A Picolinic Acid Derivative: A Plant Growth Regulator

Abstract. *4-Amino-3,5,6-trichloropicolinic acid is more toxic to many broad-leaved plants than 2,4-dichlorophenoxyacetic acid and 2,4,5-trichlorophenoxyacetic acid. It is comparable in absorption by foliage, in translocation, and in soil-leaching characteristics; in soil, however, it retains its activity for a longer time.*

The herbicide Tordon (4-amino-3,5,6-trichloropicolinic acid) is highly toxic to broad-leaved plants, but only moderately toxic to grasses. It produces distortions of growing tissue and curvature of leaves and stems. It is generally more effective on broad-leaved plants than either 2,4-dichlorophenoxyacetic acid (2,4-D) or 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) and has other properties which could make it uniquely useful as a herbicide.

Tordon, 2,4-D, and 2,4,5-T were compared at a series of dosages on a number of plant species in the laboratory by application to the soil before seeding. Pots of sandy loam soil (*p*H, 5.5; 0.3 percent organic matter) were drenched with aqueous salt solutions of the chemicals. The pots were seeded, capped with sand, and held in a greenhouse for several weeks with regular watering. The plants were compared with check plants for the amount of top growth, and an estimation was made of the values (Table 1) for 90 percent reduction. Except for cabbage, mustard, and radish—all of the family Cruciferae—Tordon appears to be generally more toxic than either 2,4-D or 2,4,5-T for broad-leaved plants.

Safflower and soybeans were particularly sensitive and other tests have demonstrated the great sensitivity of several legumes to Tordon. Grasses were moderately tolerant to all three chemicals.

When applied to foliage, the relative activities of Tordon, 2,4-D, and 2,4,5-T were generally similar to the results of treating the soil before plantings were made. This suggests good absorption of Tordon into the leaves.

To compare (*1*) translocation of the three chemicals, the second full leaf of cucumbers in the four-leaf stage was immersed in aqueous solutions of salts of the herbicides. Sublethal concentrations which produced symptoms of equal severity for the three herbicides when applied to the foliage were used, namely, Tordon, 0.8 ppm; 2,4,5-T, 80 ppm; and 2,4-D, 320 ppm. The plants were observed for the development of symptoms on the treated leaf and on other portions of the plant. All three chemicals produced symptoms in the plants at about the same time (twisting and other formative effects). This suggests that they were initially absorbed and translocated at about the same rate. However, less tissue necrosis occurred to the immersed leaf in the case of Tordon, and thus absorption might be expected to continue for a longer time, perhaps allowing greater absorption.

The potential usefulness of Tordon for soil application, as indicated by Table 1, will be influenced greatly by the chemical's leaching characteristics and its rate of loss of effectiveness in soil. To show that Tordon is about as easily leached from soil as 2,4-D or 2,4,5-T, the three chemicals were applied to the top of columns of the sandy loam soil in plastic tubes at the rate of 110 kg (acid equivalent)/hectare (100 lb acid eq/acre) and then leached with 5, 10, or 20 cm (2, 4, or 8 in.) of water.

After drainage was complete, the tube was laid on its side, a longitudinal section of the plastic tube was cut out, and the exposed soil column planted to radish as an indicator plant. In all cases, soil columns leached with 5 cm (2 in.) of water produced symptoms on the radish plants to a depth of 30 cm (12 in.) or more. Leaching with 20 cm (8 in.) of water moved the chemicals so far down that no symptoms were observed on the radish plants until a depth of at least 25 to 30 cm (10 to 12 in.). Of course, a more sensitive indicator plant would have shown symptoms at somewhat deeper and shallower depths, respectively. It appears that, like 2,4-D and 2,4,5-T, Tordon is easily leached under high rainfall conditions. Control of shallow-rooted annual weeds would probably not be maintained, but excellent control of deep-rooted plants might be expected.

Another experiment showed that the loss of effectiveness of Tordon in soil is relatively slow. Six-inch plastic pots filled with the sandy loam soil were drenched with chemicals and seeded with cucumbers and oats. When sufficiently mature, the responses were graded and the plants harvested. The pots were replanted and a regular schedule of light watering was maintained. When applied originally at 5.5 kg/ha (5 lb/acre), 2,4-D ceased to affect cucumbers after 56 days, 2,4,5-T after 87 days, while Tordon was still killing the plants at 568 days.

Table 1. Comparative toxicity of Tordon, 2,4-D, and 2,4,5-T (calculated as acid equivalent) when applied to soil before planting.

Test plant	Estimated dose for 90 percent growth reduction (kg/hectare)		
	Tordon (Na salt)	2,4,5-T (amine salt)	2,4-D (amine salt)
	Broad-leaved plants		
Cabbage	5.5	2.7	3.9
Cotton	0.023	0.34	0.34
Dichondra	0.044	1.4	2.7
Mustard	11.0	3.9	4.4
Pig weed	0.044		
Radish	18.0	6.6	2.2
Safflower	0.0021		
Soybeans	0.0027	0.68	0.68
Sugar beet	0.22	2.2	1.1
Sunflower	0.088		
Tomato	0.0057	2.7	1.4
	Grasses		
Barley	0.69	2.7	1.4
Oats	5.5	>11.0	11.0
Wheat	1.4	1.4	0.68

A quantitative estimate of the remaining herbicide was obtained by serial dilution of the soil with fresh soil and planting the resulting soil mixtures with cucumbers and with oats. By matching the degree of formative effect produced with that obtained in the same soil to which known amounts of herbicide were added, it was estimated Tordon retained 50 percent of its effectiveness after 568 days, while monuron had retained only 2 percent. However, further experiments with a variety of soils indicates that this represents an extreme case and that Tordon may lose its effectiveness more rapidly in many field soils (*2*).

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References and Notes

1. T. I. King, *Contrib. Boyce Thompson Inst.* **15**, 165 (1958).
2. We thank C. R. Youngson and J. D. Nault for technical assistance.

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