصول الأرز وتقليل التسميد بالنيتروجين المعدنى

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تتجه الأنظار نحو استخدام المواد العضوية كبدائل آمنة الاستخدام خاصة بعد الارتفاع الشديد لأسعار الأسمدة المعدنية والسعى إلى تقليل التلوث الناتج عن استخدامها.

لهذه الهدف أقيمت تجربتان حقليتان بمزرعة محطة البحوث الزراعية بسخا موسمى صيفى 2005م ، 2006م لدراسة تقييم استخدام بعض المركبات العضوية (حمض الستريك بتركيز 2000 جزء فى المليون وكحول الميثانول بتركيز 10%) مع استخدام ثلاث مستويات من النيتروجين المعدل الموصى به 60كجم ن/فدان ومعدلين 45 ، 30كجم ن/فدان وتم إضافة المواد العضوية رشا على نباتات الأرز.

أظهرت النتائج أن استخدام الرش بكلا من حمض الستريك وكحول الميثانول مع معدل 45كجم ن/فدان أعطت أعلى نتائج لمحصول الأرز ومكوناته.

- استخدام هذه المواد العضوية أدى إلى زيادة فى محتوى النبات من العناصر الغذائية النيتروجين والفوسفور والبوتاسيوم عند مرحلتى النمو (التفريع - قبيل طرد السنابل).
- أدى استخدام هذه المواد إلى زيادة محتوى الحبوب من النيتروجين وكذلك من البروتين.
- أدى استخدام هذه المواد إلى تقليل استخدام الأسمدة النيتروجينية المعدنية (اليوريا) حوالى 25% مما ينتج عند تقليل تلوث البيئة وتقليل تكاليف إنتاج محصول الأرز.