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Herbicides: Combination Enhances Selectivity

Abstract. *The herbicides* N-*(3-chloro-4-methyphenyl)-2-methylpentamamide (solan) and 1, 1′-dimethyl-4, 4′dipyridylium dichloride (paraquat) were less toxic to tomato plants when applied together than either one alone. However, the combination was more toxic to crabgrass and eggplant. This phenomenon may result from the interaction of the herbicides with photosynthesis.*

The herbicide solan, *N*-3-chloro-4-methyphenyl)-2-methylpentamamide is a selective foliar herbicide for controlling weeds in tomatoes. It inhibits photosynthesis in intact plants (*1*). Herbicides of this type inhibit the Hill reaction of isolated chloroplasts (*2*). Another herbicide, 1,1′-dimethyl-4,4′ dipyridylium dichloride (paraquat), depends on photosynthesis for its phytotoxic action; treated plants show very little injury when placed in the dark. Apparently photosynthesis supplies the potential to reduce the paraquat molecule to a free radical. Formation of free radicals appears to be associated with phytotoxicity (*3*). Another photosynthetic inhibitor, 3-(*p*-chlorophenyl) 1,1-dimethylurea (monuron), delayed the action of 1,1′-ethylene-2,2′-dipyridylium dibromide (a relative of paraquat) (*4*).

We have investigated the effects of combinations of solan and paraquat on tomato (*Lycopersicon esculentum*) and crabgrass (*Digitaria sanguinalis*) in the greenhouse. The herbicides were sprayed on the leaves of 4-week-old tomato plants and 2½-week-old crabgrass seedlings. One week later, when the plants were either dead or recovering, they were weighed.

Table 1 shows the effect of solan and paraquat alone and in combination on the growth of tomato plants. Either herbicide was quite toxic if the rate was high enough. However, the addition of a small amount of paraquat reduced the effect of solan. Furthermore, the addition of 0.5 to 2 pounds per acre (0.55 to 2.2 kg/ha) of solan to 0.1 or 0.2 pound per acre (0.11 or 0.22 kg/ha) of paraquat also reduced injury. Hence either herbicide partially reverses the toxicity of the other. The statistically significant stimulation of growth by 0.025 pound per acre (0.03 kg/ha) of paraquat alone was not observed at higher rates. The importance of this observation cannot be determined without further work. In contrast, combinations of the herbicides resulted in greater injury to crabgrass seedlings (Table 2). Initially, a protective effect was also observed on crabgrass. However, by the end of the experiment this effect disappeared.

Table 1. Effect of solan, paraquat, and combinations of solan and paraquat on the growth of tomato. Data presented are averages of six replications.

Paraquat (kg/ha)	Fresh weight (g) with solan treatment, in kilograms per hectare, indicated				
	0	0.56	1.12	2.24	4.48
0	3.24	1.85	1.41	0.48	0.57
0.028	3.81	3.33	3.20	2.29	.85
.056	3.16	3.11	2.58	1.96	.87
.112	1.23	2.63	2.55	1.75	.72
.224	.25	1.11	.77	1.04	.39

Least significant difference at 5 percent, .28; at 1 percent, .37.

Table 2. Effect of solan, paraquat, and combinations of solan and paraquat on the growth of crabgrass.

Paraquat (kg/ha)	Fresh weight (g) with solan treatment, in kilograms per hectare, indicated				
	0	0.560	1.120	2.240	4.480
0	1.79	0.74	0.44	0.41	0.48
0.028	.85	.47	.42	.36	.31
.056	.36	.29	.37	.30	.23
.112	.35	.24	.22	.19	.22
.224	.24	.30	.24	.18	.20

Least significant difference at 5 percent, .17; at 1 percent, .23.

Table 3. Effect of solan, paraquat, and a combination of solan and paraquat on the growth of tomato and eggplant.

Herbicide (kg/ha)	Fresh weight (g)	
	Tomato	Eggplant
Control	8.7	3.40
Solan (0.560)	8.6	0.63
Paraquat (0.280)	2.5	.26
Solan (0.560) + paraquat (0.280)	5.6	.20

Least significant difference at 5 percent; tomato, 1.9; eggplant, .04,: at 1 percent; tomato, 2.8; eggplant, .06.

The different responses of tomato and crabgrass are difficult to interpret and are probably the result of complex interactions. The protective effect of solan against paraquat toxicity to tomato plants may be related to the inhibition of photosynthesis by solan. The protective effect of paraquat against solan is difficult to interpret. Greater injury by the combinations on crabgrass may be related to the smaller size of the crabgrass seedlings in relation to the tomato plants. Tolerance to solan in tomato plants increases rapidly with age (*1*).

To investigate these interactions further, eggplant (*Solanum melongena*), an extremely sensitive plant, was selected for comparison with tomato plants of the same age. The plants were 5 weeks old and there were three replications. The larger tomato plants used in this experiment had already become quite tolerant to solan (Table 3). Apparently, solan protected tomato but not eggplant against paraquat.

Toxicity increased on crabgrass and decreased on tomato if solan was combined with appropriate low concentrations of paraquat (*5*).

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References and Notes

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