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In the name of Allah

NOTE

GROWTH AND NITROGEN CONTENT OF SUNFLOWER AS AFFECTED BY THE RATE AND FORM OF NITROGEN[1]

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ABSTRACT

Little information is available regarding the response of sunflower (*Helianthus annuus* L.) to various N forms and rates. Therefore, the main objective of this study was to evaluate the growth and N content of sunflower as affected by the rate and form of N. Sunflower was grown in pots and was fertilized with $(NH_4)_2SO_4$, NH_4NO_3, and $NaNO_3$ to provide 0, 25, 50, 100, and 200 ppm N in a factorial arrangement. Nitrapyrin [2-chloro-6-(trichloromethyl) pyridine] was added at the rate of 20 ppm to all pots. Plants were harvested at 32, 46, and 60 days from sowing. Growth response (top and root dry weights) and N concentration in tops and roots were determined.

Nitrapyrin toxicity appeared as a curling of leaf margins and a tendril type of stem growth; the visible toxicity symptoms decreased in the order: $(NH_4)_2SO_4 > NH_4NO_3 > NaNO_3$. Despite this, all N-treated sunflower plants produced more root and top dry weights and contained a significantly

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بنام خدا

اثر میزان ونوع ازت برروی رشدومقدار ازت آفتابگردان

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خلاصه

اطلاعات ناچیزی درزمینه عکس العمل گیاه آفتابگردان نسبت بفرم ومقادیر مختلف ازت موجوداست. منظوراصلی از این مطالعه، ارزیابی تاثیرمیزان و فرم ازت برروی رشدومقدارازت این گیاه میباشد. گیاهان آفتابگردان در گلدانهائی که به آنها مقادیرصفر، ۲۵، ۵۰، ۱۰۰و۲۰۰قسمت درمیلیون ازت از منابع کودی سولفات آمونیم، نیترات آمونیم، ونیترات سدیم اضافه شده بود بصورت فاکتوریل کشت گردیدند. نیتراپیرین بمقدار ۲۰ قسمت درمیلیون به همه گلدانها اضافه شده وگیاهان ۴۶،۳۲ و۶۰ روزبعدازکشت برداشت گردیدند. رشدگیاه (وزن خشک ریشه وقسمتهای هوائی)وغلظت ازت درقسمتهای هوائی اندازه گیری شد.

مسمومیت حاصله ازمصرف نیتراپیرین بصورت پیچیدگی حاشیه برگها وساقه ها ظاهرشده وشدت علائم ظاهری مسمومیت بترتیب ازسولفات آمونیم به نیترات آمونیم ونیترات سدیم کاهش یافت ،علی رغم این، وزن خشک ریشه وقسمت های هوائی ومقدار ازت، درگیاهانی که ازت دریافت کرده بودندازگیاهان شاهد بیشتربود. بعلاوه ۱۰۰ قسمت درمیلیون ازت بصورت نیترات آمونیم موجب رشدبیشتری در قسمت های هوائی نسبت به دوفرم دیگر

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higher N than untreated control. Moreover, 100 ppm N as NH_4NO_3 resulted in more top growth at the 46- and 60-day growth stages than when N was supplied from other sources. In contrast, N concentration and N uptake by sunflower supplied with $(NH_4)_2SO_4$ were greater than in those provided with NH_4NO_3 and $NaNO_3$.

ازت در ۴۶ و ۶۰ روز بعد از رشد گردیـــــد .
بالعکس غلظت ومیزان ازت درگیاهانی
که ازت را بصورت سولفات آمونیـــــم
دریافت کرده بودند نسبت به گیاهانـــی
که نیترات آمونیم ونیترات سدیم به
آنها اضافه شده بود، بیشتر بود .

INTRODUCTION

One of the most widely recognized problems in N management is that of N losses by leaching and denitrification. As long as N remains in the NH_4^+-N form, the likelihood for such losses is greatly reduced. The question that arises is whether the plants can effectively utilize NH_4^+-N without growth suppression.

The relative effectiveness of NH_4^+-N and NO_3^--N for plant growth has been reviewed by Viets (15). Several workers (4, 7, 10) reported that NH_4^+-N reduced plant growth as compared to NO_3^--N. In contrast, there are reports (2, 13) that young seedlings prefer NH_4^+-N. Spratt and Gasser (14) showed that kale (*Brassica oleracea* L.) utilized NO_3^--N more efficiently than NH_4^+-N, whereas wheat (*Triticum aestivum* L.) and ryegrass (*Lolium multiflorum* L.) grew better with NH_4^+-N fertilizer. Schrader *et al* (12) reported that corn (*Zea mays* L.) produced more growth when supplied with a combination of NH_4^+-N and NO_3^--N than when either form was provided alone. A similar growth response was observed by Weissman (16) in sunflower (*Helianthus annuus* L.). However, there were no significant differences between NH_4^+-N and NO_3^--N for cotton (*Gossypium hirsutum* L.), grain sorghum [*Sorghum bicolor* (L.) Moench] or coastal bermudagrass (*Cynodon dactylon* Pers) as reported by Morris and Giddens (9).

Little information is available regarding the response of sunflower to various N forms and rates. Because of this, the growth and N content of sunflower as affected by the rate and form of N were studied in a greenhouse experiment. Nitrapyrin [2-chloro-6-(trichloromethyl) pyridine] was used to limit nitrification of applied NH_4^+-N throughout the growth period.

MATERIALS AND METHODS

An alluvial calcareous silty clay loam (Xerollic Xerochrept) was used for this experiment. Some of the chemical characteristics of this soil have been given elsewhere (6). The soil was air-dried and passed through a 2-mm sieve. Treatments consisted of three N forms [$(NH_4)_2SO_4$, NH_4NO_3, and $NaNO_3$] each applied at five levels (0, 25, 50, 100, and 200 ppm) and three harvest dates (32, 46, and 60 days from sowing).

Phosphorus was added at 50 ppm to each pot as triple superphosphate. Fertilizers were thoroughly mixed with 4000 g of soil pretreated with 20 ppm nitrapyrin. Nitrapyrin was added as an emulsion diluted with water. Although the nitrapyrin rate used in this study is well above the highest recommended rate, it is not unreasonable when the high percentage of clay of the soil is considered. Based on previous work in our laboratory, the minimum nitrapyrin concentration required to inhibit nitrification in fine-textured soils similar to that used in the present study for a one month period was 10 ppm and preferably 20 ppm (3). The experiment was factorially arranged into a completely randomized design with three replications.

Eight sunflower (cv. 'Record') seeds were planted in each pot and seedlings were thinned to three after 10 days. Pots were irrigated with distilled water to near field capacity determined by weight as required.

At harvest, tops were cut at the soil surface from the roots and roots were thoroughly washed to remove the soil. Tops and roots were dried at 70°C and weights recorded. Samples were ground in a micromill to pass a 40-mesh screen and analyzed for total N by the micro-Kjeldahl method (1). Data were subjected to analyses of variance. Growth, total N, and N uptake data were regressed on N rate with respect to the three N forms at the three sampling dates.

RESULTS AND DISCUSSION

Sunflower seedlings developed nitrapyrin toxicity symptoms similar to those of soybeans [*Glycine max* (L.) Merr.] as described by Maftoun and Sheibany (5). The typical symptoms consisted of curling of leaf margins, leaf cupping, and a tendril stem growth. The visible toxicity symptoms of nitrapyrin decreased in the order: $(NH_4)_2SO_4 > NH_4NO_3 > NaNO_3$. Mills *et al.* (8) observed that garden pea (*Pisum sativum* L.) developed curling of leaf margins with 10 ppm nitrapyrin, whereas bean (*Phaseolus vulgaris* L.) showed a temporary manifestation of nitrapyrin toxicity on the primary leaves.

For each N source-harvest combination, the second order model:

$$Y = b_0 + b_1X + b_2X^2$$

was fitted for growth, N concentration, and N uptake, where X refers to the N rate and b values are the computed regression coefficients indicating linear or quadratic effects. Equations were estimated sequentially, beginning with a linear model. A quadratic term was added only if its contribution significantly reduced the residual mean squares. The estimated regression equations are graphically illustrated in Figs. 1, 2, 3, and 4. Equations are shown only if the regression is statistically significant at the 5% level. Thus, for the 32-day harvest, no significant regression was indicated for $NaNO_3$. Also, included in these figures are the multiple (R) or simple (r) correlation coefficients which provide a subjective measure of the goodness of fit.

The stimulation of root dry weight with increasing N rates as NH_4NO_3 and $NaNO_3$ showed a curvilinear effect (Fig. 1). Moreover, sunflower seedlings supplied with NH_4NO_3 produced more roots than those provided with $NaNO_3$ at the 60-day growth stage. The highest root yields were obtained with N levels of 111 and 126 ppm as NH_4NO_3 for the 46- and

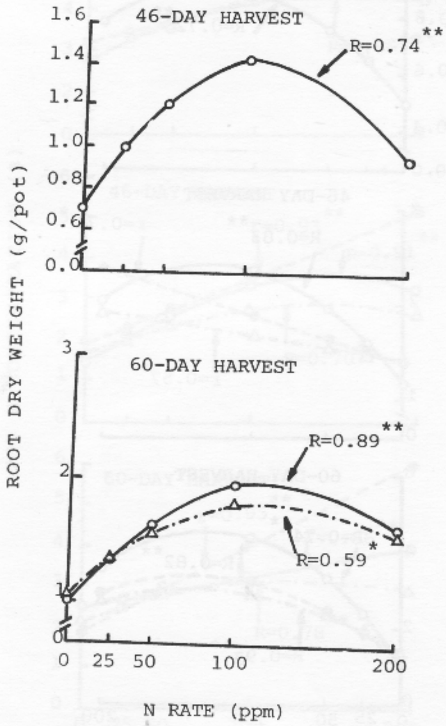

Fig. 1. Root dry weight of sunflower as affected by the rate and form of N. (O=NH_4NO_3; Δ=$NaNO_3$).

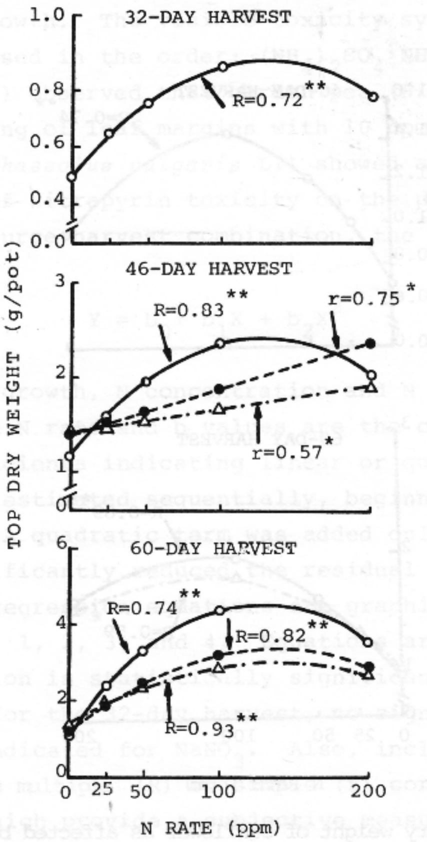

Fig. 2. Top dry weight of sunflower as affected by the rate and form of N. [●=$(NH_4)_2SO_4$; O=NH_4NO_3; Δ=$NaNO_3$].

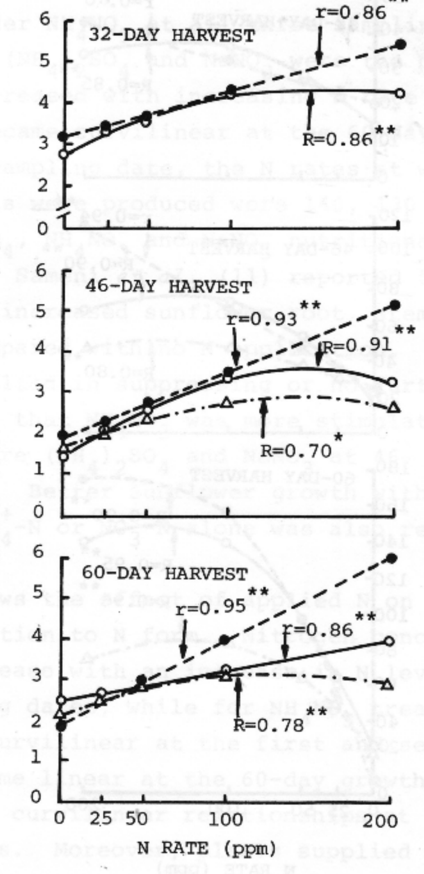

Fig. 3. Nitrogen concentration of sunflower tops as affected by the rate and form of N. [●=$(NH_4)_2SO_4$; ○=NH_4NO_3; △=$NaNO_3$].

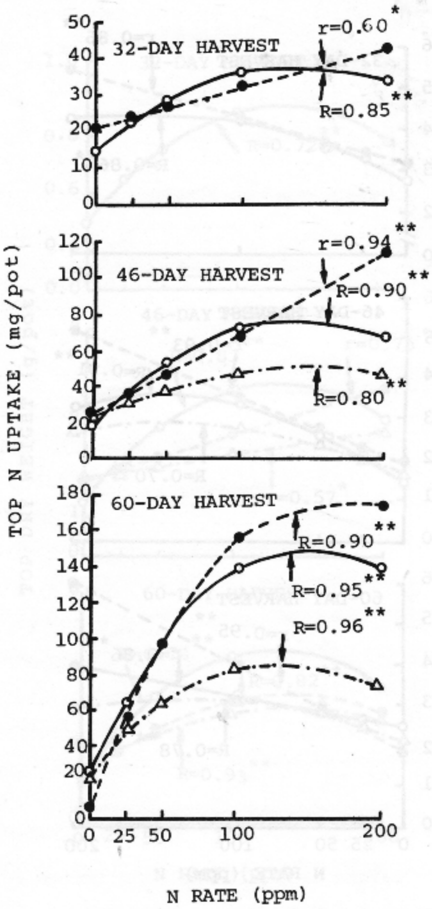

Fig. 4. Nitrogen uptake by sunflower tops as affected by the rate and form of N. [●=$(NH_4)_2SO_4$; O=NH_4NO_3; Δ=$NaNO_3$].

60-day growth stages, respectively, while with $NaNO_3$, the root weight reached a maximum value at the applied N rate of 121 ppm for the last sampling date.

There was a curvilinear relationship between N level and top growth under NH_4NO_3 at all three sampling dates (Fig. 2). However, when $(NH_4)_2SO_4$ and $NaNO_3$ were the N sources, top dry weight increased with increasing N rate at 46-day harvest and became curvilinear at the 60-day growth stage. At the third sampling date, the N rates at which maximum top dry weights were produced were 140, 130 and 132 ppm under $(NH_4)_2SO_4$, NH_4NO_3 and $NaNO_3$ nutritional regimes, respectively. Sameni *et al.* (11) reported that 25 ppm N significantly increased sunflower root, stem, and leaf dry weights as compared with no N application. Higher N rates generally resulted in suppressing or no further response. Figure 2 shows that NH_4NO_3 was more stimulative to top growth than were $(NH_4)_2SO_4$ and $NaNO_3$ at 46- and 60-day growth stages. Better sunflower growth with NH_4NO_3 than with either NH_4^+-N or NO_3^--N alone was also reported by Weissman (16).

Figure 3 shows the effect of applied N on top N concentration in relation to N form. Nitrogen concentration tended to increase with an increase in N level as $(NH_4)_2SO_4$ at all sampling dates, while for NH_4NO_3 treatment, the response was curvilinear at the first and second sampling dates and became linear at the 60-day growth stage. Sodium nitrate showed curvilinear relationships at the 46- and 60-day harvests. Moreover, plants supplied with $(NH_4)_2SO_4$ contained greater percent N than those under the other N regimes. This was especially true at the higher N rates and at the second and third sampling dates. Increasing N rate as $NaNO_3$ had the least effect in increasing N concentration. The higher N concentration in the tops of $(NH_4)_2SO_4$-treated plants as compared with NH_4NO_3-treated plants may be caused to some extent by a concentration effect due to the relatively lower yields in this treatment.

Differences in N uptake as a function of applied N from the three forms are shown in Fig. 4. It is apparent that all of the relationships were curvilinear except for $(NH_4)_2SO_4$ where N uptake continued to increase as applied N increased for the first and second sampling dates. At the 46-day growth stage, N uptake reached a maximum value at 139 and 144 ppm N as NH_4NO_3 and $NaNO_3$, respectively, whereas at 60-day harvest, the N rate at which maximum N uptakes occurred were 164, 148 and 134 ppm for $(NH_4)_2SO_4$, NH_4NO_3 and $NaNO_3$ treatments, respectively. Plants supplied with $(NH_4)_2SO_4$ accumulated more N at the 46-and 60-days growth stages than those provided with the other sources; the difference being more pronounced at the higher N levels.

This study indicates that sunflower grew equally well with $(NH_4)_2SO_4$, NH_4NO_3 and/or $NaNO_3$ except at the 46- and 60-day growth stages where this crop generally made better growth when supplied with 100 ppm N as NH_4NO_3 than when provided from the other N sources. Furthermore, 20 ppm nitrapyrin proved to be toxic to sunflower plants and the magnitude of toxicity was affected by N form and decreased in the order: $(NH_4)_2SO_4 > NH_4NO_3 > NaNO_3$.

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