J. Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 5 (10): 1355 - 1361, 2014

IMPROVING NITROGEN USE EFFICIENCY FOR WHEAT YIELD PRODUCTION

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ABSTRACT

A field experiment was conducted at EL-Gemmeiza Experiments Station using wheat plant (Triticm aestivum L.) (v.gemmeiza 9) during two successive seasons (2011/2012) and (2012/2013) to evaluate the use efficiency of urea fertilizer mixed with humic acid (HA). The treatments as follows: T1) Control without addition, T2) Urea at 75 kg N fed^{-1}+ Humic Acid (2%), T3) Urea at 50 kg N fed^{-1} + Humic Acid (2%), T4) Urea at 75 kg N $fed^{-1}$and T5) Urea at 50 kg N fed^{-1}. Results are summarized as follows: Wheat yield (grain and straw) show a significant response to nitrogen application. The best treatment was urea mixed with humic acid compared with using urea alone. The highest value of yield was recorded with 75 kg N. fed^{-1} mixed with HA, followed by 50 kg N fed^{-1} with HA. These results proved that loss of nitrogen on form of ammonia is reduced when urea is mixed with an appropriate amount of HA. Therefore, using the same amount of nitrogen fertilizer mixed with humic acid ensure a substantial increase in wheat yield.

Keywords: Humic Acid, Coating, Wheat. Nitrogen Use Efficiency

INTRODUCTION

A recent study, the use of urea account for approximately 50% of the Egypt agricultural nitrogen consumption. For instance, unbalanced used of urea has created a global environmental issue such as ammonia volatilization and leaching. Thus a new approach is needed to reduce these losses through improving or increasing urea N use efficiency in agriculture. To manage the risk of ammonia loss, several studies have been done to alleviate this problem. Research has shown that one of the ways to enhance plant nitrogen use efficiency or urea is to mixed with humic acids which are known to have chemical properties such as high total acidity (Tan, 2003, Mayhewl, 2004 and Jones *et al* 2007)..David.et al,(1994) and Adani *et al* .(1998) added that, humate could give a direct effect to plant photosynthesis by increasing chlorophyll density and plant root respiration, and promote plant growth (Chen and Aviad1990). The role of (HA) in reducing ammonia losses by either leaching or volatilization, in addition to improving soil characteristics was studied by Bundy *et al* (1992). The main objective of this study is to investigate the effect of mixing HA with urea fertilizer on wheat yield (grain and straw) and their role on reducing N losses, and then increasing N efficiency.

MATERLALS AND METHODS

A field experiment was conducted at EL- Gemmeiza Agricultural Research Station, EL-Gharbiah Governorate, Egypt (middle delta region 30* 43 latitude and 31* 07 longitude) during the two successive winter season

(2011/2012) and (2012/2013) to study the effect of mixing urea fertilizer with humic acid on wheat growth, yield and some chemical constituents of wheat grains and nitrogen use efficiency. Some physical and chemical properties of the experimental soil are presented in Table (1).

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

Particle Size Distribution			Texture class	pH (1:2.5)	ECe (dSm^{-1})	OM. %	$CaCO_3$ %	Available macronutrients mg kg^{-1}		
Saud %	Silt %	Clay %						N	P	K
9.1	31.2	59.7	Clayey	7.9	2.21	1.59	3.84	22	7.9	240

The treatments as follows:

T1: Control without addition, T2: Urea at 75 kg N fed^{-1}+ Humic Acid (2%), T3: Urea at 50 kg N fed^{-1} + Humic Acid (2%), T4: Urea at 75 kg N fed^{-1} and T5: Urea at 50 kg N fed^{-1}

The experiment was designed in a complete randomized block design for urea and humic acid with three replicates and the plot area was 10.5m^2 (3 x 3.5m).

Wheat grains (Gemmeiza 9) was sown at November 15 and 17 in 2011 and 2012, respectively at a rate of 50 kg.fed^{-1} and all treatments were received the recommended doses of phosphorus (6.75kg P fed^{-1} as calcium super phosphate, (15.5% P_2O_5). Coating urea glue and leave to few minutes and then encapsulate with2% humic acid. The Nitrogen doses with or without humic acid were added in three equal doses, the first one was applied with seed planting whiles the others were added before the second and third irrigations. The surface irrigation system was used in this experiment and all cultural practices were done according to the usual methods for wheat production in the area.

Yield measurements:

The harvesting was done at May 5th and 7th 2012 and 2013 respectively. At maturity stage, one meter square from each treatment was taken to measure the plant biomass yield: grain yield (ardab fed^{-1}), straw yield (ton fed^{-1}). Straw and grain samples of each treatment were oven dried at 70°C until a constant weight, 0.2g of each sample was digested with concentrated H_2SO_4 and H_2O_2 to determine N, P and K. Total nitrogen (N%) in the digested was determined according to Page, (1982). Total phosphorus (P %) in straw and grain was determined colorimetrically according to the method described by Snell and Snell (1976). Total potassium (K%) in straw and grain was determined using flame photometer according to the method described by Jackson (1967). N use efficiency (NUE) was calculated as a grain yield per one kg of N added. N- Recovery % was calculated as a following equation according to Hardarson and Danso (1990):

N- Recovery % = (N_1- N_0 /N add) x 100

N_1= total nitrogen uptake for treatment (kg /fed),

N_0= total nitrogen uptake for control.

Data were statistically analyzed with split Plot Design according to Snedecor and Cochran (1967). The least significant difference (LSD) was used to compare the means.

RESULTS AND DISCUSSION

1- Grain yield

Data presented in Table (2) show that the treatment of 75 kg N fed^{-1} as urea mixed with 2% humic acid led to significant increases of wheat grain yield. This treatment had the highest mean value (28.02 ardab fed^{-1}), while the lowest mean values (23.20 ardab fed^{-1}) was obtained with the 50 kg N fed^{-1} as urea (without humic acid). The relative increase (over the yield of treatment without nitrogen fertilizer in grain yield were 54.98% and 45.66% for 75 kg N fed^{-1} and 50 kg N fed^{-1} +HA and. conventional urea, respectively. Where the relative increase over the yield of that without HA in grain yield was 11.97% and 13.52% for 75 and 50 Kg N Fed^{-1} mixed with 2% HA respectively. These results are consistent with the finding of Hou *et al.* (2006) who reported that combination of urea with urease inhibitors, thiophosphorictri amide and a nitrification inhibitor, dicyandiamide, significantly reduced urea hydrolysis and in turn increased grain yield of wheat by 27.8%.

Table 2: Effect of different rates of nitrogen fertilizer mixed with or without 2% of humic acid on yield of wheat plant

Treatment	yield		Relative increase in yield	
	grain(ard*.fed^{-1})	Straw(ton.fed^{-1})	grain	straw
Without N	18.08	2.62	——	——
75kg N+2%HA	28.03	2.94	54.98	12.32
50 kg N+2%HA	26.34	2.87	45.66	9.61
75 kg N	25.03	2.65	38.42	1.18
50 kg N	23.20	2.63	28.31	0.34
L.S.D 0.05	1.44	0.21	-	-

***Ardab = 150 kg grains**

Data recorded in this study represent the mean values of the two investigated seasons

2- Straw yield

The results obtained on straw yield of wheat (Table 2) revealed that the maximum straw yield of (2.94 ton fed^{-1}) was obtained in the treatment of 75 kg N fed^{-1} mixed with 2% humic acid. Regarding the straw yield of wheat as affected by the previous nitrogen fertilizer treatments, obtained data showed a significant difference between treatments (Table 2). The highest straw yield was obtained for the plants fertilizer with 75 and 50 kg N fed^{-1} mixed with 2% humic acid. The relative increase of straw yield over the straw yield of urea without humic acid was 11.01 and 9.24 % with 75 and 50 kg N fed^{-1} mixed with 2% humic acid, respectively.

The results showed that straw yield of wheat increased with increasing level of N. Furthermore, the straw yield of wheat was generally greater for

urea coating with humic acid than urea alone application. The previous results proved that humic acid, when mixed with urea increases sustainability in the following ways, by using the same amount of urea fertilizer. Humic acid ensures a substantial increase in grain and straw yield. These results are consistent with findings of Davaid et al. (1994), Adani et al. (1998) and Nasima et al. (2010) who reported that combination of urea with humic acid significantly reduced urea hydrolysis and in term increased wheat (grain and straw) yield.

3- Nitrogen uptake and N use efficiency

The data presented in Table (3) reveal that, the application of urea fertilizer mixing with humic acid increased the nitrogen uptake by plants as compared with that fertilized by urea only. The highest N uptake (79.39 Kg fed^{-1}) was obtained in treatment receiving 75 Kg N fed^{-1} mixed with 2% humic acid. On the other hand, the lowest value (56.94 Kg fed^{-1}) was obtained for the treatment of 50 Kg N fed^{-1}.

On the basis of N removal by plant the absorption rates of N fertilizer resulted from the followimg relation (Finck, 1982):

Absorption rate = N uptake (treatment) – N uptake (control) / amount of N applied

It was found that application of N fertilizer mixed with humic acid increase the absorption rate (N-recovery) (49.68 %) as compared with the control, as the absorption of N fertilizer was 56.05 and 52.68 for the treatments which received 75, 50 Kg N fed^{-1} mixed with 2% humic acid, while 50.06 and 46.41 for the treatments that 75 and 50Kg N fed^{-1} only, respectively.

Table 3: Effect of different rates of nitrogen fertilizer mixed with or without 2% of humic acid on nitrogen concentration, uptake and nitrogen use efficiency in wheat yield

Treatment	Total nitrogen %		N content (Kg.fed^{-1})		Total N uptake (Kg.fed^{-1})	N recovery %	N use efficiency
	grain	straw	grain	Straw			
Without N	1.07	0.50	29.02	13.11	42.13	-	-
75kg N+2%HA	1.37	0.74	57.60	21.79	79.39	49.68	56.05
50 kg N+2%HA	1.19	0.7	47.02	20.11	67.13	33.3	52.68
75 kg N	1.32	0.69	49.56	18.30	67.86	34.31	50.06
50 kg N	1.16	0.63	40.37	16.57	56.94	19.75	46.41
LSD 0.05	ns	ns	ns	ns			

Data recorded in this study represent the mean values of the two investigated seasons

Many investigators reported that the use of urea mixed with humic acid reduced N losses and increased N uptake and thus increased N use efficiency (Xu *et al.* 2002 and Zaman *et al.* 2009).

The results clearly showed that humic acid markedly increased the absorption rate of N fertilizer. These results are harmony with the results of Raun, *et al.* (1999); Cai, *et al.* (2002); Jones et al. (2007).

4- Total P and K in grain and straw

Data in Table (4) indicate the effect of application of urea at rate of 50 and 75 kg N fed^{-1} and urea mixed with humic acid on the concentration of P and K in grain and straw of wheat plant. The obtained data revealed that

significantly increases of P in grain and straw yield with urea at rate of 75 kg N mixed 2% humic acid. The highest mean P values; (0.381% and 0.077%) were recorded in grain and straw with 75 Kg N fed^{-1} mixed with 2 % humic acid treatment.

Also, data in Table (4), showed that urea mixed with humic acid treatments in grain and straw yield had the highest mean values (0.199% and 0.330%), respectively. While the lowest mean values was observed with urea fertilizer only.

Table 4: Effect of different rates of nitrogen fertilizer mixed with or without 2% of humic acid on P and K concentration in grain and straw of wheat yield

Treatment	P %		K %	
	grain	straw	grain	straw
Without N	0.29	0.03	0.13	0.24
75kg N+2%HA	0.38	0.08	0.20	0.33
50 kg N+2%HA	0.36	0.07	0.17	0.28
75 kg N	0.35	0.08	0.15	0.32
50 kg N	0.32	0.06	0.14	0.30
LSD 0.05	0.03	-	-	-

Data recorded in this study represent the mean values of the two investigated seasons

CONCLUSION

Liquid form of humic acid could play an important role in enhancing urea efficiency.

The amount or rate of humic molecules to enhance NH_4 recovery in soil which can indirectly promote plant growth needs detail investigation. Based on the results of this study, application of urea mixed with 2% humic acid could provide better urea use efficiency when urea is mixed with an appropriate amount of HA. On the other hand, presence of HA with urea alleviates the pressure on the producers and increases sustain ability in the fertilizing ways. By using the same amount of fertilizer ensure a substantial increase in yield, therefore reduces input costs and also a more environmentally friendly way to farm the land

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تحسين كفاءة استخدام الاسمدة النتروجينة لمحصول القمح

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اجريت تجربة حقلية بمحطة البحوث الزراعية بالجميزة خلال موسمين متاليين 2012/2011- 2013/2012 تم فيها زراعة محصول القمح صنف جميزة 9 وذلك لتقييم كفاءة استخدام التسميد النتروجينى باستخدام اليوريا واليوريا المخلوطة بحمض الهيومك بمعدل 2% وشملت الدراسة على خمس معاملات هى : بدون اضافة اسمدة نتروجينية, استخدام اليوريا بمعدل 75 كجم. فدان $^{-1}$ + 2% حمض هيومك اسد, استخدام اليوريا بمعدل 50 كجم. فدان $^{-1}$ + 2 % حمض هيومك, استخدام اليوريا بمعدل 75 كجم. فدان $^{-1}$, استخدام اليوريا بمعدل 50 كجم. فدان $^{-1}$. اوضحت النتائج استجابة محصول القمح (قش و حبوب) للتسميد النتروجينى استجابة معنوية, وان احسن معاملة كانت استخدام اليوريا بمعدل 75 كجم. فدان $^{-1}$ + 2% حمض هيومك بالمقارنة بباقى المعاملات وايضا اعطت نفس المعاملة اعلى انتاجية تلتها معاملة استخدام اليوريا بمعدل 50 كجم. فدان $^{-1}$ + 2% حمض هيومك. من هذة الدراسة يتضح ان معاملة اليوريا بحمض الهيومك يعمل على تقليل فقد النتروجين على صورة امونيا. لذلك يوصى باستخدام كمية النتروجن الموصى بها مخلوطة بحمض الهيومك مما يعمل تقليل فقد النتروجين وزيادة انتاجية محصول القمح.