WEED CONTROL

Effects of 3-Amino-1,2,4-triazole and Derivatives On Nutgrass and Johnson Grass

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The chemical 3-amino-1,2,4-triazole and four related compounds were sprayed on nutgrass (*Cyperus rotundus* L.) and Johnson grass (*Sorghum halapense* L., Pers.) in greenhouse experiments. Intact tuber systems were treated to study the translocation of aminotriazole. Severe foliar chlorosis in new growth resulted from application of aminotriazole to the roots, shoots, and tubers; the effects persisted for several weeks following certain spray applications. The chemical was readily translocated through the foliage and into the tuber system, through intact tuber systems separated from the parent plant, or from roots to the foliage. The possibilities of using aminotriazole for the control of perennial weeds are discussed.

Nutgrass (*Cyperus rotundus* L.) is one of the most troublesome weeds in the southeastern United States. Reproduction by seed is rare (*2*), but nutgrass spreads readily and vigorously by means of underground tubers formed successively at the tips of growing rhizomes. Tubers possess a variable number of buds and several shoots may grow from each tuber. Some measures, notably soil fumigation or sterilization (*3*, *4*), have proved effective as control methods but their use on a large scale is not economically feasible. Preliminary greenhouse experiments, in the fall of 1953, showed that 3-amino-1,2,4-triazole (aminotriazole) temporarily inhibited chlorophyll formation and was translocated in nutgrass. Another experiment was conducted to determine the effect of aminotriazole on Johnson grass. This paper is concerned with the effects of several aminotriazole compounds on nutgrass and Johnson grass and the potential use of these compounds as herbicides for the control of these and other weeds. Preliminary studies have indicated the phytotoxicity of aminotriazole to several plants (*5*).

Materials and Methods

Nutgrass Studies Established nutgrass plants, transplanted from the field and grown in 4-inch pots in the greenhouse, were sprayed with 3-amino-1,2,4-triazole and several related compounds at rates of 1 and 4 pounds per acre. The chemicals used were 3-amino-1,2,4-triazole; 3-amino-1,2,4-triazole formulated with a wetting agent; 3-amino-1,2,4-triazole salts of 2,4-dichlorophenoxyacetic acid (2,4-D), 2-methyl-4-chlorophenoxyacetic acid (MCP), 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), and phosphoric acid (supplied by American Chemical Paint Co., Ambler, Pa.). A pot containing one plant was the experimental unit. The treatments were made in duplicate at a volume rate of 42 gallons per acre. Tubers from the treated plants were germinated to observe the effect of the chemicals on the seedlings.

In further experiments, translocation of aminotriazole through tuber chains was studied by separating the chains (obtained from field soil) from the parent plants and briefly dipping the terminal tuber of each chain into a solution of aminotriazole plus 0.5% Tergitol 7, an anionic wetting agent (supplied by Union Carbide and Carbon Co., New York City). The concentrations of aminotriazole used were 0, 100, 1000, and 10,000 p.p.m. The chains used contained four to nine tubers and varied in length from 9 to 22 inches. The treatments were replicated four times. After dipping, the chains were allowed to dry 1 hour on absorbent paper and then planted in sandy soil maintained at a moisture level of approximately field capacity by subirrigation. Thirty days after treatment, the intact chains were removed and observed. All ungerminated tubers were separated from the chains to break their dormancy and were planted individually in Vita-Band boxes filled with soil. Twelve weeks after treatment final observations of the tubers, tuber seedlings, and ungerminated tubers were made.

To determine if aminotriazole is absorbed by nutgrass roots and translocated to the growing point, 1 cm. of the root tips of three individual plants were dipped into a 1% solution plus wetting agent and planted individually in 4-inch pots. Previous to the treatment, the plants were separated from the tubers and rhizomes. Observations of the extent of chlorosis in the new growth were made.

Johnson Grass Studies Johnson grass rhizomes were planted in metal cans (5-quart capacity) and the plants were grown under greenhouse conditions. The plants were cut to a height of 3 inches twice but allowed to regrow to a height of 12 to 18 inches before treatment. The soil surface was covered with absorbent paper during the spraying process to prevent contact of the chemical with the soil. Aminotriazole plus 0.5% Tergitol 7 was sprayed on two replicates of plants at

rates of 1 and 4 pounds per acre. Two weeks after treatment, the rhizomes, which averaged 4 to 6 inches in length, were sectioned into segments containing two nodes and one internode each. The segments were planted in metal flats containing sandy soil. The new shoots were observed for chlorotic symptoms.

Results

Nutgrass Responses Aminotriazole and its phosphoric acid salt applied to the foliage of nutgrass caused severe inhibition of chlorophyll production in new foliar growth. Chlorophyll present in leaves at time of treatment was not visibly affected. The symptoms were most severe following application of aminotriazole formulated with a wetting agent. Little or no chlorosis resulted when nutgrass was sprayed with the aminotriazole salts of MCP, 2,4-D, and 2,4,5-T.

The tubers, which under greenhouse conditions were usually present in one- or two-tuber chains, were separated and planted individually 30 days after treatment of the parental plants. The amount of chlorosis exhibited in shoots produced by the tubers was correlated with the extent of chlorophyll inhibition in the parent plants. The most chlorotic shoots were from plants sprayed previously with the wetting agent formulation, indicating that the surface active agent enhanced penetration and translocation of the chemical. All of these plants were stunted, unthrifty, and chlorotic for a period of 6 to 8 weeks after treatment, then the new growth was green and apparently healthy. Seedlings from plants treated with the aminotriazole salts of the growth-regulators 2,4-D, MCP, and 2,4,5-T showed little or no chlorophyll inhibition.

Other experiments showed that if 2,4,D-aminotriazole mixtures were sprayed on nutgrass the responses were similar to those obtained after treatment with the aminotriazole salt of 2,4-D—i.e., little chlorosis was observed.

Translocation of Aminotriazole In Nutgrass Intact tuber systems, separated from the parent plants, were treated as previously described. The terminal tubers of the untreated chains, and terminal tubers treated with 100 and 1000 p.p.m., sprouted while the chains were still intact. Slight chlorosis developed in shoots of terminal tubers dipped in 100 p.p.m. of aminotriazole, while moderate chlorosis appeared in those dipped in 1000 p.p.m. None of the terminal tubers in chains treated with 10,000 p.p.m. had germinated 30 days after treatment.

One month after treatment, all the unsprouted tubers were separated from the chains and planted individually. Eighty per cent of the tubers from untreated chains, and 75 and 100% of tubers from chains treated with 100 and 1000 p.p.m., respectively, sprouted. In neither case, during 30 days after treatment, did the chemical move from the treated tubers to others in the chain in sufficient quantity to produce appreciable chlorophyll inhibition in the shoots. All new shoots, produced from tubers in chains treated with 10,000 p.p.m., were chlorotic and usually the symptoms were moderately severe. Following treatment with this concentration, several untreated tubers adjoining the terminal tubers in the chain did not germinate. Observations made 12 weeks after treatment indicated that the buds of unsprouted tubers were dead.

Table I. Rate of Translocation of Aminotriazole in Nutgrass Tuber Chains

Concn. of Aminotriazole, P.P.M.	No. of Tubers in Chain	Translocation	
		Total distance, cm.	Average rate, cm./1 day
10,000	6	35.6	1.19
10,000	5	17.8	0.59
10,000	4	22.9	0.76

The longest chain treated with 10,000 p.p.m. contained 6 tubers, and was 35 cm. long. Aminotriazole, at this concentration was translocated through the chains at an average rate of at least 1 cm. per day (Table I). Because all the tuber sprouts in chains receiving 10,000 p.p.m. were chlorotic, the rate of translocation was obtained by dividing the total length of the longest chain by the number of days between the day of treatment and the date the tubers were separated from the chains and planted.

To reduce the possibility that movement occurred over the surfaces of the chains after planting and not by translocation through the systems, several terminal tubers in chains of varying lengths were dipped as previously described and were allowed to absorb the chemical for 1 hour. The entire systems were then washed in a series of water-detergent solutions and tap water. This process has been used successfully to remove herbicide residues from soybean plants (*7*). Seedlings from tubers which were not actually dipped in aminotriazole were chlorotic showing that movement occurred through the rhizome and tubers.

Roots of three nutgrass plants were dipped into aminotriazole solution and then the plants were reset into 4-inch pots. The new foliar growth was severely chlorotic, indicating that aminotriazole is readily translocated from the roots to the aboveground parts.

Johnson Grass Responses The new growth of Johnson grass was chlorotic following spray application of both rates of aminotriazole. Two weeks after treatment, the rhizomes were sectioned and planted. Shoots from rhizomes of plants treated with aminotriazole, especially at the 4-pound rate, were severely chlorotic, indicating that the chemical was translocated to the rhizomes.

Discussion

Responses induced by aminotriazole in nutgrass and Johnson grass indicate that this compound may be potentially useful in the weed-control field. Under greenhouse conditions, the severe chlorotic symptoms resulting from the most effective treatments persisted for a period in excess of 6 weeks. However, in most cases, the plants were not killed and were very slowly recovering when the experiments were terminated. Although photosynthesis in the new growth was disrupted, presumably respiration continued. Such a reaction, if it could be extended over a considerable period of time under field conditions, would be expected to exhaust the reserve food supply in underground storage organs of susceptible perennial weeds. The herbicidal potentialities of aminotriazole in combination with tillage operations should be investigated.

Aminotriazole is very interesting from a physiological standpoint because of its striking effect on new growth. Spray applications of 1 pound per acre induced severe chlorosis in the new growth of nutgrass, yet the application of 2,4-D-aminotriazole mixtures or an aminotriazole salt of 2,4-D permitted near normal or partial production of chlorophyll. Further research is needed to clarify these relationships.

Literature Cited

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