Flea beetles and brassicas, or... "please pass the mustard oil."

In his project report, Richard Smith refers to "volatile mustard oils" as the mechanism that attracts flea beetles to Brassicas. As it turns out, only certain flea beetle species are attracted to these crops, and the following information about flea beetle species, their behavior, the means of attraction to plants and trap crop management may facilitate experiments with flea beetle trap cropping.

According to Kim Stoner of the Connecticut Agricultural Experiment Station, "The number one misconception about flea beetles is that there is only one kind of flea beetle and that it feeds on many different host plants. This is not true at all. Specifically, the flea beetles that feed on eggplant or tomatoes or potatoes are completely different species from the flea beetles that feed on plants in the cabbage family. Thus, keeping your cabbage family plants far away from your nightshade family plants is not going to improve the management of flea beetles"[1].

Out of the some 4,000 flea beetle species in the world, perhaps a few dozen are agricultural pests in North America[2]. Most will feed on plants of more than one family, although flea beetle species are fairly host-specific in their feeding habits, and as pests are associated with certain plants or plant families. **Table A** lists some of the most common flea beetle pests in North America, including (limited) information about their geographic distribution, and their known food preferences.

Specialization, a.k.a "Goldilocks syndrome"?

For those flea beetle species, largely members of the genus *Phyllotreta,* that are attracted to Brassica crops, how does mustard oil work as an attractant, and how might this attraction be used as a pest management tool?

Mustard oils are isothiocyanates, which are part of a complex mixture of chemicals produced by the breakdown of sulfur-containing compounds called glucosinolates, which are characteristic of plants in the family Brassicaceae. During active plant growth (i.e. in young plants), mustard oil levels may be especially high, as much as 0.7% of plant growth in milligrams dry weight per day, and as insects chew, feeding activity is stimulated further as the oils are released[3].

There are about seventy known glucosinolate compounds, and their concentrations vary within and between different species and subspecies of *Brassica*. A recent discussion about glucosinolates in Midwest Biological Control News by John Masiunas and Catherine Eastman at the University Illinois refers to a study in which glucosinolate levels were examined in five subspecies of broccoli grown under the same cultural conditions. Among commercial broccoli cultivars, "Brigadier" contained 3.5- and 6.4-fold higher total glucosinolates than 'Packman' and 'Baccus'[4].

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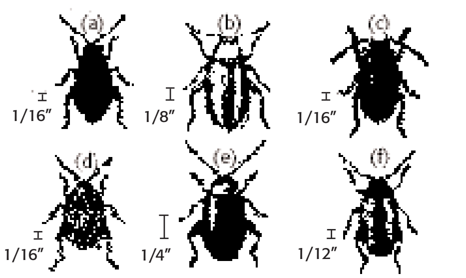
> —Kim Stoner

It is thought that glucosinolates act at low concentrations as *defenses* against generalist plant-feeders and as *attractants* to specialist feeders. But even from a specialist's perspective more isn't necessarily better. For example, maximum feeding on naturalized mustards, *Brassica rapa*, by two crucifer insect specialists, the flea beetle *Phyllotreta cruciferae* and the diamondback moth, occurred at *intermediate* glucosinolate levels[4,5].



Some common flea beetle species:
a)Corn, b)Palestriped, c)Potato, d)Sweet potato e)Spinach, and f)Striped

Eastman and other members of the University of Illinois Entomology team are examining the role of glucosinolates as possible pest management tools. They believe the specific glucosinolates and their concentrations present in certain Brassica cultivars, in combination with correlated resistance factors, might be used to affect populations of some insect pests specializing on crucifer crops. This two-year project, *Glucosinolate-rich crucifer cultivars and mulches as replacements for pesticides,* begins this year and is funded by USDA-CSREES.

To make matters more complex, glucosinolates probably interact with other feeding stimulants or deterrents. For example, the horseradish flea beetle, which feeds only on horseradish (*Armoracia rusticana*), is apparently attracted to glucosinolates in combination with other chemicals found only in that plant. Meanwhile, other flea beetles in the genus *Phyllotreta* are attracted to a particular range of Brassica-family plants, while avoiding others completely. Thus, as J.B. Harborne points out in *Introduction to Ecological Biochemistry*, "These interactions between flea beetles and their host plants recall the hackneyed aphorism: one man's meat is another man's poison...while all [brassica-loving] flea beetles enjoy mustard with their meat, they clearly discriminate very precisely between one bitter taste and another."[6]

Keys to success with trap crops

The Ontario Ministry of Agriculture has information on their website about Canadian studies with trap crops in Brassicas, based in part on the work (cited by Richard Smith) of Alan McKeown. Canadian researchers have determined that the "best and most practical" trap crop for luring flea beetles from cole crops—based on their growing conditions—is 'Chinese Southern Giant Mustard', *Brassica juncea* var. crispifolia.

Some keys to success with this trap crop include the following: "When

Table A: Common flea beetle pests of North America

Order: Coleoptera (beetles) Family: Chrysomelidae (leaf beetles) Subfamily: Alticinae (flea beetles)

Common and scientific names	Food Sources	Distribution
Western cabbage flea beetle W. black flea beetle ***Phyllotreta pusilla***	Mustards (mostly), beets, lettuce	CA, WA, OR, ID, WY, KS
Bronze-colored flea beetle ***Phyllotreta albronica***	Brassicas	CA, NM, OR, UT, MT, WY
Crucifer flea beetle ***Phyllotreta crucifera***	Brassicas; cabbage family weeds: winter cress, yellow rocket, etc.	Northeast US, OR, ID, MT, WY
Striped flea beetle ***Phyllotreta striolata***	Many crucifers; prefer mustard, turnip, radish and related weeds	Common in E. and Pacific US, not commonly found in Rocky Mtns.
Tuber flea beetle ***Epitrix tuberis***	Potatoes (by larval tunnelling)	West of the Cascades
Eggplant flea beetle ***Epitrix fuscula***	Solanaceaeous plants, esp. eggplant, but also potato, horsenettle, pokeweed, sugar beet, strawberry	Entire US, most common in southern states
Tobacco flea beetle ***Epitrix hirtipennis***	Solanaceaeous plants: tomato, potato, tobacco, pepper, horse-nettle, etc.	Fairly generally distributed, but primarily a problem in the south
Potato flea beetle ***Epitrix cucumeris***	Solanaceaeous plants: tomato, potato, tobacco, pepper, horsenettle, etc.	Maine to Carolinas, westward to Nebraska
Palestriped flea beetle ***Systena blanda***	Solanaceous crops, corn, beans, beets, cucurbits, sunflowers, peanut, oat, cotton, grape, pear, strawberry, lettuce, ragweed, lambsquarters, pigweed	Most areas of country, with northern limits in UT, CO, ID, NY
Sweet potato flea beetle ***Chaetocnema confinis***	Sweet potato, corn, small grains, bindweed, raspberry sugar beet	Entire US, where sweet potatoes are grown
Corn flea beetle ***Chaetocnema pulicaria***	A general feeder, but prefers grasses (corn). Also infests sugar beets.	Most areas east of Rocky Mountains
Grape flea beetle ***Altica chalybea***	Grape, muscadine grape	CT, OH, AL, IN, FL, TX
Spinach flea beetle ***Disonycha xanthomelaena***	Spinach, beet, lambsquarters, chickweed, thorny amaranth	CT, MA, OH, AL, IN, TX

Sources: Cranshaw, W. *Pests of the West*; North Carolina State University IPM Website; Kansas State University IPM Website; USDA 1952 Yearbook of Agriculture; Organic Gardener's Handbook of Natural Insect and Disease Control (Rodale); Alternatives to Insecticides for Managing Vegetable Insects; USDA-ARS Palearctic Flea Beetle website and research team; Kim Stoner, CT Agricultural Experiment Station.

seedlings or transplants of your commercial crop are in the field, there should always be enough healthy, growing trap crop around, so regular sowings are necessary. Flea beetles will quickly destroy the trap crop and move to the commercial crop if there isn't another choice. It is best not to let the trap go to seed as it could become a weed in your fields in the future. Additionally, this method only seems to work with traditional cole crops. Trials with Asian cruciferous vegetables such as Napa cabbage, mustard greens, etc. indicate that the trap crop of Chinese mustard will not work as well, since the commercial crops are almost as attractive to the flea beetles."[7]

It's worth noting flea beetles identified in the Canadian research are different from the flea beetle pests studied in Richard Smith's California-based project. In the Canadian study, flea beetles represented were mostly crucifer flea beetle (*Phyllotreta cruciferae*) and to a lesser degree the striped flea beetle (*Phyllotreta striolata*)[8]. Flea beetles present in the California study were probably western cabbage flea beetle (*Phyllotreta pusilla)* and the bronze-colored flea beetle, *Phyllotreta albronica*[9]. Also, the Canadian research group experienced their worst flea beetle problems in early spring, while in the California study damage was greatest in mid- to late-summer. Does the relative attractiveness of different cash and trap crops vary among Brassica-loving flea beetle species? What influence might regional climate and cropping conditions have on the effectiveness and management of trap cropping systems?

Generally, flea beetles are poorly known in this country and it is very difficult to identify them to species. If you'd like to be certain of your flea beetle species, the Systematic Entomology Laboratory at USDA-ARS provides a free insect identification service. They ask that you first try to get an i.d. from your local insect experts, but if you can't be helped locally you can send specimens directly to the SEL. Specimens MUST be prepared correctly. To get an identification request form with instructions, go to www.sel.barc.usda.gov/selhome/requests.htm, or contact Pete Tuohey, USDA-ARS, Systematic Entomology Laboratory, ptouhey@sel.barc.usda.gov, tel. 301-504-7041. —*EW, with thanks to Woody Deryckx, Kim Stoner and Helen Atthowe for their contributions.*

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