Nitrification Of Aquatic Weed Tissues In Soil

D. N. RIEMER and S. J. TOTH

Department of Soils and Crops
College of Agriculture and Environmental Science
Rutgers—The State University, New Brunswick, New Jersey

INTRODUCTION

When underwater mowers or other mechanical harvesting devices are used to control aquatic weeds, disposition of the harvested plant material is often a problem. One solution would be to compost the harvested plants for agricultural use. This would provide a means of disposal and possibly even help to alleviate the expense of harvesting. For composting to be successful, the tissues would have to decompose and a reasonably high percentage of the nitrogen in the tissue would have to nitrify or be converted to nitrates by nitrifying organisms in the soil. The purpose of this study was to determine the rate and degree of nitrification of dried, ground aquatic weed tissues when added to soil under aerobic conditions.

METHODS AND MATERIALS

Aquatic weeds were collected from various sites in New Jersey, oven-dried and ground in a Wiley Mill to pass through a 30-mesh screen. Analysis for total nitrogen was made on each tissue using the Kjeldahl method. The tissues used in the tests, their dates of collection, and the percent nitrogen in each are presented in Table 1. Except for Spatterdock, the tissues represented the entire top growth of the plants. Spatterdock was separated into leaf blades and petioles because of the large difference in nitrogen content of these two structures.

The tests were conducted by weighing out amounts of dry, ground tissue equivalent to 20 milligrams of nitrogen and adding them to 100 grams of limed Sassafras loam soil in flasks which were loosely stoppered with cotton. The flasks were then incubated at room temperature for 2, 4, 6 or 8 weeks. Adequate moisture for microbial decomposition was maintained throughout the incubation period. At the end of each two-week period, the amount of nitrate-nitrogen in the soil of the designated flasks was determined by the phenoldisulphonic acid method. All analyses were run

TABLE 1. TISSUES USED IN NITRIFICATION TESTS SHOWING COLLECTION DATES AND NITROGEN CONTENTS.

Species	Date Collected	% N*
Alfalfa (*Medicago sativa*)	Sept.	3.77
Broadleaf Watermilfoil (*Myriophyllum heterophyllum*)	7 June	3.51
Cabomba (*Cabomba caroliniana*)	7 June	2.52
Elodea (*Elodea canadensis*)	5 June	3.12
Arrowarum (*Peltandra virginica*)	6 May	3.63
Spatterdock (*Nuphar advena*) Leaf blades	6 May	5.65
Spatterdock (*Nuphar advena*) petioles	6 May	2.43
Bladderwort (*Utricularia sp.*)	10 June	3.57
Burreed (*Sparganium sp.*)	10 June	2.54
Heartleaf Pondweed (*Potamogeton pulcher*)	10 June	2.11
Pickerelweed (*Pontederia cordata*)	9 June	2.03
Duckweed (*Lemna minor*)	8 July	3.38
Common Reed (*Phragmites communis*)	6 May	3.21
Common Reed (*Phragmites communis*)	3 June	1.94
Common Reed (*Phragmites communis*)	25 July	1.30
Common Reed (*Phragmites communis*)	21 Aug.	1.44

*Percent total N on dry-weight basis

on duplicate flasks and agreement between duplicates was generally excellent. All values presented in this paper are averages of the duplicate determinations.

Four series of tests were run. Three standards were included in each series for comparative purposes. These standards were: 1) controls in which no nitrogen source was added to the soil, 2) alfalfa, and 3) $(NH_4)_2SO_4$ which served as an easily nitrified inorganic source of nitrogen.

RESULTS

Test 1. The first test included the three standards plus broadleaf watermilfoil, elodea, and cabomba. The results of this test are presented in Table 2. The percent nitrification of added N was calculated by first subtracting the amount of nitrate-nitrogen found in the controls from the amount found in that particular treatment. This was done to account for the nitrogen present in the soil to begin with. The remainder, which represented nitrogen added in the plant tissue, is expressed as a percentage of the 20 milligrams added.

As would be expected, the $(NH_4)_2SO_4$ showed the highest degree of conversion to nitrates. The watermilfoil and elodea were almost identical to alfalfa but cabomba was close to zero at all times indicating that nitrogen from this tissue was essentially not converted to nitrates at all.

Test 2. The second test included the three standards plus phragmites collected in May, spatterdock leaf blades, spatterdock petioles, and arrowarum. The results of this test are presented in Table 3. Again $(NH_4)_2SO_4$ was highest as it was in every test. Spatterdock leaf blades were consistently higher than alfalfa, reaching 58% conversion by the end of the eighth week. This was the highest value recorded for any of the aquatic weed tissues studied. Arrowarum and phragmites had relatively low values while spatterdock petioles had a negative value after 2 weeks and rose to only 4.5% by the end of 8 weeks. These low values for spatterdock petioles indicate little or no nitrification of nitrogen from their tissues.

Test 3. This test included the three standards plus phragmites collected in early May, early June, late July, and late August. The results of this test are presented in Table 4. From that table it can be seen that as the phragmites grew older and the percentage of nitrogen in the tissue decreased, the ability of the nitrifying microorganisms in the soil to convert the nitrogen to nitrates also decreased. It should be remembered that enough tissue was added in each case so that the amount of nitrogen being added was constant at 20 milligrams regardless of the concentration of nitrogen in the tissue.

The phragmites collected in May was 1-2 feet tall and had a nitrogen content of 3.21%. It nitrified just slightly more than the controls and not nearly as well as the alfalfa. The phragmites collected in June was 5 feet tall with 8 leaves per stem and had not yet started to flower. The nitrogen content had dropped to 1.94% and nitrified less than the controls as evidenced by the negative values in the table. Those plants collected in July averaged 7 feet tall and were in the stage of flowering commonly known in grain crops as "emergence from boot." The nitrogen content was down to 1.30%. Flasks containing these tissues showed almost no nitrates at all until the eighth week, indicating that the tissue was inhibiting nitrification of all nitrogen in the soil, even that which was not added with the tissue. The phragmites collected in August averaged 8 feet tall and were fully headed. They contained 1.44% nitrogen and behaved very similar in the tests to the sample collected in July. The only difference was at the end of the eighth week when the July samples showed an upward turn while the August samples remained constant at a very low level.

Test 4. The final test to be reported on in this paper included the same three standards plus bladderwort, heartleaf pondweed, pickerelweed, burreed, and duckweed. The results are given in Table 5. Duckweed performed very well, being considerably above alfalfa at the end of each 2-week period. Of all the tissues tested, duckweed nitrified second best, being only slightly lower than

TABLE 2. PERCENT NITRIFICATION OF ADDED N IN TEST 1.

Nitrogen Source	Percent of Added N Nitrified			
	2 weeks	4 weeks	6 weeks	8 weeks
$(NH_4)_2SO_4$	85.5	94.7	99.5	77.0
Alfalfa	18.0	22.5	27.5	24.0
Broadleaf Watermilfoil	14.0	19.5	26.5	22.0
Elodea	15.0	24.5	27.5	29.0
Cabomba	− 7.0	0.0	− 3.5	4.5

TABLE 3. PERCENT NITRIFICATION OF ADDED N IN TEST 2.

Nitrogen Source	Percent of Added N Nitrified			
	2 weeks	4 weeks	6 weeks	8 weeks
$(NH_4)_2SO_4$	67.0	90.0	97.5	93.0
Alfalfa	22.0	35.5	41.5	50.2
Phragmites (May)	− 1.5	14.0	11.5	6.5
Spatterdock (leaf blades)	25.0	48.0	50.5	58.0
Spatterdock (petioles)	− 14.0	− 1.5	2.5	4.5
Arrowarum	11.0	15.5	15.0	13.0

TABLE 4. PERCENT NITRIFICATION OF ADDED N IN TEST 3.

Nitrogen Source	Percent of Added N Nitrified			
	2 weeks	4 weeks	6 weeks	8 weeks
$(NH_4)_2SO_4$	71.5	74.5	65.0	76.0
Alfalfa	25.0	29.5	17.0	24.5
Phragmites (6 May)	3.5	15.5	4.5	2.0
Phragmites (3 June)	− 18.5	− 16.5	− 21.5	− 2.5
Phragmites (25 July)	− 25.5	− 29.0	− 41.0	− 15.5
Phragmites (21 Aug.)	− 25.5	− 29.0	− 40.0	− 37.5

TABLE 5. PERCENT NITRIFICATION OF ADDED N IN TEST 4.

Nitrogen Source	Percent of Added N Nitrified			
	2 weeks	4 weeks	6 weeks	8 weeks
$(NH_4)_2SO_4$	73.0	80.5	75.5	87.5
Alfalfa	11.0	14.0	13.5	29.0
Bladderwort	3.5	14.0	8.0	16.0
Heartleaf Pondweed	− 35.0	− 37.5	− 36.0	− 25.5
Pickerelweed	− 28.0	− 30.5	− 28.0	− 19.5
Burreed	− 12.0	− 0.5	− 10.0	− 9.5
Duckweed	10.5	48.0	35.5	51.5

spatterdock leaf blades. Bladderwort was slightly below alfalfa but all the values were positive indicating more nitrification than the controls. Burreed, pickerelweed, and heartleaf pondweed all had less nitrate nitrogen in the soil than the controls, as shown by the negative percentages in table 5 under these species.

CONCLUSIONS

Certain conclusions can be drawn from these experiments as follows:

1. Aquatic weed tissues vary tremendously in the ease with which nitrogen contained within the tissues is converted to nitrates by soil microorganisms.

2. Certain tissues not only nitrify poorly themselves, but inhibit or prevent conversion of nitrogen already present in the soil from other sources. There are several possible explanations for this. First, a chemical inhibitor may be present in these tissues which affects the microbiota. Second, the carbon-nitrogen ratio may be so high that microbiol decomposition cannot occur. Finally, it is possible that microbial populations build so high in soils containing these tissues that they utilize the nitrates as fast as they are produced, resulting in low nitrate values when the analyses are performed.

3. With one species at least, the age or stage of growth of the plant has a pronounced effect on nitrification. This is obvious in the phragmites experiment but it is unknown at this time what effect, if any, there would be in the case of floating or submersed species.

4. Some aquatic weeds can be composted for agricultural use without the addition of extra nitrogen but no blanket statement can be made regarding all aquatic weeds.