*J. Agric. Sci. Mansoura Univ., 28(1): 641 - 648, 2003*

# THE EFFECT OF NITRIFICATION INHIBITOR (AM) ON GROWTH AND NITROGEN UPTAKE BY COTTON PLANT AND NITROGEN EFFICIENCY RATIO OF THE ADDED FERTILIZER.

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## ABSTRACT

To study the effect of the compound AM (2 amino-4 chloro-6-methyl pyrimidine) as an inhibitor of the nitrification process, a pot experiment was conducted in a greenhouse using a clay loam collected from Agric. Res. Center Farm at Giza. The added AM levels were 3, 6, 9 and 12% of fertilizer added to the soil as ammonium sulfate or urea. Cotton plants c.v.Giza79 up to 120 day age was used a test plants.

The obtained data could be summarized in the followings:-

Addition of AM in rates of 9 or 12% of the added fertilizer resulted in depression of plant growth and uptake. It may be due to an inhibition effect of nitrifying bacteria and also due to an adverse effect on root system. The level of 3% was found to be best treatment followed by 6% where nitrogen efficiency ratio (NER) increased by either ammonium sulfate or urea especially with 3% level of AM application.

Nitrification rate increased by time in the most treatments as affected with AM limitation of nitrogen release from the both used fertilizers. Generally, it could be recommended with application of AM in a rate corresponding of 3% of added ammonical or amide fertilizers to control the release of their nitrogen and thus increased NER.

**Keywords:** *Clay loam soil, Inhibitor AM, Ammonium sulfat, Urea, Cotton.*

## INTRODUCTION

Fertilizer N is not used efficiency in irrigation because much of the N applied is lost from the plant/soil system by emission of gaseous compounds to the atmosphere. Nitrogen may be emitted by ammonia volatilization, as nitrous oxide, nitric oxide and dinitrogen during nitrification, biological denitrification and chemodentrification. Nitrogen emitted to the atmosphere as ammonia may be returned to the biosphere and recycle thus adding to the nitrous oxide and nitric oxide burden in the atmosphere. Thus ammonia volatilization needs to be controlled as well as nitrification-denrfication to limit emission of nitrogen oxides.

Many approaches have been suggested for controlling losses of fertilizer N including optimal use of fertilizer from rate and method and application, matching N supply with demand, supplying fertilizer in the irrigation water, applying fertilizer to plant rather than the soil, and use of slow release fertilizers. While these techniques have the potential to increase the effectives of applied N none of then have a large impact on gaseous loss of N.

However, the results of recent works in tropical and temperate regions with flooded rice and irrigated cotton, wheat and maize show that use of N-fertilizers and nitrification inhibitors have the capacity to prevent loss of N and increase the yield of crops (Haulk and Koshino *et al.*, 1971; Freney *et al.*, 1992; Freney 1997 and Freney *et al.*,2000).

The aim of this work is to study the effect of the nitrification inhibitor AM(2-amino-4-chloro-6-methyl pyrimidine) on cotton growth, N-uptake and N use efficiency.

## MATERIALS AND METHODS

In a greenhouse experiment, cotton c.v. Giza 79 was grown in pots containing 5 kg of clay soil of the experimental farm of Agricultural Res. Center at Giza Governorate. Fertilizers were added pre sowing as the local recommendation. N addition was in two forms of fertilizers, ammonium sulfate (20.5% N) and urea (46.5% N) with or without the inhibitor AM (2-ammino-4-chloro-6-methyl pyrimidine) at levels 3, 6, 9 and 12% of added nitrogen fertilizers.

Pots were arranged in a randomized block design in 6 replicates. Two plants were left in each pot after thinning. Soil and plant samples after 60, 90 and 120 days from sowing were obtained. Plant samples were washed with distilled water and separated into leaves and stems, dried at 70 °C for 24hrs. weighted, ground and prepared for chemical analysis. Soil samples also air dried and prepared for physico-chemical analysis using the standard procedures according to Jackson (1973) and Piper (1950).

**Table (1): Physico-chemical analyses of soil under study.**

| Properties | | Properties | |
|---|---|---|---|
| Sand % | 19.36 | Available-N (ppm) | |
| Silt % | 34.98 | $NH_4$-N | 23.94 |
| Clay % | 45.66 | $NO_3$N | 8.22 |
| Texture | clay | Available –P (ppm) | 25 |
| pH (1:2.5) | 7.5 | Available- K (ppm) | 400 |
| organic matter % | 1.5 | | |
| $CaCO_3$ % | 2.5 | | |
| T.S.S % | 0.14 | | |

Total nitrogen in plant samples was determined by the Kjeidahl method in the perchloric-sulphoric acids digestion. Ammonium was determined by distillation using Parnas-Wagner apparatus in the presence of mixture of methyl red and methyl blue as indictor (Black, 1965). Nitrate was calculated from the difference between total nitrogen and the ammonia form. Available phosphorus was determined according Olesn *et al.*, (1954), while available potassium was determined flame photometrically after Black (1965).

## RESULTS AND DISCUSSION

Data in Table (2), show that the combined application of ammonium sulfate or urea with or without the nitrification inhibitor AM at rate 3%, sireously increased the dry matter yield of cotton plant after 60,90 and 120 days from sowing. For the rate 6% slight increases in the dry matter accumulation was yielded.

Table (2): Effect of different levels of AM with amm.sulfate or urea on the Wt. and N-uptake of cotton plants after 60, 90 and 120 days from sowing.

| Tret. No. | AM % | Days after sowing | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 60 | | 90 | | | | | | 120 | | | | | |
| | | Dry wt.of 2plant (g) | N-uptake mg/plant | Dry wt. of 2 plants(g) | | | N-uptake ( mg/plant) | | | Dry wt. of 2 plants(g) | | | N-uptake ( mg/plant) | | |
| | | | | leaves | stems | Total | leaves | stems | Total | leaves | stems | Total | Leaves | stems | Total |
| 1 | 0 | 3.0 | 35.2 | 3.3 | 4.6 | 7.5 | 90.5 | 131.3 | 321.8 | 2.5 | 4.6 | 7.10 | 59.3 | 97.7 | 157.0 |
| 2 | 3 | 5.4 | 59.5 | 4.0 | 7.9 | 11.9 | 130.8 | 201.2 | 332.0 | 3.3 | 8.6 | 11.9 | 75.9 | 92.9 | 168.8 |
| 3 | 6 | 5.2 | 48.1 | 3.5 | 6.8 | 10.3 | 85.6 | 177.2 | 262.8 | 2.9 | 7.9 | 10.8 | 71.5 | 97.2 | 168.7 |
| 4 | 9 | 3.6 | 46.0 | 3.3 | 6.2 | 9.5 | 120.4 | 132.3 | 252.7 | 4.3 | 6.1 | 10.4 | 69.2 | 89.2 | 158.4 |
| 5 | 12 | 3.2 | 33.4 | 2.3 | 5.2 | 7.5 | 67.7 | 102.4 | 170.1 | 1.2 | 8.9 | 10.1 | 71.6 | 87.3 | 158.9 |
| 6 | 0 | 3.2 | 46.5 | 4.1 | 5.2 | 9.3 | 90.6 | 130.8 | 221.4 | 3.6 | 8.1 | 11.7 | 115.5 | 132.8 | 247.3 |
| 7 | 3 | 4.3 | 65.4 | 4.7 | 8.9 | 13.6 | 171.0 | 189.5 | 360.5 | 4.8 | 8.2 | 13.0 | 128.0 | 175.2 | 303.2 |
| 8 | 6 | 5.4 | 50.8 | 3.6 | 7.6 | 11.2 | 91.1 | 150.1 | 241.2 | 3.3 | 8.9 | 12.6 | 106.4 | 179.4 | 285.8 |
| 9 | 9 | 4.2 | 44.2 | 3.6 | 4.9 | 8.5 | 87.2 | 141.2 | 228.4 | 3.6 | 8.1 | 11.7 | 84.9 | 176.6 | 267.5 |
| 10 | 12 | 2.5 | 31.8 | 2.5 | 2.8 | 5.7 | 97.7 | 125.7 | 223.4 | 2.0 | 7.8 | 9.8 | 103.5 | 145.0 | 248.5 |

AM = 2-amino-4 chloro-6-methyl pyrimidine.

On the contrary, the highest rates 6%, 9% and 12% commonly depressed the dry matter accumulation with both nitrogen fertilizers.

Regarding the nitrogen uptake, the aforesaid table reveal that using 3% Am with either ammonium sulfate or urea, gave the highest values of nitrogen uptake as compared to the other levels of AM, after 60,90 and 120days from sowing. While, the least content of nitrogen was found by using AM at 12% and that may be due to the more inhibition effect of AM on both nitrosomonas and nitrobacter bacteria,

It is significant to note, that both the total nitrogen content and dry matter accumulation decreased by increasing AM levels with ammonium sulfate or urea.

It's worthy to mention, that after 60,90 and 120 days from sowing N content in stems was higher than that of leaves but their content decreased by increasing rate of AM to over 6% with the two kinds of N fertilizers under investigation. The obtained data show that the N-uptake in both leaves and stems was lower at 120 days old than that found at 90 days old, and this may be due to the movement of N forms from stems and leaves to other plant organs. Similar results were found by many workers using various nitrification inhibitors on cotton plant eg. York and Tucer 1985; Reeves *et al.*, 1988; Rzaev and Ismailov,1991;Freney *et al.*,1992 Chen *et al.*,1994 and Rochoster *et al.*,1996 and 2000.

Concerning the nitrogen efficiency ratio (NER), Table (3) reveal that during the tested period 60 days after sowing, a slight differences were resulted between its values when AM was used at 3 and 6% with ammonium sulfate and urea. But these values were higher than all treatments.

Briefly, the highest levels of AM (9 and 12% of the added nitrogen) depressed the rate of plant growth and consequently N uptake. Hauck and Koshino(1971) referred that using 3% of AM mixed with urea gave the best resuits on cotton plant growth. The former tabie shows that NER of stems was higher than that of leaves. This results was in agreement with that obtained by Sullivan *et al.*,(1974).

**Table (3): The effect of AM as nitrification inhibitor with the amm.sulfate or urea on the nitrogen efficiency of the 60,90 and 120 days from sowing.**

| Treat. No. | AM % | Days after sowing | | | | |
|---|---|---|---|---|---|---|
| | | 60 | 90 | | 120 | |
| | | Whole plant | Leaves | Stems | Leaves | Stems |
| 1 | 0 | 36.82 | 25.89 | 50.30 | 32.37 | 50.29 |
| 2 | 3 | 45.63 | 29.68 | 41.62 | 39.36 | 134.14 |
| 3 | 6 | 44.05 | 30.38 | 44.16 | 35.50 | 113.17 |
| 4 | 9 | 42.04 | 25.50 | 50.30 | 32.33 | 113.17 |
| 5 | 12 | 41.16 | 23.84 | 50.30 | 29.68 | 63.53 |
| 6 | 0 | 35.57 | 24.64 | 47.04 | 29.68 | 47.03 |
| 7 | 3 | 47.04 | 29.68 | 56.31 | 28.52 | 104.66 |
| 8 | 6 | 44.04 | 28.43 | 50.31 | 33.84 | 97.88 |
| 9 | 9 | 39.40 | 27.00 | 50.31 | 33.84 | 50.44 |
| 10 | 12 | 39.37 | 27.34 | 47.04 | 32.33 | 44.16 |

AM = 2-amino-4 chloro-6-methyl pyrimidine.

Table (4) illustrate that the nitrification inhibitor AM caused a slow release of nitrogen from both ammonium sulfate and urea. Moreover, the aforementioned data show that N content, in soil under study, in the $NH_4$-N form was higher than that in the $NH_3$-N form after 60,90 and 120 days from sowing. Comparing the $NH_3$-N form in soil during the study period, it was higher at 60 days than that at 90 or 120 days plant old, whichever the inhibitor level.

Generally, it may be concluded that conventional nitrogen fertilizers such as ammonium sulfate or urea can be used as controlled release nitrogen inhibitor AM by mixing them with nitrification inhibitor AM at the rate 3% of added nitrogen fertilizers. Hauck and Koshino (1971) on cotton plant confirmed the former result. Freney *et al.*, (1992) found that the application of 2-ethylpyridine with urea to cotton plant increased the N-recovery in the soil/plant system. Chen *et al.*, (1994) on cotton plants studied the effect of nitrapyrin as nitrification inhibitor on N transformations and dentrification losses following pressowing application of urea. They reported that N-loss from pre sowing application of urea can be significantly reduced by the use of nitrification inhibitors.

Finally, the bresent work are in agreement with data obtained by numerous workers used nitrification inhibitors to prevent loss of N and increase rowth and yield of cotton plants, e.g. Iruthayaraj, 1981, York and Tueker, 1985 ;Rzeav and Ismailov,1991; Geethalkshmi *et al.*,1998.

Table (4): Nitrogen forms in soil samples as mg N/100g soil taken at different periods from plots grown with cotton plants under 4 levels of AM inhibitor.

| Tret. No. | Fert. | AM % | Days after sowing | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 60 | | | 90 | | | 120 | | |
| | | | $NH_4$-N | $NO_3$-N | N.E | $NH_4$-N | $NO_3$-N | N.E | $NH_4$-N | $NO_3$-N | N.E |
| 1 | AS | 3 | 23.24 | 1.98 | 0.079 | 27.44 | 1.96 | 0.067 | 28.28 | 5.25 | 0.082 |
| 2 | U | 3 | 28.84 | 2.80 | 0.086 | 23.44 | 5.60 | 0.194 | 27.44 | 4.20 | 0.133 |
| 3 | AS | 6 | 30.24 | 2.40 | 0.073 | 27.44 | 1.40 | 0.045 | 27.44 | 0.60 | 0.021 |
| 4 | U | 6 | 20.44 | 1.40 | 0.064 | 31.64 | 2.60 | 0.076 | 23.24 | 4.20 | 0.181 |
| 5 | AS | 9 | 23.24 | 2.00 | 0.079 | 27.44 | 1.40 | 0.045 | 23.24 | 3.40 | 0.128 |
| 6 | U | 9 | 24.64 | 1.97 | 0.074 | 27.44 | 2.80 | 0.093 | 26.04 | 6.82 | 0.208 |
| 7 | AS | 12 | 28.84 | 1.80 | 0.059 | 26.84 | 0.20 | 0.007 | 26.04 | 3.40 | 0.116 |
| 8 | U | 12 | 19.88 | 2.92 | 0.128 | 24.64 | 8.22 | 0.250 | 23.24 | 2.80 | 0.102 |
| 9 | AS | - | 30.24 | 7.00 | 0.217 | 26.04 | 3.02 | 0.104 | 23.24 | 2.04 | 0.881 |
| 10 | U | - | 21.84 | 1.40 | 0.060 | 23.24 | 8.40 | 0.266 | 24.64 | 2.80 | 0.102 |

**Notetes:** **AM = 2-amino-4 ch loro-6-methyl pyrimidine.**
**N.E. = $NO_3$- N / ($NH_4$+ $NO_3$)-N**
**AS= ammonium sulfate**
**U = Urea.**

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## تأثير مثبط التحول لنترات (AM ) على نمو وامتصاص النيتروجين بنباتات القطن ونسبة الكفاءة النيتروجينية للسماد المضاف.

**حسب النبى أحمد مدكور**

**معهد بحوث الاراضى والمياه والبيئة- مركز البحوث الزراعية - الجيزة - مصر**

لدراسة أثر المركب (AM ) ( ٢ أمينو-٤ كلورو-٦-ميثايل بريميدين) كمثبط لعملية التحول لنترات أجريت تجربة أصص بالصوبة باستعمال أرض طمية طينية من مزرعة مركز البحوث الزراعية بالجيزة، وكانت المعدلات المضافة من المركب(AM ) تعادل ٣،٦،٩،١٢% من كمية السماد النتروجينى المضاف (كبريتات النشادر أو اليوريا)، وقد زرع القطن صنف جيزة ٧٩ واستمر نموة حتى ١٢٠ يوما كنباتات اختبار.

ويمكن تلخيص النتائج المتحصل عليها فى الاتى:

نتج عن اضافة معدل ٩ أو ١٢% من السماد النتروجينى المضاف تثبيط فى نمو النبات وكمية النتروجين التى امتصها وقد يرجع ذلك للاثر المثبط على البكتيريا المحولة لنترات وكذلك لاثرة العكسى على النظام الجذرى للنباتات.

وقد وجد أن معدل ٣% من المركب (AM ) هو أفضل المعاملات يلية معدل ٦% حيث زادت نسبة الكفاءة النتروجينية لاى من كبريتات النشادر أو اليوريا خاصة عند معدل اضافة ٣% من المركب(AM) .

هذا وقد زاد مع الوقت معدل عملية التحول لنترات فى معظم المعاملات بفعل تأثير المركب (AM ) المحدد لانطلاق النيتروجين لكلا السمادين المستعملين.

عموما يمكن التوصية باضافة المركب (AM ) بمعدل يعادل ٣% من كمية السماد النيتروجينى المضاف فى صورة نشادرية أو أميدية لضبط انطلاق النيتروجين منها وبالتالى زيادة نسبة الكفاءة النتروجينية.