Managing Flea Beetles on Brassica Greens

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Flea beetles are small oval-shaped beetles with large hind legs that enable them to jump large distances. Many species of flea beetles exist, and each species is adapted to be able to locate, feed and reproduce on a certain plant group. Crucifer and striped flea beetles feed on Brassica crops as well as weeds that are in the same family, such as yellow rocket or wild mustard. Other species of flea beetles attack other crop families: solanaceous crops such as eggplant, potato, and tomato, or sweet corn, for example. These beetles may look very similar to those that attack Brassicas, but if they are feeding on a different crop group, they are almost certainly a different species of flea beetle. Thus, management strategies for flea beetles in Brassica greens needs to focus on cultural practices and insecticides that are used specifically in Brassica crops.

The crucifer flea beetle (*Phyllotreta cruciferae)* is uniformly black and slightly shiny, about 2 mm in length, and is the most abundant species on Brassicas in New England. The striped flea beetle (*Phyllotreta striolata)* can be distinguished from the crucifer flea beetle by two yellow stripes, one on each side of its back. Neither is native to North America. Crucifer flea beetle has achieved pest status fairly recently; it was first reported in the Northeast in the 1950's.

Feeding damage and crop preference. Flea beetle adults feed on the surface of leaves and stems, resulting in numerous small holes, or 'shot-holes'. Intensive feeding damage can kill plants, especially young seedlings, and moderate damage can reduce plant size, delay maturity, reduce yield, or render crops unmarketable. In addition, flea beetle larvae feed on roots. Their damage is less obvious and has not been well studied, but may also cause reductions in the size and health of plants.

Flea beetles show differences in preference and feeding behavior among the Brassica species. Most of the Brassica vegetable crops that are of European origin (cabbage, broccoli, cauliflower, Brussels sprouts, collards, kale, and kohlrabi) are variations of the same species, *Brassica olerace*a. The cotyledons of these crops tend to be very attractive to flea beetles, but as plants develop the leaves become more waxy. The waxy surface is more difficult for beetles to grasp and feed; as a result, beetles feed mostly at the leaf margins in older crops. While waxiness varies among these crops, in general, once seedlings are past the two or three leaf stage, flea beetles tend to be less of a pest problem.

Many Brassica greens – and also Brassica root crops -- belong to different *Brassica*s species that are more preferred by flea beetles. These include *Brassica rapa* (Pac choi, Choi Sum, Chinese cabbage, tatsoi, mizuna, komatsuna, turnip), *Brassica juncea* (mustards), and *Brassica napus* (red Russian kale, rutabega). There are also Brassica greens from other genera including *Raphanus sativus* (radish, daikon) and arugula (*Eruca vesicaria*)*.* Most farmers who produce Brassica greens are well aware of the preference that flea beetles have for these species compared to the *Brassica oleracea*. A key difference is that these species have non-waxy leaves, which are easier to grasp and feed. There may be other differences in plant chemistry that play a role. There is also evidence that larvae survive better on these species. Feeding occurs across the whole surface of the leaf and feeding continues from the seedling stage until harvest. Holes that are made to small leaves expand as the leaf grows. Control is needed throughout crop growth. While some markets are more demanding than others, many markets will not accept greens with even slightly shot-holed appearance.

Flea beetle life cycle. In the autumn, adult flea beetles move into shrubby or wooded areas near fields where they have been feeding. At UMass we have sampled overwintering beetles in different types of habitats in or next to fields. We found the highest numbers in shrubby borders, somewhat fewer in the woods, and virtually none in more open grassy areas near the edge of the field. This is consistent with what has been found by researchers in other regions.

Adults become active and leave overwintering sites to feed and mate in early spring. In 2003 we collected beetles from the field every week from late April through September and dissected them to determine when female beetles contained eggs. The first eggs were found in female beetles in mid May.

Eggs are laid in the soil near host plants, and larvae feed on root hairs and roots. The rate of larval development is temperature-driven, so cooler soils will result in slower growth and delayed emergence of the summer adult generation. It requires 456 Degree days (with a base temperature of 51.8 °F, or 11 °C) for development from egg to adult (Kinoshita 1979). Depending on temperature, the new generation of adults will begin to emerge in mid to late July. Based on what we found in 2003, we believe that at least some of these summer beetles produce offspring. Eggs were found in dissected beetles until the end of August. Larvae from these eggs would emerge as adults during the fall.

Newly emerged beetles appear to have a strong propensity to feed. In cage studies of field-collected beetles, adults collected in early August fed at a higher rate (ie, the same number of beetles produced more holes per plant in 24 hours) than those collected in spring. In late August and early September, feeding by field-collected beetles declined greatly. At that time, some beetles are likely to be leaving the field to find overwintering sites.

What does this mean for growers? We hope that this information suggests how certain cropping systems create a very favorable environment for flea beetles – and what changes might help reduce their numbers. Succession-planted Brassica crops, side by side in the same field, provide a steady supply of food for both adults and larvae from early spring to fall. Planting Brassica greens that are preferred host plants also favors higher populations. On small farms with few rotation options, spring plantings may be close to the fields that were used for Brassicas the previous fall, which makes it easy for flea beetles to colonize the spring crops in large numbers. Greens are often especially important for organic growers, and effective organic insecticides have not been available. The combined result is that we are seeing an increase in pest pressure for longer periods of the growing season. Growers have reported finding more beetles not only in spring crops, but also in August-planted Brassicas. For example, fall broccoli suffers heavy feeding damage in mid August, most likely from newly emerged summer beetles.

Management strategies. Below are several cultural practices that can be used to reduce flea beetle damage to Brassica crops. They may or may not be suitable for a particular farm.

Crop rotation. To reduce and delay flea beetle invasion of spring crops, move them as far away from the fields that were used for fall Brassica crops as possible. Barriers such as woods, roads, waterways, etc. help slow movement from overwintering sites to the new spring field. We do not know enough about beetle flight patterns to answer the question 'how far is far enough?" We do know that any rotation is better than none, and the farther the better.

Delayed planting. If no Brassica crops are planted until mid to late July, this will stop the reproductive cycle because overwintered beetles will have no where to feed or reproduce (except on Brassica weeds). This strategy can be very effective in bringing the numbers down. Some mesclun growers use only non-Brassica greens in their mix until late summer. Depending on your markets, this strategy may require serious adjustments to the farm's production and marketing plan – and may not be feasible. It is hard to imagine a successful farmstand or CSA farm with no Brassicas until fall.

Separate early and late crops. Let's assume that emergence of the summer generation of beetles from a spring crop begins in mid July. If there are young Brassicas close by, they will be heavily damaged. However, if fall Brassicas are seeded into an isolated, rotated field, beetle numbers will be low and the crop will suffer much less damage.

Provide crops with good growing conditions. Research studies have shown that well-fertilized plants growing in good soil with adequate water are attacked less than plants that are wilted, poorly fed, or growing in compacted soil. While this may not overcome a large flea beetle population, it can make a difference in plant survival, growth and quality.

Using row covers. One of the best ways to protect Brassica crops from flea beetles is to place a floating row cover over the bed or row. At UMass we have conducted trials of various insecticides for the past three years, and we usually include row cover as one treatment. The cleanest, highest quality greens are always those under row cover. For growers with relatively small (<1/2 acre) plantings row covers can be practical and cost-effective; however, they are a management-intensive system.

It is critical to seal the edges immediately after seeding, because Brassica seeds germinate quickly and beetles rapidly invade the emerging cotyledons. Flea beetles can fit through extremely tiny cracks when they want to. Edges of the cover must be sealed on all sides with a ridge of soil, periodic shovelfuls of soil, black plastic bags filled with soil, or some other method. One key entry point for beetles that is often neglected is the end of the row. Often there are a few uncovered plants at the end of the row that draw the beetles in, and an opening of the cover that allows them to get underneath. One advantage of wider row covers is that they protect a larger area relative to the length of the edges. However, if there are raised beds, the furrow may have a large gap that allows entry. In 2003 we worked a farmer to test eight-foot, water-filled plastic tubes for the ends of the bed. These tubes conformed to the contour and sealed the ends very effectively. Black plastic bags worked almost as well, if the bags were placed in the bottom of the furrow.

The weight of the row cover fabric should be considered. Heavier covers are more durable (an important factor, given the cost of row cover), have lower light transmission, and provide more heating and more cold protection. Lower light transmission increases tenderness and length, which can be desirable. However, if heavier covers are used in midsummer, yield may be reduced. Non-heating, reinforced covers may be desirable for midsummer plantings.

Weed control is another major issue with row covers. Preparing a stale seedbed before seeding, using flaming, cultivation or herbicide, will help delay weed emergence. We have also observed a compost mulch being used with success for intensively planted beds of greens. For conventional growers, preplant incorporated herbicide is an option. Even when weed control techniques are used prior to planting, covers may need to be removed for cultivation or hand hoeing. To minimize beetle entry, replace covers the same day.

Table 1. Results of insecticide trials for flea beetle control in komatsuna, 2002 and 2003						
Treatment	Trade Name	Rate (formulated)	2002		2003	
			mean damage* (holes/leaf)	mean weight* (g/plant)	mean damage* (holes/leaf)	mean weight* (g/plant)
control			25.23 b**	64.16 c**	137.40 bc**	41.53 bc**
row cover	Agril 17 (2002); Covertan P30 (2003)		0.88 d	108.06 ab	2.38 e	58.97 abc
pyrethrin	Pyganic EC 5.0	16 oz/A	--	--	161.90 ab	72.39 a
carbaryl	Sevin XLR Plus	0.75 qt/A	6.05 cd	128.44 a	33.45 de	74.69 a
spinosad-Spintor	Spintor 2SC	5 oz/A	10.19 c	85.87 bc	91.40 cd	69.91 ab
spinosad-Entrust	Entrust	1.5 oz/A	--	--	71.15 d	62.87 ab
spinosad-seed trt	Tracer	2.5 g ai / 100 g seed	--	--	88.75 cd	31.34 c
kaolin	Surround WP	1/2 lb/gal water	25.38 b	64.11 c	--	--
thiamethoxam- seed	Cruiser 5FS-C	2.5 g ai / 100 g seed	--	--	215.65 a	50.29 abc
thiamethoxam- furrow	Platinum	0.31 oz/1000 row feet	36.77 a	109.22 ab	192.45 ab	53.11 abc
Capsaicin	Hot Pepper Wax	8 oz/gal water	9.93 c	77.8 c	--	--

* Harvest samples taken five weeks after seeding.
**Means within the same column followed by the same letter are not significantly different (Duncan's, $p<0.05$)

Insecticides. There are a number of synthetic pyrethroids and carbamates, which are labeled for flea beetle in Brassicas and which can give effective control of flea beetles for conventional growers. Organic growers have lacked an effective material. Rotenone, which was somewhat effective, is no longer allowed. For the past three years we have conducted insecticide trials at the UMass Research farm with the goal of identifying low-risk and organic insecticides that will suppress or control flea beetles.

We conducted these trials using Komatsuna, *B. rapa* species that is attractive to flea beetles, with an open growth habit and flat leaves. Treatments were tested in replicated plots that were 5 rows wide X 7.5 feet long (2002) or 6 rows X 9 feet (2003), and separated by 15 feet on all sides. The seeding date was June 13 in 2002 and May 30 in 2003; in both years, flea beetle populations were high enough to reduce plant growth rates in unprotected treatments. Foliar treatments were applied weekly. Furrow treatments (thiamethoxam) were applied once at seeding. The final harvest sample was taken at 5 weeks.

Results (see Table 1). In leaf damage at harvest, neither kaolin nor pyrethrin treatments were significantly better than the untreated control. Spinosad, both the Spintor and the Entrust formulations, significantly reduced leaf damage in both years, though it did not result in signficantly higher plant weights. Carbaryl and row cover treatments had the lowest damage, and plant weights were signficantly higher than the untreated controls for carbaryl in both years and for row cover in 2002. Capsaicin, in the Hot Pepper Wax formulation, reduced leaf damage as much as carbaryl and spinosad. Because this product is currently not allowed by the National Organic Program (NOP) we did not test this again in 2003. However, the level of protection provided by spinosad is an encouraging result for organic growers because Entrust is allowed by the NOP.

Thiamethoxam (Platinum) is currently not labeled for brassicas; however, the manufacturer is seeking registration for this crop. This sytemic neo-nicotinoid insecticide is absorbed through the roots into leaf tissue. This treatment, either as a furrow drench or a seed treatment, showed higher plant weight, and reduced flea beetle damage for about 3 weeks after seeding (see Figure 1; the June 16 sample was taken approximately two weeks after seeding). At harvest (July 8), leaves were heavily damaged, indicating that the insecticide was no longer present in leaf tissue.

Reference:

Kinoshita G.B., H.J. Svec, C.R. Harris and F.L. McEwan. 1979. Biology of the crucifer flea beetle, *Phyllotreta cruciferae* (Coleoptera: Chrysomelidae), in southwestern Ontario. The Canadian Entomologist 111:1395-1407

Figure 1. Flea beetle damage to Komatsuna (average number of holes per leaf) at the two-leaf stage and at harvest