NITROGEN NUTRITION IN DAFFODIL PRODUCTION

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This bulb fertility research started in 1978 as a field survey of all of the bulb producing areas in western Washington (3). The survey indicated that some fields were not adequately fertilized with lime, magnesium, manganese, zinc, and boron. The survey also indicated that most bulb ground was high in phosphorus and potassium.

In 1981 we suggested fertilizer guidelines for daffodils for all nutrients except nitrogen (5). Nitrogen has been a problem as growth analysis studies of daffodils have indicated nitrogen does not begin to accumulate in the plant until the morphological stage correlated with about two weeks prior to flower picking (4). This has created a question as to how much nitrogen applied in the fall is available for plant utilization in the spring.

Nitrogen in the ammonium form has a positive charge and adheres to clay colloids and organic matter in the soil. However, soil organisms cause the ammonium form to convert to a nitrate form that has a negative charge and which is repelled from the absorption sites in the soil. Nitrate then becomes part of the soil solution which can be readily leached from the soil root zone during periods of heavy rainfall. Fall applications of ammonium nitrate may also be lost since nitrification, the chemical reaction that converts ammonium to nitrate, has several rate-related factors. One important factor is soil temperature (2). Nitrification reactions increase as the soil temperature increases and decreases to 0 at about 37^{O}F (Fig. 1). Even during January, the coldest month of the year, there is a slow rate of nitrification taking place in all bulb growing regions of the Pacific Northwest (1) (Table 1). Temperatures are adequate for significant nitrification rates to occur in the fall, winter, and spring in the Mount Vernon area (Table 2).

The addition of nitrogen in the fall has been done from a practical standpoint (3). Spring applications of nitrogen are difficult because of the wet field conditions and the disturbance of weed control if fertilizer is banded.

The utilization of nitrogen stabilizers would therefore appear to be a practical alternative consideration. Nitrogen stabilizers are compounds that slow the nitrification rate by inhibiting the bacteria in the soil necessary for the chemical reaction to occur (6). One of the first chemicals to be registered as a nitrogen stabilizer by the Environmental Protection Agency is Nitrapyrin and is sold under the Dow Chemical trade name of N-Serve. N-Serve functions by being toxic to the Nitrosomonas bacteria required to convert ammonium ion to nitrate ion and, consequently, interrupts the nitrification reaction (Fig. 2).

Nitrogen stabilizers, such as N-Serve, could therefore be potentially useful in the fall-applied nitrogen program providing the nitrogen was in the ammonium form and adequate concentrations of the nitrogen stabilizers were jointly incorporated. Two experiments were initiated in the fall of 1981 to determine if the nitrogen stabilizer N-Serve could be utilized effectively in daffodil bulb production.

FIRST EXPERIMENT

The first experiment was designed to study how fast nitrogen disappeared from the cultivated soil during the fall and winter. Plots were established by spraying a tank mix of Solution 32 with varying rates of N-Serve on the ground and immediately rototilling it into the soil to a depth of 4 inches. The nitrogen was applied at 250 pounds N per acre, which is 75 percent in the ammonium form and 25 percent in the nitrate form. The treatments were applied on October 23, 1981, and the first soil samples were taken October 30 and thereafter at approximately monthly intervals through mid-May, 1982. The soil profile was sampled to rotovator depth in each of the plots and was immediately frozen in plastic bags. The soil samples were analyzed for ammonium and nitrate nitrogen by the Oregon State University Soils Laboratory. From the time-course studies, we were able to follow the rate of nitrogen disappearance from the surface to 4 inches of soil.

RESULTS

Time-Course of Ammonium Nitrogen -- The base line of ammonium N from the initiation of the experiment through March ranged between 2-5 ppm (Fig. 3). The addition of fertilizer initially increased this fraction of N to above 30 ppm (Fig. 3). The ammonium fertilizer had virtually disappeared by December 2 sampling where no N-Serve was included in the treatment. The N-Serve treatments retained about 20 ppm ammonium N from the fertilizer application on December 2. Comparing the 2-quart-per-acre N-Serve treatment to the 1-quart treatment showed greater effectiveness on nitrogen retention in the later sampling dates of January, February, and early March. The 2-quart-per-acre treatment had significantly greater N retention compared to the no N-Serve treatments through the March 4 sampling date.

Time Course of Nitrate Nitrogen -- The nitrate base line started at 20 ppm and dropped down to 3 ppm during January and February and proceeded to climb back to 12 ppm in late March (Fig. 3). Fertilizer treatment without

N-Serve started October 30 at 46 ppm and fell rapidly to 4 ppm by January 14. The N-Serve treatments retarded the ammonium to nitrate conversion shown in an intermediate nitrate concentration between the base line and no N-Serve treatment through January 14 and then March through mid-May showed an increase release rate of nitrate.

Time Course of Total Nitrogen -- The background or base line of nitrogen was at 24 ppm on October 30 and progressively dropped to 8 ppm by January 14 and then began to rapidly increase in April. This is probably related to the increased microorganism activity which is related to the soil warming trend which causes the release of nitrogen from the decaying organic matter. The treatment of 250 pounds of N per acre without N-Serve started October 30 at 69 ppm N and by January 14 had dropped to 9 ppm. This indicated that all nitrogen applied in October had disappeared from the sampling zone by mid-January. The addition of 1 and 2 quarts of N-Serve per acre resulted in the retention of 10-20 ppm more total nitrogen during January, February, and March.

SECOND EXPERIMENT

To determine the effect of N-Serve treatment on daffodil production, liquid ammonium phosphate (10-34-0) and Solution 32 were combined to provide the desired ratio of nitrogen and phosphorus. Increasing rates of N-Serve were added to the fertilizer solution which was injected approximately 2 inches below the bulb furrow in two bands spaced 8 inches apart prior to planting the bulbs. The plots were planted to the cultivar Fortune and equivalent to 5 tons per acre. Foliage tissue samples were taken at monthly intervals from March through June. Bulbs were harvested, graded, and bulb tissues sampled for N and other nutrients.

RESULTS

The nitrogen in the leaf blade dropped progressively throughout the foliage growing period (Fig. 4). The general slope of the line remained the same when comparing no nitrogen and nitrogen plus N-Serve treatments. However, the nitrogen content in the blade tissue was consistently higher for all sampling dates in the nitrogen plus N-Serve treatments (Table 3). The rapid changes in nitrogen rates as the foliage matures and the concentration differences between nitrogen treatments probably limits the usefulness of foliage tissue analysis as a diagnostic tool.

The bulbs were harvested in the summer, cured, graded, and weighed. The data showed average yield improvement of 20 percent and increased size with 0.8 gallon per acre N-Serve treatment compared to treatment with no N-Serve (Table 4). The yield was not statistically significant because of variability experienced between the plots. The treatments caused no negative visual effects on the plant development or any apparent disease problems on the stored bulbs. There was a general trend toward increased nitrogen in the bulb tissue; however, the largest increase occurred between no nitrogen and the nitrogen treatment with no N-Serve. There was no significant difference in other bulb tissue nutrients between treatments, and therefore only the average content of all treatments were included (Table 5).

CONCLUSIONS

1. Fall applied nitrogen as has been done in western Washington is a questionable practice. Data supplied in this report indicate that nitrogen applied in the fall without nitrogen stabilizers incorporated has been completely converted to nitrate and will be leached from the root zone of the soil by mid-January.

2. Broadcast applications of N-Serve at 0.5 gallon per acre caused significant retention of ammonium ions through the March 4 sampling date. This should retain nitrogen for crop utilization for the spring growing period.

3. N-Serve applied in concentrated fertilizer bands had no visual phytotoxic effects on leaves, flowers, or the harvested bulbs.

4. There were trends in the data for improved daffodil yield and improved bulb size for those treatments that incorporated nitrogen and N-Serve.

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