Vol. 30, No. 6,1997

NITROGEN SOURCE EFFECTS ON THE GROWTH AND DEVELOPMENT OF BURLEY TOBACCO TRANSPLANTS IN THE FLOAT SYSTEM.

B. Pearce and G. Palmer

INTRODUCTION

During the spring of 1996, many tobacco producers used a water soluble 20-10-20 fertilizer in their float beds, only to have to throw out the stunted sickly plants that resulted, and start over. The fertilizer that caused the problems turned out to have 100% of the nitrogen (N) as urea-N. It was hypothesized that the poor growth was related to with the conversion of the urea-N to other forms of N. There have been numerous other cases where producers using fertilizers high in urea-N or ammonium-N (NH4-N) have had problems with stunted plant growth. Further study of nitrogen transformations is warranted to determine what caused the poor growth, and to improve nitrogen management in tobacco float systems.

LITERATURE REVIEW

Nitrogen, one of sixteen elements required by all plants, is used by burley tobacco in relatively large quantities. Although N is slowly available to plants from natural sources, the majority of N used by tobacco comes from inorganic fertilizer. Most inorganic fertilizers contain N in three basic forms: urea, ammonium (NH4), and nitrate (NO3). Fertilizers can be formulated to contain varying proportions of each of these forms by choosing different ingredients. Tobacco plants generally show the best growth response to NO3-N. In the field, however, N can be satisfactorily supplied by any of the three fertilizer sources, because enzymes and microorganisms in the soil rapidly convert urea-N and NH4-N to NO3-N. An enzyme called urease breaks the urea-N down to NH4-N (urea hydrolysis). Urease is found in soils, plants, and plant residues, and is long lived even in the absence of the organism which produced it. The conversion of NH4-N to NO3-N is a called nitrification, and it is carried out by two groups of soil dwelling bacteria. These bacteria must be present in sufficient numbers for nitrification to occur.

As transplant production practices have moved away from the traditional plant bed to the newer float system, a new set of problems have been encountered. The potting mixes used in the tobacco float system typically do not contain any field soil. Such mixes have many advantages over soil based systems. They are lightweight, easy to handle, and are generally free of weed seed. Many of the components that are used to make up these soilless mixes (e.g., peat, vermiculite, perlite) are nearly sterile, so populations of microorganisms are relatively low compared to soil-based systems. This is an advantage in that it may reduce the potential for soil-borne diseases, but it also means that populations of beneficial organisms, such as nitrifying bacteria, are low or nonexistent. The activity of enzymes, such as urease, may also differ from their activity in field soils. Because of these important differences, we cannot directly apply the usual principles of soil fertility management to soilless mixes. Furthermore, this may be one of the reasons for the recent problems we have experienced with some types of fertilizers in the float system.

The horticulture industry has been using soilless mixes for the last 10 to 15 years. Studies with these mixes have shown that urea hydrolysis is generally found to occur to a much greater extent than nitrification, owing to the fact that urease is both stable and likely to be present in the peat that makes up the bulk of most mixes (Elliot, 1986). Nitrifying bacteria, on the other hand, are relatively scarce in peat (Herlihy, 1972). Elliot (1986) also observed an accumulation of nitrite (NO2, an intermediate in nitrification) in soilless media that had been cropped for four weeks. The hydrolysis of urea in the absence of nitrification, or the partial nitrification of N to nitrite (NO2), could lead to a toxic condition for plants fertilized with urea-N. The inherent rates of urea hydrolysis and nitrification have been found to vary widely from one type of potting media to the next (Elliot, 1986). It stands to reason that different tobacco mixes will vary considerably in their capacity to carry out these important N transformations. This could explain why some growers have had problems with urea containing fertilizers, while others have had good success using the same fertilizer.

Even though populations of nitrifying bacteria are initially low in most soilless mixes, several studies have shown that nitrification increases as a crop is grown in the media (Elliot, 1986; Lang and Elliot, 1991). These studies have shown that nitrification activity peaks at 4 to 6 weeks of cropping, and then declines. The reasons for the decline are not known. If such patterns exist in tobacco float systems, they may have a significant impact on the management N supply for transplant production.

The objectives of the study reported here were to evaluate the effects of different N-sources on tobacco transplant growth in the float system, and to look for evidence of N transformations. A secondary objective was to evaluate the use of liquid fertilizer formulations in the float system.

MATERIALS AND METHODS

Single tray beds were prepared in a glass greenhouse with 1" x 8" dimensional lumber. The individual beds were lined with 55 gallon plastic trash bags of 2 mil thickness. Forty liters of water was added to each bed. Beds were fertilized with the appropriate treatment at 100 ppm total N. The fertilizer treatment consisted of a check, which was a granular, water soluble 20-10-20 fertilizer that is commonly used with good success in tobacco float systems. The other treatments were liquid fertilizer formulations prepared by a fertilizer manufacturer with different sources of N used to make up the total N. The distribution of N sources is shown in Table 1. Treatments were assigned to individual beds in a randomized complete block design with three replications.

Primed and pelleted Tn-90 tobacco seed was sowed into 200-cell Styrofoam float trays using a vacuum seeder. For treatment N2, filled unseeded trays were floated on a water bed fertilized with liquid fertilizer containing only NH4-N. At 1, 2, and 3 weeks after seeding, counts were made to determine germination and survival. Water samples were collected weekly for determination of NO3-N and NH4-N. At six weeks after seeding plants were "harvested". Ten plants were randomly selected from each tray. The roots were carefully washed and separated from the plant tops. Roots and shoots were dried in an oven at 75oC for 48 hours, and the dry weight was recorded. Solution was extracted from the "plug" of each of the sampled plants, and analyzed for the presence of NO3-N and NH4-N.

RESULTS AND DISCUSSION

Liquid fertilizer formulations which had a high proportion of NH4-N caused the pH of the float water to increase (Table 2). This was due to the fact that the NH4 source was ammonium hydroxide. At this high pH the phosphorous (P) in the fertilizer precipitated with the calcium (Ca) in the tap water used in the float beds. To bring the pH back into an acceptable range, sulfuric acid was added, resulting in the adjusted pH (Table 2). By three weeks after seeding, the pH had stabilized.

Germination was good in all treatments, with seven-day germination percentages in the lower 90s (Table 3). However, between 14 and 21 days, there was a significant loss of plants in treatments N2, N3, N4, N5 and N6. The symptom observed was an overnight disappearance of leaf tissue, leaving only the stem and small midribs. The causal agent was identified as fungus gnat larvae. Damage was reduced after treatment with acephate. It is not clear why certain treatments were preferred by the fungus gnats; however, the reduced population in these treatments did result in greater individual plant growth due to less competition.

Figure 1 shows the changes in solution NO3-N concentration over time. Solution NO3-N concentration changed very little during the first three weeks of growth. Between the third and fourth weeks there was a slight increase in NO3-N concentration in the treatments which initially had no added NO3-N. This indicated that some nitrification was occurring. After four weeks, NO3-N concentration decreased rapidly due to plant uptake except in the no-plant (N2) treatment. Further evidence of nitrification can be seen in Table 4. A significant accumulation of NO3-N was observed in the N2 treatment where there were no plants to take up the nitrate produced. This suggests that nitrification did occur in the soilless tobacco media used in this study. The question remains as to whether this conversion is rapid enough to supply young tobacco transplants with enough NO3-N.

When plants were supplied with a fertilizer containing at least some NO3-N, they grew much better (Table 5). In the absence of NO3-N, shoot growth was significantly slowed due to the lower availability of N. Note the plants in treatment N6 grew much larger than the others. This is probably due to the fact that there was a greater loss of plants in this treatment than in the others. The remaining plants thus grew larger due to less competition for light.

CONCLUSIONS

Transplants grew faster and larger with a ready supply of NO3-N. Fertilizer containing a high proportion of urea appeared to cause a toxic response to tobacco transplants. Liquid fertilizer formulations performed as well as the commonly used water soluble formulation, and were found to be a convenient method of nutrient delivery in tobacco float systems. As a general recommendation, a fertilizer used in the float system should contain at least 50% of the total N in the NO3-N form with little or no urea-N.

REFERENCES

Elliot, G.C. 1986. Urea hydrolysis in potting media. Journal of the American Society of Horticulture Science. Vol. 111, pp. 862-866.

Herlihy, M. 1972. Microbial and enzyme activity in peats. Acta Horticulture. Vol 26, pp. 45-50.

Lang, H.J. and G.C. Elliot. 1991. Influence of ammonium:nitrate ratio and nitrogen concentration on nitrification activity in soilless potting media. Journal of the American Society of Horticulture Science. Vol. 116, pp. 642-645.

Table 1. Fertilizer Treatments.

Treatment	% Urea-N	%NH4-N	% NO3-N
Control+	0	40	60
N1	0	100	0
N2++	0	100	0
N3	0	80	20
N4	0	60	40
N5	0	40	60
N6	20	40	40
N7	100	0	0

+ The control was a 20-10-20 water soluble dry formulation, treatments N1-N7 were 6-3-6 liquid formulations.

++ Treatment N2 was not seeded.

Table 2. Effect of Fertilizer Treatments on Float Water pH.

Treatment	Initial	Adjusted+	21 Days
Control	7.13	7.20	7.37
N1	9.87	5.73	6.93
N2	9.90	5.87	7.17
N3	9.93	5.46	6.90
N4	8.80	4.77	6.73
N5	7.10	6.80	6.60
N6	7.87	5.30	6.17
N7	5.93	3.83	6.63

+ pH was adjusted with sulfuric acid.

Table 3. Effect of Fertilizer Treatments on Percentage Seed Germination and Plant Survival.

Treatment	7 days	14 days	21 days
Control	91	94	92
N1	93	94	80
N2	0	0	0
N3	93	92	70
N4	92	91	70
N5	93	92	77
N6	91	91	55
N7	92	95	93

Table 4. Solution Nitrate and Ammonium Concentration in Media Extract.

Treatment	NO3-N(ppm)	NH4-N(ppm)
Control	0.00c*	2.60b
N1	0.00c	2.31b
N2	61.60a	41.76a
N3	0.22c	2.91b
N4	0.45c	4.76b
N5	5.15b	4.53b
N6	3.43b	4.05b
N7	0.10c	5.53b

*Means followed by the same letter are not significantly different at p= 0.05.

Table 5. Effect of Fertilizer Treatment on Plant Growth.

Treatment	Fertilzer % NO3-N	Shoot (g/10 plants)	Root (g/10 plants)
Control	60	8.01 b*	1.32 b
N1	0	4.40 d	1.63 b
N2	0	NA+	NA
N3	20	6.51 bc	1.66 b
N4	40	7.76 b	1.38 b
N5	60	7.69 b	1.32 b
N6	40	10.42 a	2.47 a
N7	0	5.28 cd	1.65 b

* Means followed by the same letter are not significantly different at p= 0.05.
+ Treatment N2 was not seeded.

Figure 1. Nitrate-N Concentration in Float Water