New Herbicides for Vegetables

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Introduction

A number of issues pose threats to the existing vegetable herbicides, among them the Food Quality Protection Act, the Clean Air Act as well as the withdrawal of herbicides by the manufacturers. Clearly the loss of any herbicide would have severe repercussions to vegetable weed management programs. There are several strategies for dealing with the potential loss of herbicides in vegetables:

1. Search for new replacement herbicides.
2. Develop integrated weed management strategies to “protect” existing vegetable herbicides. These strategies would utilize chemical and nonchemical weed control tools as well as knowledge of weed biology to make the best use of existing vegetable herbicides.
3. Develop herbicide resistant vegetables.

Of course to create the greatest number of options we should consider all three strategies. However all strategies do have major limitations. This presentation will focus on strategy no. 1. There are severe limitations to this strategy, among them the small number of herbicides old or new that fit the very narrow set of criteria necessary for a vegetable herbicide. The objective of the research discussed here is to search for vegetable herbicide tolerance in a pool of new low-risk herbicides.

Materials and methods

Broccoli, cantaloupe, carrot, lettuce, onion, spinach, and tomato were screened for tolerance to low-rate herbicides at four locations in California. Preemergence rates tested at all locations were: carfentrazone at 0.05, 0.1, 0.15 and 0.2, dimethenamid at 0.94 and 1.2, fluamidine at 0.525, 0.6, and 0.675, flumioxazin at 0.0625, 0.125 and 0.25, halosulfuron at 0.032 and 0.047, isoxaben at 0.25 and 0.5, rimsulfuron at 0.0156 and 0.0313, and sulfentrazone at 0.15 and 0.25 lb ai/A. Postemergence rates tested at all locations were: carfentrazone at 0.01 and 0.03, cloransulam at 0.0078 and 0.0156, dimethenamid at 1.5, halosulfuron at 0.032 and 0.047, imazamox at 0.032 and 0.04, rimsulfuron at 0.0313, sulfentrazone at 0.15 and 0.25, and triflusulfuron at 0.0156 and 0.0313 lb ai/A. Tests were conducted at the University of California, Coachella Valley Agricultural Research Station at Indio, CA, the University of California, Davis, Vegetable Crops Unit at Davis, CA, the USDA Station at Brawley, CA and the USDA Station at Salinas, CA. Stand counts, crop phytotoxicity estimates and crop biomass were taken at all sites.
Results

**Preemergence.** Broccoli and carrot were not tolerant to any of the herbicides tested. Cantaloupe was tolerant of halosulfuron at 0.032, while lettuce was tolerant to carfentrazone at 0.05 and 0.1 lb ai/A. Onion injury resulting from carfentrazone at 0.05 lb ai/A was acceptable. Treatment with carfentrazone at 0.05, dimethenamid at 0.94, and fluamide at 0.525, 0.6 and 0.675 lb ai/A all resulted in acceptable levels of spinach injury. Tomato was tolerant to carfentrazone at 0.15, dimethenamid at 0.94, and halosulfuron at 0.032 and 0.047 lb ai/A. All combinations not previously mentioned resulted in unacceptable crop injury.

**Postemergence.** Broccoli, carrot and onion were not tolerant to any of the herbicides tested. Herbicides with acceptable tolerance in cantaloupe were: halosulfuron at 0.04 and rimsulfuron at 0.031 lb ai/A. Lettuce was tolerant to imazamox at 0.032 and 0.04 lb ai/A. Spinach treated with cloransulam at 0.008 and 0.016 and dimethenamid at 1.5 lb ai/A resulted in acceptable levels of injury. Processing tomato was tolerant to halosulfuron at 0.032 lb ai/A. All combinations not previously mentioned resulted in unacceptable crop injury.

Discussion

**Constraints to the development of new vegetable herbicides.** There are a number of constraints to the development of new vegetable herbicides: (1) the small potential market, (2) the high liability exposure for manufacturers, (3) complex crop rotation sequences. Given the large acreages of the major crops and the small acreages of vegetable crops, there is very little incentive for private industry to focus efforts on developing new vegetable herbicides. Furthermore, the high value of vegetable crops means that by selling herbicides into these crops an agricultural chemical company is exposed to high liabilities. For example the average acre of soybean in 1998 was worth $208 and the average acre of lettuce was worth $5,300 (Anonymous, 1999). To sell a soybean herbicide at $20/A and a lettuce herbicide at $50/A the manufacturer would be exposed to sales: liability ratios of approximately 10:1 and 100:1 for soybean and lettuce, respectively. These strong disincentives for herbicide manufacturers is exactly the reason that the IR-4 program exists, that is to facilitate minor crop registrations.

**Physical limits to the number of new vegetable herbicides.** A chemical company might screen 80,000 compounds to find one compound that is eventually sold on the marketplace (Lichtner, 1999). In the research reported above, 11 registered herbicides were screened for vegetable herbicide tolerance. This means that approximately 880,000 compounds were screened originally to find these 11 herbicides. For example, in cantaloupe we found tolerance in 2 out of 11 compounds screened. This means that about 440,000 compounds must be screened to find one cantaloupe herbicide. By similar reasoning about 880,000 compounds must be screened to find one lettuce, onion or spinach herbicide, 440,000 compounds must be screened to find one tomato herbicide, and more than 880,000 compounds must be screened to find a broccoli or carrot herbicide. The total number of chemical companies has been steadily declining in recent years. Does this mean that the total number of potential vegetable herbicides screened annually is also declining?
Conclusion

1. Screening for herbicide tolerance in vegetables is a long-term project with a low rate of success. It will take at least 10-15 years to find replacements for existing vegetable herbicides.

2. The existing vegetable herbicides that we have are extremely valuable tools. We need to use them judiciously, and do everything we can to protect them. Integrated methods of weed control appear to be the best approach. For example, by understanding the biology of our weeds, making optimal use of mechanical cultivation, and adjusting our herbicide rates and choices according to expected weed pressures, we may be able to limit some of our herbicide use in vegetables. A great deal more research must go into this approach.

3. The development of herbicide resistant vegetables may be the most rapid method to increase the number of herbicide options available in vegetables. We should consider this option.

Literature cited


Lichtner, F. 1999. Herbicide development. 1999 Weed School Notes, Weed Research and Information Center, University of California, Davis pp. 235-244.