Improving Nitrogen Utilization Efficiency by Potato (*Solanum tuberosum* L.)

A. Influence of Nitrification Inhibitors in Combination with Different Nitrogen Sources on Reducing Nitrogen Losses, Improving Productivity and Chemical Composition

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**ABSTRACT:** Two field experiments were conducted at Baramo Research Station, Mansoura, Dakahlia Governorate, Egypt (+7m altitude, 30°11’ latitude and 28°26’ longitude), during Nili seasons of 2007/08 and 2008/09, to study the effect of soluble-N (ammonium nitrate; AN, ammonium sulphate; AS and urea; U) and/or slow-N (compost and nitroform) fertilizers with or without nitrification inhibitor (guanylthiourea, GTU) on reducing nitrogen loss, productivity, and chemical composition of potato cv. Cara. The obtained results indicate that GTU with compost 50% and AS 50% led to significant increases in all traits, except NO3-N and NO2-N accumulation, which was significantly decreased in potato tubers. Application of compost 50% and AS 50% with GTU had significant effect of most vegetative growth, quality, yield parameters and chemical composition of potato tubers in both season of the investigation. This treatment led to significant increase in plant height, plant dry weight, total and marketable of tuber yield and significant decrease in unmarketable tuber yield in both season of study. Application of compost 50%, and AS 50% with GTU gave rise to a significant increase in tuber dry matter, starch and specific gravity and decrease nitrate and nitrite content in tubers in comparison with other treatments. The NPK uptake of potato tubers and nitrogen efficiency ratio in treatment amended with compost 50%, + AS 50%, and GTU was higher than the other treatments in two seasons. The highest value of residual NH4-N in soil was obtained from compost treatment alone followed by nitroform, whereas, AN gave the highest residual NO3-N compared with other treatments, in both seasons of study. It could be concluded that, application of nitrogen fertilizer in the form compost at the rate of 9 ton fed-1 and ammonium sulphate at the rate of 90 kg fed-1 with GTU (nitrification inhibitor) in potato fields were the most effective treatment for improving nitrogen use efficiency with reducing the pollution of environment.


**Key words:** potato; nitrogen; nitrification inhibitors; guanylthiourea

**INTRODUCTION**

Modern agricultural practices require a new concept of N-fertilizer management in order to optimize N-utilization and avoid N-losses. Nitrification inhibitors or "N-stabilizers" fit very well into this conception.

Nitrification inhibitors are compounds that delay bacterial oxidation of the ammonium-ion (NH4+) by depressing over a certain period of time the activities of *Nitrosomonas* bacteria in the soil. They are responsible for the transformation of ammonium into nitrite (NO2-) which is further changed into nitrate (NO3-) by *Nitrobacter* and *Nitrosolobus* bacteria. The objective of using nitrification inhibitors is, therefore, to control leaching of nitrate by keeping nitrogen in the ammonia form longer, to prevent denitrification of nitrate-N and to increase the efficiency of nitrogen applied (Trenkel, 1997).

Nitrification inhibitors may reduce loss of fertilizer N from the root zone by reducing leaching and denitrification. This reduced N loss should be reflected in increased crop yields (Martin, *et al.*, 1993).

Guanylthiourea (GTU) is an efficient nitrification inhibitor and blocks the first step of nitrification for 1–3 months (depending on temperature). GTU is a non-toxic, water soluble compound and will be degraded to CO2, NH3 and H2O without any residues. There are various possibilities to use GTU: addition to liquid manure temporarily prevents oxidation of ammonium nitrogen e.g. of slurry or waste water from potato starch production (Amberger and Germann-Bauer, 1990).

Several studies emphasized that treating ammonium fertilizers and organic manure with nitrification inhibitors helped in delaying nitrification of ammonium based fertilizers. By
inhibitor and the combined urease plus nitrification pot experiment, and the application of the urease to 0.16% to 0.27% of the total fertilization, than in the cauliflower +2.3 t ha$^{-1}$, maize +0.24 t ha$^{-1}$, wheat +0.24 t ha$^{-1}$, which increase the mean crop yield (grain yield: winter Pasda of various agricultural and horticultural crops, dimethylpyrazole phosphate) on yield and quality the new nitrification inhibitor DMPP (3,4-oxo-dimethylpyrimidine) to order to assess the effects of N-fertilizers with grown in a sandy field. 

Dachler (1993) found that potatoes showed clear positive effects in yield, tuber size and starch-yield and economically higher proceeds with the use of ammonium-sulfate-nitrate (ASN) + nitrification inhibitor (DCD) compared with ammonium-nitrate-lime (ANL) with or without DCD. Amberger (1989) mentioned that nitrification inhibitor, dicyandiamide (DCD), reduced nitrate leaching and increased yields and N uptake of potato plants.

Shoji et al. (2001) found that use of controlled release fertilizer (polyolefin coated urea) and/or nitrification inhibitor (dicyandiamide) to conserve air and water quality are basically due to maximizing nitrogen use efficiency (NUE), reducing the N fertilization rate and gave maximum tuber yields under center-pivot irrigated potato grown in a sandy field.

In field trials were conducted under various soil-climatic conditions in west and south Europe, in order to assess the effects of N-fertilizers with the new nitrification inhibitor DMPP (3,4-dimethylpyrazole phosphate) on yield and quality of various agricultural and horticultural crops, Pasda et al. (2002) showed that DMPP may increase the mean crop yield (grain yield: winter wheat +0.24 t ha$^{-1}$, wetland rice +0.43 t ha$^{-1}$; grain maize +0.24 t ha$^{-1}$; tuber yield: potatoes +1.9 t ha$^{-1}$, corrected sugar yield: sugar beets +0.24 t ha$^{-1}$; biomass: carrots +1.9 t ha$^{-1}$; lettuce +2.6 t ha$^{-1}$, onions +1.0 t ha$^{-1}$, radish +4.6 t ha$^{-1}$, cauliflower +2.3 t ha$^{-1}$; leek +3.1 t ha$^{-1}$, and celeriac +1.9 t ha$^{-1}$). Valleejo et al. (2006) reported that nitrification inhibitor dicyandiamide (DCD) inhibited nitrification rates and reduced N$_2$O and NO emissions from pig slurry by at least 83% and 77%, respectively. Similar finding were reported by Watanabe (2006). In the wheat growth experiment, Khalil et al. (2009) reported that the N$_2$O losses were generally smaller, ranging from 0.16% to 0.27% of the total fertilization, than in the pot experiment, and the application of the urease inhibitor and the combined urease plus nitrification inhibitors decreased N$_2$O emissions by 23% to 59%.

The objective of this study was to estimate the productivity, quality and chemical composition of potato fertilized with different sources of N-fertilizers in sole or combined applications with or without nitrification inhibitor. It was also aimed to reduce nitrogen loss in soil and nitrate and nitrite contents in potato tubers.

**MATERIALS AND METHODS**

Two field experiments were carried out at Baramoon Research Station, Mansoura, Dakahlia Governorate, Egypt (+ 7m altitude, 30° 11’ latitude and 28° 26’ longitude), during two successive winter growing seasons of 2007/08 and 2008/09. Potato (Solanum tuberosum L.) Cara cultivar was used in this study. Seed tubers were planted on 15$^{th}$ of October in both seasons of study. Plot area was 11.25 m$^2$; consisted of 3 ridges; 5 m long; 75 cm wide, and 25 cm apart. The experimental soil was analyzed, using the methods described by Page et al. (1982), for the physical and chemical properties and the obtained data are shown in Table (1).

The following treatments have been tested:

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Description</th>
<th>Rate of N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Ammonium sulphate (20.5% N) (AS)</td>
<td>Ammonium nitrate (33.5%) (AN) (U)</td>
<td>15.5%</td>
</tr>
<tr>
<td>(2) ammonium nitrate (33.5%) (AN) (U)</td>
<td>Urea (46.0% N) (U)</td>
<td>20.5%</td>
</tr>
<tr>
<td>(3) Urea (46.0% N) (U)</td>
<td>AS + Guanythiourea (GTU)</td>
<td>33.5%</td>
</tr>
<tr>
<td>(4) AS + Guanythiourea (GTU)</td>
<td>AN + GTU, (U)</td>
<td>50%</td>
</tr>
<tr>
<td>(5) AN + GTU, (U)</td>
<td>Urea + GTU, (U)</td>
<td>50%</td>
</tr>
<tr>
<td>(6) Urea + GTU, (U)</td>
<td>AS + GTU, (U)</td>
<td>50%</td>
</tr>
<tr>
<td>(7) AS + GTU, (U)</td>
<td>AS + urea + GTU</td>
<td>50%</td>
</tr>
<tr>
<td>(8) AS + urea + GTU</td>
<td>Nitroform (38% N)</td>
<td>38%</td>
</tr>
<tr>
<td>(9) Nitroform (38% N)</td>
<td>(10) Compost (1.2%)</td>
<td>27%</td>
</tr>
<tr>
<td>(10) Compost (1.2%)</td>
<td>(11) Compost + AS + GTU</td>
<td>50%</td>
</tr>
<tr>
<td>(11) Compost + AS + GTU</td>
<td>(12) Compost + AN + GTU</td>
<td>50%</td>
</tr>
</tbody>
</table>
| (12) Compost + AN + GTU                                                    | Ammonium nitrate, ammonium nitrate, and urea were used as a soluble N-fertilizer, while, compost and nitroform were used as a slow release N-fertilizers.

The slow release-N was added to experimental soil before planting, whereas, soluble form of fertilizers was added at two equal doses, i.e. the first after emergence, and second dose was applied with 2nd irrigation. Single superphosphate (15.5% P$_2$O$_5$) was applied before planting at the rate of 75 kg P$_2$O$_5$ fed$^{-1}$. Potassium sulphate (48% K$_2$O) was used as a source of potassium at the rate of 96 kg K$_2$O fed$^{-1}$ and was added in two equal doses with the 2nd and 3rd irrigation. Other agricultural practices were conducted according to recommendations.
pH: (1: 2.5 soil extract).

seasons of study. On the other hand, application of
applied in comparison to other treatments, in both
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the amount of nitrogen in kg fed
and element percentage in tubers) were determined
accumulation in tubers (based on tuber dry weight
1990). Nitrogen, phosphorus and potassium
gravity, starch, and nitrate and nitrite content)
according to the methods described by (AOAC,
parameters: 1. Vegetative growth and tuber yield
parameters. In general the presence of nitrification
inhibitor tended to increases in all studied
parameters. Such result could be explained on the
basis the efficiency of this material in decreasing
nitrification of nitrogen, either added or produced
through mineralization of organic compounds, and
thus minimize its loss by leaching or volatilization
(Amberger and Germann-Bauer, 1990; Martin,
et al., 1993; Vallejo et al., 2006; Watanabe, 2006).
These results are in agreement with those reported
by Pasda et al. (2002) who showed that use of
nitrification inhibitor increase the tuber yield of
potatoes by 1.9 t ha⁻¹.

2. Tuber quality characters:
Tuber quality as affected by N-source and
nitrification inhibitor is given in Table 3. Results
reveal that the application of GTU associated with
AS 50%, or AN 50%, or compost 50% caused
significant increase in tuber dry matter, specific
gravity and starch content in tuber. In contrast,
NO₃⁻ and NO₂⁻ accumulation was markedly
decreased. These results were true in both seasons.
The pronounced positive effect on potato
tuber quality may be attributed to decreasing
N-losses (delaying the nitrification process) and
increasing the N-use efficiency with nitrification
inhibitor (Laskshmanan and Prasad, 2004; Di and
Cameron, 2004), and consequently, increase the
plant chance to absorb nitrogen and other nutrients
(Table 4), thereby, produce good quality, especially
where soils are poor in nitrogen and organic matter
(Table 1). The negative effect of GTU associated
with AS 50%, or compost 50% on NO₃⁻ and NO₂⁻
accumulation may be attributed to the role of GTU
and compost in reducing NO₃⁻ concentration in soil,

Table 1: The main physical and chemical properties of the experimental site during the two growing seasons.

<table>
<thead>
<tr>
<th>Some Physical Properties</th>
<th>Values</th>
<th>Some Chemical Properties</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st season</td>
<td>2nd season</td>
<td></td>
</tr>
<tr>
<td>Sand (%)</td>
<td>28.1</td>
<td>27.9</td>
<td>pH* value</td>
</tr>
<tr>
<td>Silt (%)</td>
<td>31.8</td>
<td>31.6</td>
<td>EC dSm⁻¹</td>
</tr>
<tr>
<td>Clay (%)</td>
<td>40.1</td>
<td>40.5</td>
<td>Total N (%)</td>
</tr>
<tr>
<td>Texture class</td>
<td>Clay-loam</td>
<td>Clay-loam</td>
<td>Available N (ppm)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NO₂⁻N</td>
</tr>
<tr>
<td>CaCO₃ (%)</td>
<td>3.2</td>
<td>3.0</td>
<td>NO₃⁻N</td>
</tr>
<tr>
<td>Organic matter (%)</td>
<td>1.8</td>
<td>1.6</td>
<td>Available P (ppm)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Available K (ppm)</td>
</tr>
</tbody>
</table>

*pH: (1: 2.5 soil extract).

At 70 days after planting (DAP), a random
sample of four plants was taken from each
experimental unit to determine the growth
parameters of potato plants (plant height and dry
weight/plant). At the harvesting time (130 DAP),
the total tuber yield, marketable and unmarketable
yield per feddan was recorded. A representative
sample of 10 to 15 healthy tubers from each
experimental plot was selected from the largest
sizes to obtain quality data (dry matter, specific
plant height and dry weight/plant). At the harvesting
time (130 DAP), a sole of slow or soluble
fertilizers did not materially increase the
parameters. In general the presence of nitrification
inhibitor tended to increases in all studied
parameters. Such result could be explained on the
basis the efficiency of this material in decreasing
nitrification of nitrogen, either added or produced
through mineralization of organic compounds, and
thus minimize its loss by leaching or volatilization
(Amberger and Germann-Bauer, 1990; Martin,
et al., 1993; Vallejo et al., 2006; Watanabe, 2006).
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where soils are poor in nitrogen and organic matter
(Table 1). The negative effect of GTU associated
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accumulation may be attributed to the role of GTU
and compost in reducing NO₃⁻ concentration in soil,
subsequently, gives the chance for plant to absorb more NH$_4^+$-N, thereby reduced NO$_3^-$ accumulation in plant (Bakr and Gawish, 1997).

Table 2: Vegetative growth and tuber yield characters of potato as affected by nitrogen sources and nitrification inhibitors in 2007/08 and 2008/09 seasons.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Plant height (cm)</th>
<th>Dry weight/plant (g)</th>
<th>Tuber yield (ton fed$^*$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>47.33g</td>
<td>47.00de</td>
<td>35.71de</td>
</tr>
<tr>
<td>T2</td>
<td>48.17efg</td>
<td>49.00e</td>
<td>34.18 f</td>
</tr>
<tr>
<td>T3</td>
<td>46.33 gh</td>
<td>52.00 a</td>
<td>30.72 h</td>
</tr>
<tr>
<td>T4</td>
<td>50.55 cde</td>
<td>46.00 ef</td>
<td>36.78 d</td>
</tr>
<tr>
<td>T5</td>
<td>49.33 def</td>
<td>46.33 f</td>
<td>35.00 ef</td>
</tr>
<tr>
<td>T6</td>
<td>46.00 h</td>
<td>43.00 g</td>
<td>28.65 i</td>
</tr>
<tr>
<td>T7</td>
<td>51.33bcd</td>
<td>50.00bc</td>
<td>38.76 c</td>
</tr>
<tr>
<td>T8</td>
<td>45.33 h</td>
<td>45.00 f</td>
<td>32.40 g</td>
</tr>
<tr>
<td>T9</td>
<td>49.00 ef</td>
<td>48.67cd</td>
<td>31.42 f</td>
</tr>
<tr>
<td>T10</td>
<td>51.67abc</td>
<td>45.67 ef</td>
<td>32.28 g</td>
</tr>
<tr>
<td>T11</td>
<td>53.67 a</td>
<td>52.00 a</td>
<td>42.40 a</td>
</tr>
<tr>
<td>T12</td>
<td>52.67ab</td>
<td>51.00ab</td>
<td>40.08 b</td>
</tr>
</tbody>
</table>

Table 3: Tuber quality characters of potato as affected by nitrogen sources and nitrification inhibitors in 2007/08 and 2008/09 seasons.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Tuber dry matter (%)</th>
<th>Specific gravity of tuber</th>
<th>Starch (%)</th>
<th>Nitrate accumulation (ppm)</th>
<th>Nitrite accumulation (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>21.41 ef</td>
<td>21.48 bcd</td>
<td>1.082d</td>
<td>1.085e</td>
<td>14.16 ced</td>
</tr>
<tr>
<td>T2</td>
<td>21.14 fg</td>
<td>22.08 abc</td>
<td>1.081d</td>
<td>1.084f</td>
<td>14.00 de</td>
</tr>
<tr>
<td>T3</td>
<td>20.96 g</td>
<td>20.82 cde</td>
<td>1.079ef</td>
<td>1.083 g</td>
<td>13.66 ef</td>
</tr>
<tr>
<td>T4</td>
<td>22.08 cd</td>
<td>21.47 bcd</td>
<td>1.087 b</td>
<td>1.092 c</td>
<td>14.35 ced</td>
</tr>
<tr>
<td>T5</td>
<td>21.99 e</td>
<td>21.08 b-e</td>
<td>1.085bc</td>
<td>1.089 d</td>
<td>14.26 ced</td>
</tr>
<tr>
<td>T6</td>
<td>20.88 g</td>
<td>20.53 de</td>
<td>1.078 f</td>
<td>1.081 h</td>
<td>13.40 c</td>
</tr>
<tr>
<td>T7</td>
<td>22.32 bc</td>
<td>21.82 abc</td>
<td>1.087 b</td>
<td>1.0972i</td>
<td>14.52 bc</td>
</tr>
<tr>
<td>T8</td>
<td>20.14 h</td>
<td>19.89 e</td>
<td>1.077 f</td>
<td>1.0782i</td>
<td>12.94 g</td>
</tr>
<tr>
<td>T9</td>
<td>21.62 d</td>
<td>21.64 a-d</td>
<td>1.083cd</td>
<td>1.086e</td>
<td>12.90 g</td>
</tr>
<tr>
<td>T10</td>
<td>22.22 c</td>
<td>22.10abc</td>
<td>1.088 b</td>
<td>1.096 b</td>
<td>14.82 b</td>
</tr>
<tr>
<td>T11</td>
<td>22.93 a</td>
<td>22.84 a</td>
<td>1.097 a</td>
<td>1.098 a</td>
<td>15.78 a</td>
</tr>
<tr>
<td>T12</td>
<td>55.83 ab</td>
<td>22.32 ab</td>
<td>1.095 a</td>
<td>1.095 a</td>
<td>15.40 a</td>
</tr>
</tbody>
</table>

Means followed by the same letter (s) within each column do not significantly differred using Duncan’s Multiple Range Test at the level of 5%.

Table 3: Tuber quality characters of potato as affected by nitrogen sources and nitrification inhibitors in 2007/08 and 2008/09 seasons.

3. Chemical composition and nitrogen efficiency ratio:

Data presented in Table 4 show that, the differences in means of N, P and K-uptake as well as nitrogen efficiency ratio due to various application sources and/or nitrification inhibitor were differed significantly, in both season of study. The highest values of these traits were obtained from potato plants receiving Compost $50\% + AS_50\% + GTU$, while the lowest values were recorded with sole soluble form of nitrogen (AS or AN). The positive effect of GTU on N, P and K-uptake may be due to the efficiency of nitrification inhibitor in keeping nitrogen for longer time in the form of NH$_4^+$ which helps in modification of nutrient uptake by plant (Laskshmanan and Prasad, 2004; Di and Cameron, 2004). Moreover, Tisdale et al. (1985) reported that the addition of nitrogen in combination with adequate phosphorus tended to have a positive effect on N, P and K-uptake.

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increase K-uptake by plants. They added also that, potassium concentration may be as high in the NH$_4^+$-nourished plants as it absorbed by soil colloids, so, it does not leach out of soil and still reliable for plants, generally such case may give the plant amore chance for absorbing N, and consequently, the other nutrients for building dry matter. Shoji et al. (2001) discussed that contributions of controlled-release fertilizer and nitrification inhibitor to conserve air and water quality are basically due to maximizing NUE and reducing the N fertilization rate.

Table 4: Chemical composition of potato tuber and nitrogen efficiency ratio as affected by nitrogen sources and nitrification inhibitors in 2007/08 and 2008/09 seasons.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>N-uptake (mg/plant tuber)</th>
<th>P-uptake (mg/plant tuber)</th>
<th>K-uptake (mg/plant tuber)</th>
<th>Nitrogen efficiency ratio (NER)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>4312.48 ef</td>
<td>4122.88 e</td>
<td>375.12 e</td>
<td>4486.02 ef</td>
</tr>
<tr>
<td>T2</td>
<td>4354.22 ef</td>
<td>3518.78 f</td>
<td>309.01 e</td>
<td>452.23 f</td>
</tr>
<tr>
<td>T3</td>
<td>3437.70 h</td>
<td>2701.42 h</td>
<td>312.65 e</td>
<td>372.65 h</td>
</tr>
<tr>
<td>T4</td>
<td>4826.16 cd</td>
<td>4523.27 d</td>
<td>494.80 d</td>
<td>504.20 e</td>
</tr>
<tr>
<td>T5</td>
<td>4587.23 de</td>
<td>4307.34 e</td>
<td>478.96 d</td>
<td>490.96 e</td>
</tr>
<tr>
<td>T6</td>
<td>3961.12 fg</td>
<td>3342.56 fg</td>
<td>359.47 e</td>
<td>420.73 g</td>
</tr>
<tr>
<td>T7</td>
<td>4924.64 cd</td>
<td>4892.04 c</td>
<td>615.42 b</td>
<td>602.23 c</td>
</tr>
<tr>
<td>T8</td>
<td>3629.20 gh</td>
<td>3172.36 g</td>
<td>336.99 e</td>
<td>398.10 gh</td>
</tr>
<tr>
<td>T9</td>
<td>4875.82 cd</td>
<td>4712.21 cd</td>
<td>540.49 cd</td>
<td>540.28 d</td>
</tr>
<tr>
<td>T10</td>
<td>5176.46 bc</td>
<td>4900.32 c</td>
<td>597.32 bc</td>
<td>680.04 a</td>
</tr>
<tr>
<td>T11</td>
<td>5765.08 a</td>
<td>5369.28 a</td>
<td>710.37 a</td>
<td>642.16 b</td>
</tr>
<tr>
<td>T12</td>
<td>5432.15 ab</td>
<td>5115.50 b</td>
<td>650.54 ab</td>
<td>580.47 c</td>
</tr>
</tbody>
</table>

Means followed by the same letter (s) within each column do not significantly differed using Duncan's Multiple Range Test at the level of 5%. T1: AS 20.5% N; T2: AN 33.5% N; T3: Urea 46.0% N; T4: AS + GTU; T5: AN + GTU; T6: Urea + GTU; T7: AS$_{50\%}$ + AN$_{50\%}$ + GTU; T8: AS$_{50\%}$ + Urea$_{50\%}$ + GTU; T9: Nitroform$_{38\%}$ N; T10: Compost$_{1.2\%}$ N; T11: Compost$_{50\%}$ + AS$_{50\%}$ + GTU, and T12: Compost$_{50\%}$ + AN$_{50\%}$ + GTU.

AS: Ammonium sulphate; AN: Ammonium nitrate; GTU: Guanylthiourea (nitrification inhibitors).

4. Residual NH$_4$ and NO$_3$ in soil:

Concerning the residual ammonium and nitrate nitrogen in soil after plants harvesting. Data in Figures 1&2 indicate the highest residual available of NH$_4^+-$N was obtained in the treatment of compost and nitroform, while, a soluble form of AN or U gave the highest residual NO$_3^-$N compared with other treatments, in both seasons of study. NO$_3^-$N leaching loss decreased in the leachates with Compost, Compost$_{50\%}$ + AS$_{50\%}$ or AN 50$_{hs}$ + GTU compared to soluble form of nitrogen. In the case of compost combined with GTU or nitroform treatment increase yield of NH$_4^+-$N and a reduction in NO$_3^-$N compared with the amount of NH$_4^+-$N formed from other treatments. This result may be attributed to the effect of GTU or Compost or coated fertilizer on delaying the release of nitrogen as indicated by Vallejo et al. (2006) and Khalil et al. (2009). The application of GTU as a nitrification inhibitor regulate the release of NH$_4^+$-$N out of compost treatments and it can also retard the nitrification process which produce NH$_3^-$N in that easily leachable (Dahadouh, et al. 2004).
Fig. 1: Residual NH$_4$-N in soil at harvesting as affected by nitrogen sources and nitrification inhibitors in 2007/08 and 2008/09 seasons.

Fig. 2: Residual NO$_3$-N in soil at harvesting as affected by nitrogen sources and nitrification inhibitors in 2007/08 and 2008/09 seasons.

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Date of submission 05/03/2011
تحدث أكمة بيولوجية للأمونيا NH₄⁺ (المضافة للتربة) من خلال التسميد الاصطناعي أو نتيجة تحلل المادة العضوية في ترشيحات من خلال عملية النتروجينية، والتي تقوم بها بكتيريا مخصصة، ولها نفس من المتضمن استخدام أي تربة يؤدي إلى تأخير عملية النتروجينية وبالتالي تقليل فقد النتروجين في صورة ترشيحات من خلال عملية الرش.

هذا البحث قائم على استخدام الأسمدة النتروجينية عن طريق استخدام مثبتات النتروجين والتحلل، وتأثير ذلك على تقليل فقد النتروجين وتقليل التركيب الكيميائي في النباتات في صف الكرات، كما يهدف إلى تقليل الأسمدة الأوروبية المضافة وتأخير النروجين على النظام الأساسي.

وتلقي الأغراض أجريت تجربتين حديثين في الزراعة البحتية بالبرازيل، المصحابة بمحافظة العقولية خلال العروة الشتوية لموسم 2007-2008 ودراسة تأثير العوامل التي تتعلق بنتروجينات (ترشيحات حاملة، نوع العوامل وتأثير ذلك على تأثير) بنيهة الأحماض (الكيمياوية، تنشيرالوم، مع/بدون إضافة مثبتات النتروجين الفواكه حالة ثور) (guanylthiourea, GTU) وتأثر ذلك على تأثير للأسمدة السائجة. استخدمت متطلبات الفئات الشاملة في ثلاث مكررات. وكانت أهم النتائج المتصادمة على ما يلي:

- صفة عامة أدي اضافة مثبتات النتروجين مع الكيمياوية (70% من معدل المادة العضوية) وسلفنشاد (50% من معدل المادة العضوية) إلى حدد زائدة معوية في كل الفئات المنشطة، ما عدا تكرار كل من الفئات والتربيتيت في الفئات.
- أدي اضافة الكيمياوية (50%) وسلفنشاد (30%) إلى حدود زائدة معوية في صفات النمو الخضري (مثالية في GTU) مع/Sنداد (50%) وسلفنشاد (30%) وآخرون تأثر في طول النباتات والوزن الجاف، وصفات المتحول (المحصول الكلي والمحصول القابل للتسويق) ونسبة النباتات (المحصول الكلي والمحصول القابل للتسويق) والتكريبي النباتي (المحصول الكلي والمحصول القابل للتسويق) ونسبة النباتات (كينولس نور، ميرو، بوب)، بينما أدت هذه المعاملة إلى حدود نقص معوية في صفات المنتجات الغير قابل للتسويق، وتأثر الكتلة والتربيتيت في الفئات، وذلك مع مساعدة ما سجلت معتمدة
- أعطت تعاملات الكيمياوية وسلفنشاد أعلاي للفئات بالنسبة للنتروريجين الناقل في النباتات في صورة N, وذلك مقارنة بباقي المعاملات خلال موسم الأداء.

وبناء على توصيات هذه الدراسة باستخدام سلفنشاد بكم (90 كجم/31 المعدل المصغر) مع اضافة مثبتات النتروجين GTU إلى حقول البطاطس للحصول على أفضل النتائج بالنسبة للمحصول وتحقيق أقصى استفاد من النتروجين المضاف للتربة، بخفض التلوث البيئي.