Foliar Application of Liquid Urea-triazone-based Nitrogen Fertilizers and Crop Safety

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Summary. **Urea-triazone-based nitrogen (N) solutions were evaluated for potential leaf injury on agronomic and horticultural crops at 61 commercial grower sites throughout the United States. Poliar spray solutions containing triazone N were used at concentrations ranging from 1.5% to 15.7%. Safe N concentrations for urea-triazone-based N products ranged from 1.5% for crops such as sweet corn, apple, cherry, and pear, and up to 15.7% for nursery root stocks. Urea-triazone-based N solutions were found to be much safer on crop foliage than ammonium-, nitrate-, and/or all urea-based foliar fertilizer products than reported in the literature.**

Most foliar nitrogen (N) products developed prior to the discovery and commercialization of urea-triazone solutions contained ammonium, nitrate, and/or urea N sources. These sources have a very high osmolality index, which results in a high burn potential when applied to plant foliage (Clapp and Parham, 1991). Due to this burn potential, products developed from these sources generally are applied at low application rates and in dilute spray concentrations.

Embleton et al. (1986) reported that, in order to avoid the toxic effects of dilute urea sprays on citrus, the concentration should not exceed 14 g urea/liter, or 0.64% N. Ferrer and Forshey (1988) used only 6 g urea/liter (0.28% N) concentration on apples in Ohio. Ippersiel et al. (1989) selected a 0.88% N concentration of urea for applications on corn, and considered it to be the highest practical safe application rate without causing leaf injury.

The potential for leaf injury from foliar fertilizer products containing urea as the N source, along with other nutrients, has limited the rate of application. For example, Jones (1989) reported that the manufacturer of a N-P_2O_5-K_2O plus micronutrient product (12-6-6) suggested that the product be applied in a spray concentration of only 0.25%.

Urea-triazone liquid N fertilizers are produced by the Triazone Division, Arcadian Corp., Memphis, Tenn. These solutions contain a patented,

Table 1. ***Safe foliar nitrogen concentrations observed on selected crops from a urea-triazone-based N solution (N-Sure: 28–0–0)[z].***

Crop	Growth stage	Application rate (gal/acre) N-Sure	Application rate (gal/acre) Water	Spray N concn. (%)
Cauliflower	Six-leaf	10	40	6.8
Cherry (Bing)	Full leaf	20	80	6.8
Grape (Thompson Seedless)	Canes 2 to 3 ft	10	40	6.8
Lettuce	Heading	10	40	6.8
Pepper	4 inches	10	40	6.8
Spinach	Midway	10	40	6.8
Tomatoes	Closing row	20	30	13.2
Nursery rootstock (Almond, Marianna 29C, Nemagard, Nemared)	30 Apr.	20	20	15.7

[z]*N-Sure applied at rates up to 20 gal/acre (unpublished data from D.T. Schulteis, Fresno, Calif.)*

Table 2. ***Safe foliar nitrogen concentrations on vegetable crops from a urea-triazone-based nutrient solution (Trisert: 13–3–4).[z]***

Crop	Growth stage	Location	Application rate (gal/acre) Trisert	Application rate (gal/acre) Water	Spray N concn. (%)
Asparagus	Fern	Mich.	20	0	13.1
Beans (green)	First trifoliate	Mich.	10	10	7.1
Beans (pinto)	Midpod	N.D.	5	15	3.7
Broccoli	Before button	Calif.	15	5	10.2
Cabbage	Early head	Texas	15	5	10.2
Cauliflower	10-leaf	Mich.	20	0	13.1
Collards	Midharvest	Texas	20	0	13.1
Corn (sweet)	Four- to five-leaf	Calif.	5	45	1.5
Corn (sweet)	Five-leaf	Mich.	5	15	3.7
Cucumber	Three- to four-leaf	Mich.	20	0	13.1
Cucumber	Early bloom	Texas	15	5	10.2
Dill	Early harvest	Texas	20	0	13.1
Kale	Midharvest	Texas	20	0	13.1
Lettuce	Four- to five-leaf	Calif.	5	15	3.7
Lettuce	Capping	Calif.	5	15	3.7
Pepper (bell)	5 to 6 inches	Texas	20	0	13.1
Pepper (bell)	6 inches	Calif.	20	30	5.8
Pepper (bell)	After first picking	Calif.	10	40	3.0
Potato	14 days after emergence	Calif.	20	30	5.8
Potato	Late tuber	Calif.	10	10	7.1
Squash (zucchini)	Five-leaf	Mich.	20	0	13.1
Squash	Midharvest	Texas	15	5	10.2
Tomato	5 to 6 inches	Calif.	20	30	5.8
Tomato (processing)	Full bloom	Calif.	20	30	5.8

[z]*Trisert solution applied at rates up to 20 gal/acre in a spray volume of either 20 or 50 gal/acre.*

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Table 3. *Safe foliar nitrogen concentrations observed on berries, fruits, nuts, vines, and Christmas trees from a urea-triazone-based nutrient solution (Trisert: 13–3–4).*[z]

Crop	Growth stage	Location	Application rate (gal/acre) Trisert	Application rate (gal/acre) Water	Spray N concn. (%)
Almond	Full leaf	Calif.	20	30	5.8
Apple	0.5-inch fruit	Mich.	15	5	10.2
Apple	Full bloom	N.Y.	10	10	1.5
Blueberry	Early fruit coloring	Mich.	10	10	7.1
Muskmelon	1-inch fruit	Texas	15	5	10.2
Cherry (sour)	Petal fall	N.Y.	10	40	3.0
Cherry (sour)	Mature foliage	N.Y.	5	45	1.5
Christmas tree (Douglas fir)	Budbreak	Mich.	20	0	13.1
Grape (French colombard)	Full leaf	Calif.	20	30	5.8
Orange	0.25-inch fruit	Texas	20	0	13.1
Peach	Full leaf	Calif.	20	30	5.8
Peach	0.75-inch fruit	Mich.	20	0	13.1
Pear	Late bloom	N.Y.	5	45	1.5
Plum	Full leaf	Calif.	20	30	5.8
Plum	0.5-inch fruit	Mich.	10	10	7.1
Strawberry	Prebloom	N.Y.	10	10	7.1
Strawberry	Bloom	Mich.	20	0	13.1
Watermelon	Early bloom	Texas	20	0	13.1

[z]*Trisert solution applied at rates up to 20 gal/acre in a spray volume of either 20 or 50 gal/acre.*

Table 4. *Safe foliar nitrogen concentrations observed on field crops from a urea-triazone-based nutrient solution (Trisert: 13–3–4).*[z]

Crop	Growth stage	Location	Application rate (gal/acre) Trisert	Application rate (gal/acre) Water	Spray N concn. (%)
Flax	First bloom	N.D.	20	0	13.1
Flax	Boll development	N.D.	20	0	13.1
Oat	Heading	N.C.	20	0	13.1
Rice	0.5-inch head	Mo.	20	0	13.1
Rice	Early head emergence	Mo.	20	0	13.1
Soybean	Early bloom	N.C.	15	5	10.2
Sugar beet	Seven- to 11-leaf	N.D.	20	0	13.1
Sunflower	Early bloom	N.D.	10	10	7.1
Sunflower	Early seed fill	N.D.	10	10	7.1
Tobacco	Six- to eight-leaf	N.C.	20	0	13.1
Wheat	Heading	N.C.	20	0	13.1

[z]*Trisert solution applied at rates up to 20 gal/acre.*

heterocyclic, organic N compound identified by Hawkins (1985, 1986, 1988) as S-tetrahydrotriazone and described by Landels et al. (1990). Urea-triazone solutions have been recognized by the Assn. of American Plant Food Control Officials (AAPFCO, 1991) as a source of slowly available N.

Urea-triazone solutions were evaluated first on turf grasses and were found to be much safer than urea or urea-ammonium nitrate solutions, especially when applied as concentrated solutions (Clapp and Parham, 1991).

The commercial urea-triazone product, "N-Sure" solution, is a clear liquid product that contains 28% total N. This product contains 3 lb N/gal (360 g N/liter) and has a salt-out-temperature (SOT) of <OF (-17.X). Hodgson and MacLeod (1988) were unable to use urea solutions, made by dissolving granular urea on cotton, if the N concentration was >167 g·liter^{-1}, because of low solubility.

Results

N-Sure solution, originally developed for use on turf, has been evaluated as a foliar N source on several crops at N rates up to 60 lb/acre (67 kg·ha^{-1}) and at spray concentrations up to 15.7% N. The results from a California cooperator are summarized in Table 1. No leafinjury was observed for these applications on selected crops. The N concentrations were up to 25 times the rate reported by Embleton et al. (1986) to be acceptable on citrus.

A N-P_2O_5-K_2O product containing urea-triazone solution as the N source, Trisert (13-34) solution, was evaluated extensively for potential leaf injury on a number of crops throughout the United States (Tables 24). Field trials were established, primarily in major vegetable and fruit production regions, to determine the crop safety level for application rates of 5, 10, 15, and 20 gal/acre (47, 94, 141, and 188 liter·ha^{-1}). At most locations a maximum spray volume of 20 gal/acre was used for vegetable and field crops. The &gal/acre Trisert solution rate was applied with 15 gal/acre of water, whereas the 20-gal/acre rate was applied undiluted.

Trisert solution contains 1.3 lb N/gal (156 g N/liter) and was applied at concentrations of 3.7%, 7.1%, 10.2%, and 13.1% N for the four rates evaluated. All of these rates are much higher than the N concentrations being recommended and applied with ammonium, nitrate, and/or all urea-based foliar fertilizer products.

Crops, growth stage, and locations varied considerably, depending on the time of year when the trials were initiated for a given region. Leafinjury observations generally were made 7 to 10 days after treatment. If signs of leaf burn were observed, they were recorded, even if as low as 1% of the crop foliage showed burns.

Tables 24 summarize the safe concentrations observed for these field trials. A total of 53 crop-growth, stage-location observations were noted. Of these, 21 were at the maximum undiluted Trisert solution application rate of 20 gal/acre, or 13.1% N.

Crops most sensitive to Trisert solution applications were sweet corn, apple, cherry, and pear, but they were still safe at a N concentration of 1.5%, which is 2 to 5 times higher than reported from all urea N sprays.

These results illustrate that significantly higher N rates and/or spray concentrations can be applied safely to crop foliage when the N source is from a urea-triazone solution.

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