**Materials for Beating Flea Beetles in Brassicas**

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Early spring plantings of Brassica crops are often hit hard by flea beetles. 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. The crucifer flea beetle (*Phyllotreta cruciferae)* is uniformly black and shiny, about 2 mm in length, while the striped flea beetle (*Phyllotreta striolata)* has two yellow stripes on its back.

Other species of flea beetles attack other crop families: solanaceous crops such as eggplant, potato, and tomato, or sweet corn. These beetles may look very similar to those found on Brassicas, but if they are feeding on a different crop group, they are almost certainly a different species of flea beetle.

While this article will discuss biorational insecticides that will suppress flea beetle, it is important for growers to be familiar with the life cycle of flea beetles and to combine insecticides with many cultural practices to reduce damage and keep populations from building up to unmanageable levels.

**Feeding damage and crop preference.**

Flea beetle adults feed on leaves and stems, resulting in numerous 'shot-holes'. Heavy feeding can kill plants, especially seedlings, and moderate damage can reduce plant size, delay maturity, reduce yield, or render crops unmarketable. Flea beetle larvae feed on roots. The impact of their feeding damage on crop yield is not well understood.

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 oleracea*. The cotyledons of these crops are 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 upon; as a result, beetles feed mostly at the leaf margins once true leaves have developed. This is especially true for cabbage. While waxiness varies among these crops, and damage depends on flea beetle numbers and time of year, in general, once seedlings are past the two or three leaf stage, flea beetles tend to cause less damage to this type of Brassicas.

Many Brassica greens – and also Brassica root crops -- belong to different Brassica species that are more preferred by flea beetles. These include *Brassica rapa* (Pac choi, Choi Sum, Chinese cabbage, Tatsoi, Mizuna, Komatsuna, turnip), *B. juncea* (mustards), and *B. napus* (red Russian kale, rutabaga). Other highly attractive Brassicas 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*. These species all have non-waxy leaves, which are easier to grasp and feed. There may be other differences in plant chemistry that play a role. Larvae may survive better on the roots of some of these species.

In Brassica greens, beetles feed on the whole surface of the leaf, and will continue feeding 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. Samples of over-wintering beetles in different types of habitats in or next to fields showed 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.

Adults leave overwintering sites in April and early May, to feed, mate, and lay eggs. When we have collected beetles from the field on a weekly basis, eggs were found in female beetles from mid May until the end of August.

Eggs are laid in the soil near host plants, and larvae feed on root hairs and roots. After the pupal stage, new adults emerge from the soil. 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 cumulative air and soil temperatures, 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 eggs. These offspring probably 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 rates declined greatly. At that time, beetles are probably leaving the field for overwintering sites.

**Management strategies.**

Basically, strategies for flea beetles could be summarized as one of five options:

1) Escape them
2) Starve them
3) Kill them
4) Shut them out
5) Combine as many of these as possible.

Here are more details:

**Crop rotation (escape).** 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 (starve).** 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 (escape).** 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.

**Till under crops as soon as harvest is complete (kill).** The root zone under Brassicas is a nursery for the next generation of flea beetles. Tillage to disturb roots and chop up the residue will reduce survival and subsequent emergence of hungry adults from that section of the field. Don't consider those yellow blossoms as an insectary for beneficials: consider it a sign that the plants have been there long enough to mature a new crop of beetles!

**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.

**Use row covers (shut out).** One of the best ways to protect Brassica crops from flea beetles is to place a floating row cover over the bed or row. In every pesticide trial conducted at UMass, 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 find the cotyledons. Flea beetles can fit through extremely tiny cracks. Edges of the cover must be sealed on all sides using soil, black plastic bags filled with soil, or some other method. Occasionally growers leave a few uncovered plants at the end of the row and don't seal the ends of the row cover. The open crop attracts beetles to the bed, where they may crawl underneath the cover. Wide row covers have the advantage of protecting 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. Make sure to weight the ends in 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. They transmit less light, and provide more heating and more protection from the cold. Lower light transmission increases tenderness and length of the greens, which may be desirable. However, if heavier covers are used in midsummer, growth may be reduced and disease probmes may be worse. 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 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.

**Insecticides (kill).**

For conventional growers, 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 (See *2006-2007New England Vegetable Management Guide)*. However, if growers rely on these exclusively in succession planted crops, without using cultural methods such as crop rotation, they can find themselves spraying weekly throughout the season.

For organic growers, flea beetles have been especially difficult because there have been no effective insecticides. Many organic growers depend on succession-planted greens as a key part of their crop mix, which means their farm may build up hefty populations of flea beetles.

In trials at UMass, in our search for effective biorational and organic products, we used Sevin XLR Plus as the standard conventional insecticide for comparision. These insecticide trials were conducted in 2002-2003 using Komatsuna, a *B. rapa* species that is highly attractive to flea beetles and can be harvested for bunched greens about five weeks after seeding. We used small replicated plots, separated by bare ground, with weekly spray applications. Flea beetle populations were high. Leaf damage (number of holes per plant), plant weight at harvest and beetle counts on plants and yellow sticky cards were used to compare treatments.

**Results.** Row cover – sealed on all sides with soil and placed over the crop immediately after seeding -- always gave the best control. Carbaryl and row cover treatments had the lowest damage, and plant weights were significantly higher than the untreated controls for carbaryl in both years and for row cover in 2002. Kaolin (Surround WP, ½ lb/gal; NOT labeled for Brassicas) and pyrethrin (Pyganic EC 5.0, 16 oz/A) treatments had as much damage as the untreated control.

Spinosad was tested in both Spintor (5 oz/A) and Entrust (1.5 oz/A) formulations. Both of these reduced leaf damage, although not as effectively as Sevin or row cover. This result was consistent in both years, although statistically the final harvest in 2002 was not different from the control. The level of protection provided by spinosad, though far from perfect, is an encouraging result for organic growers because Entrust is allowed by the NOP. Both formulations are labeled for use in Brassica crops; however, flea beetle is not listed as a target pest on the national label. Thus it is legal to use Entrust in Brassica crops, and growers who use it can anticipate suppression of flea beetles and reduction of feeding damage. There is a limit of three applications allowed in a 30 day period. In 2005, the manufacturer published supplemental label for use against flea beetle in Brassicas in Massachusetts, and this may be extended to additional states in 2006.

Capsaicin (Hot Pepper Wax, 8 oz/gal.) was tested in 2002 and reduced leaf damage as much as carbaryl and spinosad. Capsaicin as an active ingredient is allowed by the National Organic Program (NOP); however Hot Pepper Wax was no longer allowed in 2003 so we did not test again. Other capsaicin products may be available.

Similar experiments were conducted by Dr. Kimberly Stoner at the Connecticut Agricultural Experiment Station, comparing several organic treatments. Spinosad, pyganic and hot pepper wax all showed significantly less damage than the control. Spinosad, both Entrust and Spintor formulations, gave the highest levels of control. Pyganic was intermediate. Neem (Aza-direct) and insecticidal soap were no different from untreated plots.

Imidacloprid (Provado) was tested in 2001, and did not provide suppression in that trial. We also tested another neonicotinoid, thiamethoxam, which is not currently labeled for brassicas. Damage was significantly reduced for 2-3 weeks after seeding, but after that was not different

from the untreated control. This suggests there is potential for a neonicotinoid systemic to give protection for emerging seedlings.

**Other options**

There may be some benefit from combinations of materials for organic growers (eg mix of pyrethrum and spinosad) but this has not been tested.

We also see potential for perimeter trap cropping in this system– but only if the main crop is a *Brassica oleracea* so that a *B. rapa* can be used as a trap crop. If you are planting a sizable block of kale, collard, cabbage, broccoli, or other *B. oleracea*, consider using a perimeter planting of Komatsuna. Use one or two rows and completely surround the crop. I recommend Komastuna because the seed is relatively inexpensive, is highly attractive to flea beetle, has an open growth habit, and puts out young, attractive leaves over a long period of time. When flea beetles first arrive, spray the Komatsuna. Repeat border sprays as needed during the susceptible period of the main crop. Small plot work has shown that flea beetles accumulate in the Komtsuna border. If you are interested in this and would like more information, please contact me at the above address.

In our trials, feeding damage was heavier on outer leaves of Komatsuna greens. Komatsuna plants had an average of 9-10 leaves at harvest. Removing the *four* outermost leaves removed 64—72% of the feeding holes on the plant (and also removed 45% of the total leaf area). Removing the *two* outmost leaves removed 36-41% of the feeding damage, while removing approximately 15% of the leaf area. Thus, removal of outer leaves could make crops proportionally less damaged and more marketable, though it will reduce the total weight and leaf area to be sold.

**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