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 Baramoon Research Station, Mansoura, Dakahlia Governorate, Egypt (+ 7m altitude, 30^o 11^- latitude and 28^o 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 NO_3 and NO_2 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 significantly increased tuber dry matter, starch and specific gravity and significantly decreased 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 NH_4-N in soil was obtained from compost treatment alone followed by nitroform, whereas, AN gave the highest residual NO_3-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 improvement nitrogen use efficiency with reducing the pollution of environment.

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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 (NH_4^+) 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 (NO_2^-) which is further changed into nitrate (NO_3^-) 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 CO_2, NH_3 and H_2O 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 preventing rapid formation of nitrate in the soil, leaching and denitrification losses of nitrogen are limited, thus increasing the efficiency of fertilizers. Lower concentration of nitrate in soil should result in less nitrate contamination of the ground water as well as reduced emission of nitrous oxide from denitrification (Laskshmanan and Prasad, 2004; Di and Cameron, 2004). Moreover, nitrification inhibitor not only decrease nitrate leaching and nitrous oxide emission as reported previously, but also decrease the leaching loss of cation nutrient such as Ca^{2+}, K^{+} and Mg^{2+} (Di and Cameron, 2004).

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}).

Vallejo *et al*. (2006) reported that nitrification inhibitor dicyandiamide (DCD) inhibited nitrification rates and reduced N_2O 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_2O 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_2O 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^{o} 11^{-} latitude and 28^{o} 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 15th 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: (1) Ammonium sulphate (20.5% N) (AS), (2) ammonium nitrate (33.5% N) (AN), (3) Urea (46.0% N) (U), (4) AS + Guanylthiourea (GTU), (5) AN + GTU, (6) Urea + GTU, (7) AS $_{50\%}$ + AN $_{50\%}$ + GTU, (8) AS $_{50\%}$ + Urea $_{50\%}$ + GTU, (9) Nitroform (38% N), (10) Compost (1.2% N), (11) Compost $_{50\%}$ + AS $_{50\%}$ + GTU, and (12) Compost $_{50\%}$ + AN $_{50\%}$ + GTU. The amount of added fertilizers was adjusted to a total N supply of 180 kg/feddan (feddan=4200 m^2) for potato production. Guanylthiourea (GTU) as nitrification inhibitor was mixed with the fertilizers at the rate of 5% of added nitrogen dose. A complete randomized blocks design with three replicates was used in this respect.

Ammonium sulphate, 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_2O_5) was applied before planting at the rate of 75 kg P_2O_5 fed^{-1}. Potassium sulphate (48% K_2O) was used as a source of potassium at the rate of 96 kg K_2O fed^{-1} and was added in two equal doses with the 2nd and 3rd irrigation. Other agricultural practices were conducted according to recommendations.

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

Some Physical properties	Values		Some Chemical Properties	Values	
	1st season	2nd season		1st season	2nd season
Sand (%)	28.1	27.9	**pH* value**	8.0	7.9
Silt (%)	31.8	31.6	**EC dSm^{-1}**	0.9	0.9
Clay (%)	40.1	40.5	**Total N (%)**	0.03	0.04
Texture class	Clay-loam	Clay-loam	**Available N (ppm)**		
			NH_4-N	23.37	23.00
			NO_2-N	0.162	0.126
			NO_3-N	13.21	13.12
$CaCO_3$ (%)	3.2	3.0	**Available P (ppm)**	13.3	12.6
Organic matter (%)	1.8	1.6	**Available K (ppm)**	304	302

*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 gravity, starch, and nitrate and nitrite content) according to the methods described by (AOAC, 1990). Nitrogen, phosphorus and potassium accumulation in tubers (based on tuber dry weight and element percentage in tubers) were determined using the methods described by Cottenie *et al.*, (1982). For calculation of nitrogen efficiency ratio (NER), total tuber yield (kg fed^{-1}) was divided by the amount of nitrogen in kg fed^{-1}(=180 kg fed^{-1}) (Aujla *et al.*, 1982). The soil samples were taken out from plots for residual available nitrogen at harvesting according to Black (1965).

Data obtained were subjected to statistical analysis by the technique of analysis of variance (ANOVA) according to Snedecor and Cochran (1982). The treatments mean were compared using Duncan multiple range test at 5 % level of probability as described by Steel and Torrie (1980).

RESULTS AND DISCUSSION

1. Vegetative growth and tuber yield parameters:

Data presented in Table 2 demonstrate the effect of various treatments of slow release-N and soluble-N fertilizers with nitrification inhibitors (GTU) on vegetative growth parameters of potato plants and tuber yield characters. Significant effects on plant height, dry weight/plant, total, and marketable yields were obtained under the treatment where Compost $_{50\%}$ + AS $_{50\%}$ + GTU was applied in comparison to other treatments, in both seasons of study. On the other hand, application of urea significantly increases in unmarketable yield, in both seasons.

It is quite obvious that dry matter accumulation and tuber yield were always much higher whenever organic manure was added. This trend being clearer with two sources of soluble N. On the other hand, 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). 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 $_{50\%}$ plus compost $_{50\%}$ caused significant increase in tuber dry matter, specific gravity and starch content in tuber. In contrast, NO_3 and NO_2 accumulation was markedly decreased. These results were true in both seasons.

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.

Treatments	**Plant height (cm)**		**Dry weight/plant (g)**		**Tuber yield (ton fed^{-1})**					
					Total		**Marketable**		**Unmarketable**	
	2007/08	**2008/09**	**2007/08**	**2008/09**	**2007/08**	**2008/09**	**2007/08**	**2008/09**	**2007/08**	**2008/09**
T1	47.33fgh	47.00de	35.71de	33.10 e	11.373e	11.920d	10.740f	11.280d	0.633 g	0.640 f
T2	48.17efg	49.00 c	34.18 f	31.18 f	11.187e	11.767d	10.540f	11.100d	0.647fg	0.667 f
T3	46.33 gh	52.00 a	30.72 h	34.24 d	10.880f	10.867f	9.907 g	9.893 f	0.973 a	0.973 a
T4	50.55cde	46.00 ef	36.78 d	37.18 b	13.267c	12.874b	12.553cd	12.161c	0.713 e	0.713 e
T5	49.33def	46.33 ef	35.00 ef	29.20 h	12.573d	12.233c	11.833e	11.387d	0.740 d	0.847 c
T6	46.00 h	43.00 g	28.65 i	29.57gh	10.273g	10.653f	9.447 h	9.693fg	0.826 b	0.960 a
T7	51.33bcd	50.00bc	38.76 c	36.18 c	9.893 h	10.193g	9.227 h	9.420 g	0.667 f	0.773d
T8	45.33 h	45.00 f	32.40 g	30.28fg	9.707 h	9.886 g	8.926 i	9.006 h	0.780 c	0.880b
T9	49.00 ef	48.67cd	34.12 f	32.67 e	13.247c	11.380e	12.760c	10.773e	0.487 h	0.607g
T10	51.67abc	45.67 ef	32.28 g	30.65 f	12.767d	11.200e	12.360d	10.700e	0.406 i	0.500h
T11	53.67 a	52.00 a	42.40 a	39.52 a	14.127a	13.740a	13.813a	13.373a	0.313 k	0.367 j
T12	52.67ab	51.00ab	40.08 b	37.10bc	13.573b	13.180b	13.207b	12.773b	0.367 j	0.407 i

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)

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

Treatments	**Tuber dry matter (%)**		**Specific gravity of tuber**		**Starch (%)**		**Nitrate accumulation (ppm)**		**Nitrite accumulation (ppm)**	
	2007/08	**2008/09**	**2007/08**	**2008/09**	**2007/08**	**2008/09**	**2007/08**	**2008/09**	**2007/08**	**2008/09**
T1	21.41efg	21.48bcd	1.082de	1.085 ef	14.16cd	14.38cd	49.28 f	48.18fg	0.40 h	0.42 e
T2	21.14 fg	22.08abc	1.081de	1.084fg	14.00de	14.21de	67.32 a	65.38 a	0.64 a	0.58 a
T3	20.965 g	20.82cde	1.079ef	1.083 g	13.66ef	13.80ef	63.00bc	61.22bc	0.58 c	0.53 b
T4	22.08 cd	21.47bcd	1.087 b	1.092 c	14.35cd	14.10de	51.74 f	50.00ef	0.46 g	0.38 f
T5	21.99cde	21.08b-e	1.085bc	1.089 d	14.26cd	14.00de	65.40ab	62.23ab	0.62 b	0.57 a
T6	20.88 g	20.53 de	1.078 f	1.081 h	13.40 f	13.43 f	62.12 c	58.80 c	0.55 d	0.51 bc
T7	22.32 bc	21.82abc	1.087 b	1.0792i	14.52bc	14.40cd	58.72 d	55.34 d	0.51 e	0.48 cd
T8	20.14 h	19.89 e	1.077 f	1.0782i	12.94 g	12.80 g	55.38 e	52.30de	0.48 f	0.45 de
T9	21.62def	21.64a-d	1.083cd	1.086e	12.90 g	15.38 b	44.17 g	45.13gh	0.38 j	0.35 fg
T10	22.22 c	22.10abc	1.088 b	1.096 b	14.82 b	14.80 c	38.33 h	38.71 i	0.33 j	0.28 h
T11	22.93 a	22.84 a	1.097 a	1.098 a	15.78 a	15.91 a	36.18 h	35.82 i	0.28 k	0.25 h
T12	55.83 ab	22.32 ab	1.095 a	1.095 b	15.40 a	15.73ab	41.70 g	44.23 h	0.37 i	0.32 g

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)

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 $_{50\%}$ plus compost $_{50\%}$ on NO_3 and NO_2 accumulation may be attributed to the role of GTU and compost in reducing NO_3 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).

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 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.

Treatments	**N-uptake (mg/plant tuber)**		**P-uptake (mg/plant tuber)**		**K-uptake (mg/plant tuber)**		**Nitrogen efficiency ratio (NER)**	
	2007/08	**2008/09**	**2007/08**	**2008/09**	**2007/08**	**2008/09**	**2007/08**	**2008/09**
T1	4312.48 ef	4122.88 e	375.12 e	485.12 e	4486.02 ef	4183.16gh	63.18	66.22
T2	4354.22 ef	3518.78 f	370.01 e	452.23 f	4452.91ef	4172.52 h	62.15	65.37
T3	3437.70 h	2701.42 h	312.65 e	372.65 h	3584.39 h	3520.01 k	60.44	60.37
T4	4826.16 cd	4523.27 d	494.80 d	504.20 e	4943.45 d	4612.04 f	73.71	71.52
T5	4587.23 de	4307.34 e	478.96 d	490.96 e	4693.22 e	4311.44 g	69.85	67.96
T6	3961.12 fg	3342.56 fg	359.47 e	420.73 g	4271.78 f	3927.70 i	57.07	59.18
T7	4924.64 cd	4892.04 c	615.42 b	602.23 c	5400.31 c	5050.21 d	54.96	56.63
T8	3629.20gh	3172.36 g	336.99 e	398.10 gh	3875.12 g	3729.10 j	53.93	54.92
T9	4875.82 cd	4712.21cd	540.49 cd	540.28 d	5137.93 d	4823.28 e	73.59	63.22
T10	5176.46 bc	4900.32 c	597.32 bc	680.04 a	5530.75 c	5337.11 c	70.92	62.22
T11	5765.08 a	5369.28 a	710.37 a	642.16 b	6270.50 a	5922.34 a	78.48	76.33
T12	5432.15 ab	5115.50 b	650.54 ab	580.47 c	5842.04 b	5729.20 b	75.40	73.22

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 $50_{\%}$ + 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).

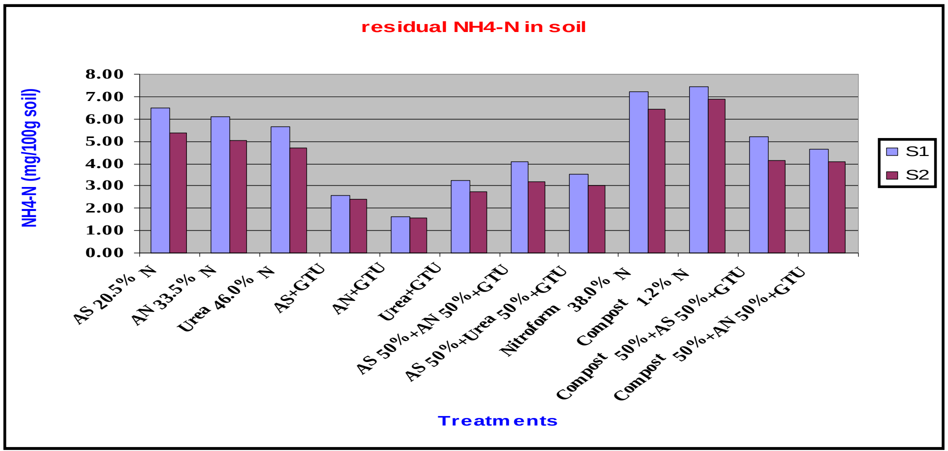

Fig. 1: Residual NH_4-N in soil at harvesting as affected by nitrogen sources and nitrification inhibitors in 2007/08 and 2008/09 seasons.

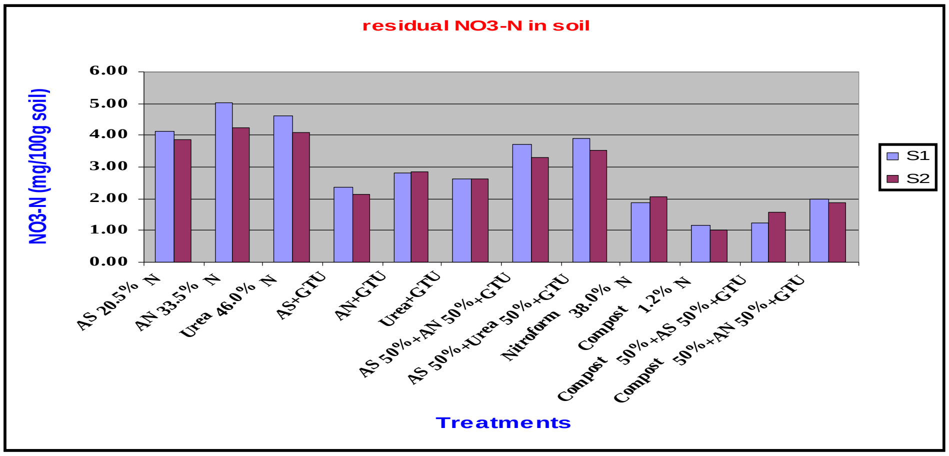

Fig. 2: Residual NO_3-N in soil at harvesting as affected by nitrogen sources and nitrification inhibitors in 2007/08 and 2008/09 seasons.

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تحسين كفاءة النتروجين المستفادة بواسطة نباتات البطاطس
أ. تأثير مثبطات النترتة مع مصادر مختلفة للنتروجين علي تقليل فقد النتروجين وتحسين الإنتاجية والتركيب الكيماوي

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تحدث أكسدة بيولوجية للأمونيا NH_4^+ (المضافة للتربة من خلال التسميد المعدني أو نتيجة تحلل المادة العضوية) إلي نترات من خلال عملية النترتة nitrification ،والتي تقوم بها بكتريا متخصصة، وقد يكون من المفضل استخدام أي تكنيك يؤدي إلي تأخير عملية النترتة، وبالتالي تقليل فقد النتروجين في صورة نترات من خلال عملية الرشح.

يهدف هذا البحث إلي رفع كفاءة استخدام الأسمدة النيتروجينية عن طريق استخدام مثبطات النترتة وتأثير ذلك علي تقليل فقد النتروجين وزيادة الإنتاجية والتركيب الكيماوي في البطاطس صنف كارا. كما يهدف إلي تقليل الأسمدة الأزوتية المضافة وتقليل التلوث البيئي والمحافظة علي صحة الإنسان.

ولتحقيق هذه الأغراض أجريت تجربتان حقليتان في المزرعة البحثية بالبرامون- المنصورة- محافظة الدقهلية خلال العروة الشتوية لموسمي 2008/2007 و 2009/2008 لدراسة تأثير الصور الذائبة من الأسمدة الأزوتية (نترات نشادر- سلفات نشادر- يوريا)، مع/أو الصور بطيئة الأمداد (الكمبوست- نتروفورم)، مع/أو بدون أضافة مثبط النترتة جوانيل ثيوريا (guanylthiourea, GTU) وتأثير ذلك علي تحقيق الأهداف السابقة. استخدم تصميم القطاعات الكاملة العشوائية في ثلاث مكررات. وكانت أهم النتائج المتحصل عليها ما يلي:

§ بصفة عامة..أدي أضافة مثبط النترتة GTU مع الكمبوست (50% من المعدل الموصي به) و سلفات نشادر (50% من المعدل الموصي به) إلي حدوث زيادة معنوية في كل الصفات محل الدراسة، ما عدا تركيز كل من النترات والنيتريت في الدرنات.

§ أدي أضافة الكمبوست (50%) و سلفات نشادر (50%) مع GTU إلي حدوث زيادة معنوية في صفات النمو الخضري (متمثلة في طول النبات والوزن الجاف) وصفات المحصول (المحصول الكلي والمحصول القابل للتسويق) والجودة (المادة الجافة في الدرنات والكثافة النوعية والنشا) و التركيب الكيماوي لدرنات البطاطس (المحتوي الغذائي من ن، فو، بو)، بينما أدت هذه المعاملة إلي حدوث نقص معنوي في صفات المحصول الغير قابل للتسويق، وتركيز النترات والنيتريت في الدرنات، وذلك في موسمي الدراسة.

§ أعطت معاملة الكمبوست وسماد النتروفورم أعلي القيم بالنسبة للنيتروجين المتبقي في التربة في صورة NH_4^+، بينما سجلت معاملة سماد نترات النشادر أعلي القيم بالنسبة للنتروجين المتبقي في التربة في صورة NO_3^- وذلك مقارنة بباقي المعاملات خلال موسمة الدراسة.

وبناءا عليه توصي هذه الدراسة باستخدام سماد الكمبوست بمعدل 9 طن/فدان مع سلفات النشادر بمعدل 90 كجم (2/1 المعدل الموصى به) مع أضافة مثبط التأزت GTU إلي حقول البطاطس للحصول علي أفضل النتائج بالنسبة للمحصول وتحقيق أقصى استفادة من النتروجين المضاف للتربة، مع خفض التلوث البيئي.