UMASS EXTENSION

# VEGETABLE NOTES

For Vegetable Farmers in Massachusetts

**Volume 10, Number 3** **Spring 2001**

*This issue of Vegetable Notes provides an update for weed and insect management in 2001. The current issue of the New England Vegetable Management Guide will not be updated until 2002. For that reason, please keep this newsletter with your copy of the current guide. The authors welcome your feedback and questions.*

*Rich Bonanno*
*Vegetable Team*

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# 2001 SWEET CORN WEED MANAGEMENT UPDATE

*By Rich Bonanno, Dept. of Plant & Soil Sciences, University of Massachusetts*

Sweet Corn growers have several weed management options available to them. Because of the highly effective herbicide options, vegetable growers can take the opportunity to reduce weed seed pressure by rotating their fields to sweet corn occasionally and maximizing control during the sweet corn year. In addition to the herbicides registered, many growers still combine timely cultivations with herbicides. Remember to always keep cultivations shallow, cultivate when weeds are small, and orient the rows to minimize soil erosion during times of heavy rainfall.

**As with all new registrations, growers should gain experience with these products before using them on a wide scale.**

Over the past year, there have been new registrations and label changes which have occurred for weed management in sweet corn. This article will cover the basics. Please check both the herbicide labels as well as the current *New England Vegetable Management Guide* for additional information (most of these changes will not appear until the 2002-2003 version of the guide is published late in 2001). Remember that the label is the final authority. As with all new registrations, growers should gain experience with these products before using them on a wide scale.

## New Registrations

*Permit (halosulfuron)* 75% WSG. 2/3 to 1.33 ounce per acre (0.032 to 0.063 lb a.i./acre). This herbicide provides postemergence control of many weed species which are not under drought stress. It is rainfast in 4 hours. Use a non-ionic surfactant at a rate of 1-2 qt/100 gal spray or a crop oil concentrate at 1 gal/100 gal spray. Control varies with type and size of weed. Species listed on the label include redroot pigweed, pokeweed, common ragweed, Pennsylvania smartweed, common sunflower, velvetleaf, wild mustard, yellow nutsedge, and wild radish. Do not cultivate for 7 days after application. Most vegetables can be planted within 12 months of application except crucifers, carrot, leeks, onions, lettuce, beets, and spinach. Some sweet corn varieties may be injured by *Permit* and no reliable list of susceptible varieties has yet been developed. Regular sugary varieties do not appear to be more tolerant than *se* (sugar enhanced) types or *sh2* (supersweet) types. Initially, this herbicide should be used on a small scale to control problem weeds such as yellow nutsedge, ragweed, velvetleaf, and

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triazine-resistant lambsquarters. Other postemergence options continue to exist. These include *AAtrex (atrazine)*, *Basagran (bentazon)*, *Formula 40* (2,4-D), *Lorox (linuron)*, and *Evik (ametryn)*. Atrazine, Basagran, and 2,4-D have been the most commonly used.

*Prowl (pendimethalin)* 3.3 EC. 1.8 to 4.8 pt/acre (0.75 to 1.9 lb a.i./acre). Apply preemergence only after seeding. DO NOT incorporate into the soil. A broadleaf herbicide such as *atrazine*, *Bladex*, or simazine should also be used to control broadleaf weeds. If this herbicide is moved into the seed zone, there is potential for crop injury. To minimize the potential for crop injury, plant in a firm seedbed, plant corn seed at least 1.5" deep, plant into moisture rather than into dry soil, do not mix *Prowl* with liquid fertilizers, and avoid sandy soils. If the soil is dry, consider irrigating or waiting for rainfall prior to application. If heavy rains follow an application to dry soil, *Prowl* can move to the seed zone and cause crop injury.

Specific weeds for which this herbicide should be considered include triazine-resistant lambsquarters, and velvetleaf. Growers may consider a lower rate of *Prowl* and adding another grass herbicide such as *Dual Magnum*, *Lasso*, *Frontier*, or *Eradicane*. This label change is pending. See your dealer for the current label prior to use.

*Frontier (dimethenamid)* 6 EC. 16 to 32 ounces/acre (0.75 to 1 lb/acre). Apply preplant surface, PPI, PRE, or POST (corn can be up to 18" tall). A split application can be used. Frontier will not control emerged weeds. A broadleaf herbicide such as *atrazine*, *Bladex*, or simazine should also be used to control broadleaf weeds. Some sweet corn varieties may be injured by *Frontier* and no reliable list of susceptible varieties has yet been developed. *Frontier* has activity which is similar to *Dual Magnum* and *Lasso*. It offers an alternative for rotational purposes. Growers should gain some experience before widespread use on the farm.

## Modified Registrations

*BLADEX (cyanazine)* 4L. 1 qt/acre (1 lb a.i./acre) is new maximum rate. Apply after seeding but before crop emergence. *Bladex* is weak on most grasses but excellent on many broadleaf species. The last year for use is 2002. Observe all label precautions related to tractor cabs and applicator safety.

*CyPro (atrazine + cyanazine) DF*. This is a formulated prepack of *Atrazine* and *Bladex (cyanazine)*. This cannot be used postemergence in sweet corn because of the *Bladex* which can seriously injure or kill emerged sweet corn. It should be used in combination with a grass herbicide such as *Dual Magnum*, *Lasso*, *Prowl*, *Eradicane*, or *Frontier*. The use rate for this product for 2001 and 2002 is 1.5 lb/acre (1 lb a.i./acre cyanazine and 0.32 lb a.i./acre atrazine). Depending on weed pressure, additional atrazine at planting, cultivation, or a postemergence application of *atrazine*, *Basagran*, *2,4-D*, *Permit*, *Lorox*, or *Evik* may be needed.

*DUAL Magnum* and *DUAL II Magnum (metolachlor)* 7.6 EC. 13 to 27 ounces/acre (0.77 to 1.6 lb a.i./acre). Can be applied at planting or up to 5" corn. Apply to weed free soil. *Dual Magnum* has excellent activity on grasses and is weak on lambsquarters. These formulations replace *Dual* and *Dual II*. The "II" is a safener which may lessen the potential for crop injury in cold soils. Basically, the activity of the *Magnum* formulation is the same as with the old *Dual* but the use rates are lower. When these products occur in prepacks with *atrazine*, they are called *Bicep* and *Bicep II*. □

### NEW FACT SHEET ON PEST MANAGEMENT FOR VEGETABLE BEDDING PLANTS

For growers who produce vegetable transplants as part of their spring bedding plant mix, or for their own use in the field, this fact sheet provides valuable information on insects and diseases, how to scout for them and identify them, and what to do for control. Catch problems early by knowing what to look for and how. Since products for vegetable crops often differ from those labeled for ornamentals, this fact sheet helps sort out what you can use. This was a collaborative project of the UMass and UConn Extension greenhouse programs. Free copies may be obtained, while supplies last, from the Vegetable Extension Program office (413-545-3696, or send an email request to *rhazzard@umext.umass.edu*.) Or find the fact sheet on the web at *www.umass.edu/umext/programs/agro/floriculture.*

# INSECTICIDES FOR 2001: NEW AND RECENT REGISTRATIONS EXPAND THE OPTIONS FOR VEGETABLE GROWERS.

*By Ruth Hazzard, Dept. of Entomology, University of Massachusetts*

Several new products are available in the coming season, expanding the range of options for insect control in a number of vegetable crops. New registrations in the "reduced risk" category are most common, which is good news for applicators and for growers seeking shorter pre-harvest intervals. These new "biorational" pesticides have received more emphasis recently from manufacturers and from EPA, partly as a result of concern over potential loss of products from FQPA.

Biorationals selectively target insects – ideally, pest insect groups such as caterpillars, beetles, or aphids – and are less toxic to humans, non-target mammals, fish, and often to non-target beneficial insects. One approach to achieving this selectivity is to target an organ system that functions differently in insects than it does in humans, mammals, or birds. For example, the endocrine system of insects, which regulates molting, is very different from the endocrine system in humans. While the overall nervous system is quite similar in insects and humans, certain receptors in the nervous system are very different in insects. By targeting these unique aspects of insect physiology, products can be developed that have lower impact on humans and the environment.

Products that target caterpillar pests are the most common among the new materials, though some work against beetles, aphids, spider mites, and other types of insects. The list below includes some products which were registered previously, but which growers may not yet have tried. For each product, I will summarize what crops and pests are labeled, the mode of action, the REI and pre-harvest interval, and other notes that might be relevant. One drawback of these materials can be cost, but low rates may compensate for a high cost per ounce **(see Table 1)**.

**Table 1: Sample costs for some vegetable insecticides, 2001**

| PRODUCT | UNIT USED | PRICE/UNIT* | LOW RATE/ACRE | | HIGH RATE/ACRE | |
|---|---|---|---|---|---|---|
| | | | RATE | COST | RATE | COST |
| Confirm 2S | fl oz. | $1.30 | 2.4 | $3.19 | 4.8 | $6.38 |
| Avaunt | fl oz. | $5.25 | 2.5 | $13.13 | 3.5 | $18.38 |
| Spintor 2SC | fl oz. | $4.38 | 3.0 | $13.13 | 4.5 | $19.69 |
| Proclaim | fl oz. | $8.25 | 2.4 | $19.80 | 4.8 | $39.60 |
| Admire 2F** | fl oz. | $4.38 | 16.0 | $70.00 | 24.0 | $105.00 |
| Pounce | fl oz. | $1.09 | 4.0 | $4.38 | 8.0 | $8.75 |
| Warrior | fl oz. | $2.66 | 1.9 | $5.10 | 3.8 | $10.20 |
| Dipel ES | pt | $4.75 | 1.5 | $7.13 | 2.5 | $11.88 |
| Orthene | lb | $12.50 | 1.0 | $12.50 | 1.3 | $16.25 |

*Based on information available at time of printing. Prices may vary among suppliers and during the season.*
*Products may be sold by gallon, quart, pint, or pound.
** Rate per acre for banded applications at wide row spacings will be lower than lowest rate listed.

For sweet corn, the expanding options include insecticides (see spinosad, below), a new biological control organism that is available this year, and the oil applicator for corn earworm that will be commercially available.

## Materials aimed at the nervous system

### Avaunt *(indoxycarb)*

This product from DuPont received national registration late in 2000 and has been approved in most northeastern states. It is a general use product, registered under the reduced risk track. It has new chemistry which is active against several insect groups. In vegetables it is currently labeled only against caterpillars. *Indoxycarb* must be ingested; once ingested, it is converted to a toxin which inhibits sodium ion entry into nerve cells, causing paralysis and death. Feeding stops rapidly. The restricted entry interval is 12 hours and preharvest interval for most vegetables is 3 days. Rates are 2.5 to 3.5 oz/acre (0.09-0.11lb AI).

**Crops and pests include:**

Broccoli, Cabbage (tight head), Cauliflower: cabbage looper, diamondback moth, imported cabbageworm, beet armyworm. Sweet corn: (whorl application only): fall armyworm, European corn borer. Pepper, bell and non-bell : tomato fruitworm, beet armyworm (ECB not listed

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on label). Tomato, Head and leaf lettuce.

**Proclaim *(Emamectin benzoate)***

A selective insecticide for caterpillars, derived from a metabolite of a bacteria *(Streptomyces avermitilis)*, hence one of the general category called *avermectins*. This is a restricted use product (due to risk of eye injury) from Novartis (now Syngenta AG). It is active against some of the more difficult-to-control caterpillars and those that have developed resistance to other products, such as beet and fall armyworm, cabbage loopers, and diamondback moth. *Proclaim* is labeled for head and stem brassicas (not brassica leafy greens), head lettuce, and celery.

The product must be ingested and causes caterpillars to become paralyzed and stop feeding quickly. Death occurs in 2-4 days. The product has trans-laminar (but not systemic) activity: treated leaves absorb the material which gives a longer residual period.

The mammalian toxicity is low (considered slightly toxic to mammals, rat oral $LD_{50}$ = 1516 mg/kg ). Avoid drift into aquatic areas (a 25 ft border required). Highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. The restricted entry interval is 48 hours and preharvest interval is 7 days. Use rates are 2.4 - 4.8 oz/acre (.0075 lb. to .015 lb.AI).

**Agri-Mek 0.15EC *(Abamectin)***

This is another avermectin product, which has been labeled for several years on pepper, celery, cucurbits, lettuce and potato. Like *Proclaim*, it is a restricted-use material produced by Novartis (now Syngenta AG). The mode of action differs from other nerve poisons, thus avoiding cross resistance with other types of products that target the nervous system of insects. Insects and mite are immobilized shortly after ingesting treated tissue, and die in 3-4 days. Surface residues degrade rapidly, but abamectin penetrates leaf tissue and has a long residual period within the leaf. It provides an alternative product for Colorado potato beetle in potatoes, which is important given the current or potential resistance to other products (see accompanying article on imidacloprid resistance). In other vegetables and fruits, the target pests on the label are primarily spider mites and *Liriomyza* leafminers. Preharvest intervals are 7 days on most vegetables (14 on potato) and restricted entry interval is 12 hours. Use rates are 8-16 oz./acre.

**Spintor 2SC (Spinosad):**

This product from Dow AgroSciences has been registered for several years, and is receiving positive reports from growers who have tried it in brassicas, peppers and sweet corn. It has very low toxicity to mammals, and birds (rat $LD_{50}$ oral and dermal > 5,000 mg/kg) and was registered as reduced risk material.

*Spinsoad* is derived from naturally-occurring soil organisms, and has two modes of action: as a nerve poison ( by contact with treated surfaces) and a stomach poison (by ingestion of treated surfaces). It has a broad range of activity, including some beetles (Colorado potato beetle), most caterpillars, leafminers, and thrips.

**Crops and pests include:**

Potato: Colorado potato beetle, ECB, thrips, leafminers. Cole crops (heading and leafy brassicas): imported cabbageworm, diamondback moth, cabbage looper, thrips, leafminers. Fruiting crops (eggplant, tomato, pepper, etc): caterpillars, Colorado potato beetle. Leafy vegetables: caterpillars, leafminers, thrips. Sweet corn: European corn borer, corn earworm, armyworms.

*Spinosad* has the advantage of conserving beneficial insects such as ladybeetles, which can reduce resurgence of aphids in crops such as peppers and sweet corn. The one-day pre-harvest interval and four-hour re-entry interval makes it particularly useful in peppers or eggplants where harvest periods coincide with heavy pest pressure and the need for regular sprays. It has shown excellent control of European corn borer and fall armyworm in sweet corn and is ideal for early-season sprays to control ECB. In trials in New York State, it controlled these ECB, fall armyworm and corn earworm as well as *Warrior*, even with high corn earworm pressure of up to captures of 10 corn earworm moths/night. *(See article on page 11)*. In potato and eggplant, it is active against all larval stages of CPB. Rates of 3 oz can be adequate in pepper and brassicas, and 3-4.5 oz in corn, which can help keep the cost per acre down. Limited to 2-3 consecutive applications or 29 oz per crop to prevent resistance. Avoid exposing bees to direct spray.

## Insect growth regulators

**Confirm 2F (Tebufenozide)**

This product from Rohm and Haas was one of the first insect growth regulators (IGR) to be registered for use on vegetable crops. It was designated a reduced risk material and targets caterpillars. It has a general use label, with specific activity against a wide range of caterpillar pests on fruiting vegetables, virtually all leafy vegetables, brassicas, and mint. It has low risk to mammals (rat oral LD 50 > 5000 mg/kg) and a restricted entry interval of 4 hours. *Tebufenizode* mimics the natural insect hormone *(ecdysone)* that induces molting in insects. It must be ingested to be effective. Once ingested, feeding stops within 24 hours and a premature molt is induced. Death takes several days. It has a long residual period (10-14 days).

Research trials show excellent efficacy, equivalent to standard pyrethroids, so this product should provide an effective alter-

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native for caterpillar control to allow rotation with other products and conservation of beneficials. The long residual period has advantages, but also means there is a relatively long preharvest interval (7 days on fruiting vegetables).

### Neem products (Azadirachtin)

Neem products are extracts of the seed of the neem tree, *Azadirachta indica*, which has been used for centuries for insect control in tropical regions. Several companies have products with this active ingredient, including *Grace (Neemix), Amvac (Ecozin 3% EC)* and *Gowan (Aza-direct)*. Generally the labels are quite broad and include leafhoppers, whiteflies, aphids, caterpillars, beetles, thrips and flies on leafy and brassica vegetables, cucurbits, fruiting vegetables, herbs, and root vegetables.

*Azadirachtin* acts as a repellent, a deterrent to egg-laying, and an insect growth regulator which interferes with molting. Toxicity to non-target organisms is low. Organic certification standards generally allow neem products. It is effective against CPB larval stages in potato and eggplant. Efficacy for many labeled uses is not known. Because it is slow-acting and preventative rather than a knock-down material, use repeated applications, starting when pest numbers are low.

## Neural inhibition of feeding

### Fulfill (pymetorzine)

Has received new EPA registrations for use against aphids on fruiting vegetables (tomatoes, peppers, eggplants) and cucurbits. It already has a label for potatoes and tobacco. EPA granted reduced risk status to the active ingredient, which affects the nerves that control feeding, especially for aphids, whiteflies and other sucking insects. The greatest efficacy is against aphids. Feeding and plant damage stop shortly after insects come in contact with the material, although aphids may be visible on the plants for several days. *Fulfill* has translaminar and systemic activity, enters leaf tissue and remains present in the leaf for up to two weeks. Restricted entry interval is 12 hours, with a 14-day preharvest interval. Impact on beneficial insects is low, thus this material will not cause secondary outbreaks of other pests which are suppressed by natural enemies, and will conserve aphid predators. Can be used during pollination, but do not apply directly to bees foraging in the field.

## Repellents

### Surround WP (kaolin clay)

Manufactured by Engelhard Corp., this product is labeled for fruiting vegetables and cucurbits, and is approved for certified organic growers. *Kaolin clay* has sufficiently low toxicity that EPA has listed it as "generally regarded as safe" (List 4). It could be used as a food additive up to 2.5%, and is exempt from food tolerance requirements. The REI is 4 hours and it can be used up to the day of harvest; however, it leaves a residue which must be washed off any parts of the plant that will be harvested. Leaves and fruit turn white as if sprayed with paint, but photosynthesis and growth are not inhibited. It is unlikely that it could be washed off of leaves or soft fruit like summer squash, but could be used against leaf-feeding insects that attack early stages, before fruit is formed. Insect groups controlled or supressed include beetles, thrips, leafhoppers, flies, and soft bodied insects such as pear psyilla.

*Kaolin* has several modes of action:

1. repellency - hides visual and tactile cues that the pest uses to recognize host plants, hence it does not feed.
2. irritation - particles adhere to insect body parts.
3. mortality – by covering small, soft-bodied insects with particles.

**Crops and pests labeled include:**

Tomato, eggplant, pepper: flea beetle, Colorado potato beetles, leafhoppers

Onions: thrips

Cucurbits: cucumber beetles

Grapes: leafhoppers, Japanese beetle, June beetle, thrips

Use rates are high, about 6-25 lb/acre. For larger sprayers, mix a slurry first, in a bucket, then add this to the spray tank with agitation running. The material may need to be re-applied after a heavy rain. Since repellency is the main mode of action, good coverage of leaf surfaces is important.

## Insect digestive system

### Transgenic *Bt* crops

While *Bt* field corn has made national news, sweet corn varieties which express the *Bt* gene have been less noticed and less widely used. The genetic change in these varieties enables both leaf and kernel tissue to produce high levels of the *Bt* protein toxin, so that caterpillars ingest a toxic dose wherever they feed. Seed companies developed processing varieties first, and there was a requirement for planting a minimum of 40 acres, which meant these were planted mainly by larger growers on contract with processing plants. The *Bt* sweet corn variety Attribute is available as a yellow and a bicolor. Trials consistently show high efficacy against caterpillar pests in the *Bt* sweet corns. Growers should consider the many issues involved in transgenic crops prior to any decision about planting *Bt* sweet corn. A new fact sheet ***Issues about genetically engineered vegetable crops*** presents both sides of this controversial issue and can be obtained from any member of the UMass Extension Vegetable team.

## Biological Controls

### *Trichogramma ostriniae*

This tiny wasp (smaller than a dot on this page) parasitizes eggs of European corn borer and has shown remarkable efficacy

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in field trials conducted by Dave Ferro and by Mike Hoffman's group at Cornell University in New York State. Other species of *Trichogramma* wasps such as *T. pretiosum* have been commercially available for many years, but are less effective against European corn borer.

*T. ostriniae* was originally imported about 10 years ago from temperate regions of China with the hope that it could overwinter, become established, and suppress European corn borer over the long term. Unfortunately, it does not survive our winters and has to be released each season. However, it can be released in relatively small numbers (30,000 wasps/acre) early in the season when corn is 'knee-high,' and it will establish and reproduce through the season. It has a tremendous ability to disperse from release sites, which means that one release site per acre is sufficient.

Paired studies of release and non-release fields, conducted in New York State last summer, showed that on average, corn at harvest had 48% less damage in release plots. Egg parasitism was about 4% (from natural Trichogramma species) in non-release plots and 47% in release plots.

One advantage of an egg parasitoid is that it kills the pest early in its development. Also, if egg mortality is not sufficient to reduce ECB larval infestations below the 15% threshold at the tassel stage, it is still possible for the grower to apply controls and prevent ear damage. Similarly, insecticides can be applied if corn earworm arrives during silking. It appears that parasitized egg masses can survive treatment with some insecticides that are used in corn, such as *Spintor, Lannate, Dipel, Xentari, or Ambush,* allowing new wasps to emerge after treatment.

The UMass Extension Vegetable IPM staff is interested in working with sweet corn growers to make pilot releases of *Trichogramma ostriniae* this season. Please contact Ruth Hazzard at 413-545-3696 if you are interested.

### Oil applicator for sweet corn (Zea-later)

Control of corn earworm and European corn borer in organic or small-scale sweet corn production can be achieved with a single direct-silk application of a mixture of corn oil and *Bacillus thuringiensis.* Cost per acre is comparable to standard IPM systems of multiple sprays during corn earworm flights, but relies on hand labor rather than the farmer's time on the sprayer. Hand applications are made easier by an oil applicator designed for this purpose, which uses a lightweight hand-held syringe pump and waistbelt tank. Known as the Zea-later, this oil applicator is now available through Johnny's Selected Seeds (207-437-4395). For a fact sheet on how to use this system, contact Ruth Hazzard or Pam Westgate at 413-545-3696.

*References:*

*Shelby Fleischer, Dept of Entomology, Pennsylvania State University. The New and Safer Insecticides, Vegetable Gazetter, April 2000 Mike Hoffman, Mark Wright and Tom Kuhar. Inoculative releases of Trichogramma for suppression of European corn borer in sweet corn. Proceedings of the NYS Vegetable Conference, February 2001. Page 81-84* □

## SOME THOUGHTS ON SPRING LAND PREP AND WEED MANAGEMENT

*Dr. Rich Bonanno, UMass Extension*

Although weeds are not high on the list in the spring, give some thought to how land preparation can affect future problems:

**1.** If rye, vetch, or another cover crop is not completely turned under it may continue to grow and compete with early planted crops such as greens, lettuce, or cabbage. If a problem is anticipated, any remaining cover crop can be disked, tilled, flamed, or sprayed with a non-selective herbicide such as *Gramoxone, Roundup, Scythe, or Touchdown.* Once the crop is growing, check the Poast or Fusilade labels for information on controlling any rye which is still standing. The more developed and tillered the rye cover crop is, the harder it is to control. Broadleaf cover crops, such as vetch and clover, are difficult to control once the crop is planted.

**2.** If spring moldboard plowing is not done, some winter annual weeds, such as annual bluegrass or chickweed may continue to grow. This usually happens with spring disking of fall-plowed fields or when fields are chisel plowed. Although these weeds are disturbed, good soil moisture and a few healthy roots are all that is needed for the weed to survive. In some cases, common lambsquarters can survive the winter and continue to grow and produce seed in the spring. Effective tillage is the easiest way to control these weeds. They can also be killed with an application of a non selective herbicide such as *Gramoxone, Roundup, Touchdown, Scythe*, or by flaming.

**3.** Weeds grow best with firm and moist soil. Try to avoid compacting the soil too much, especially close to the crop rows. Tire marks and firm planting rows provide the best soil conditions for weed germination and emergence.

**4.** Stale beds are usually not practical in the early spring. Although soil moisture is adequate, soil temperatures are usually too low. Stale beds work best for later planting crops such as cucurbits. □

# STRIPED CUCUMBER BEETLE AND BACTERIAL WILT MANAGEMENT IN VINE CROPS

*By Ruth Hazzard, Dept. of Entomology, University of Massachusetts*

Both striped cucumber beetle and spotted cucumber beetle are found in vine crops, but the most numerous early in the season is the striped cucumber beetle. These beetles overwinter in plant debris in field edges and with the onset of warm days and emergence of cucurbit crops will move rapidly into the field. Densities can be very high especially in non-rotated fields or close to last year's cucurbit crops. Adult feeding on cotyledons and young leaves can cause stand reduction and delayed plant growth. More importantly, the striped cucumber beetle vectors *Erwinia tracheiphila*, the causal agent of bacterial wilt. This disease overwinters within the beetle and is transmitted by contact of beetle feces with the open wounds in leaf tissue caused by beetle feeding. Bacteria multiply and block the vascular system of the plant, causing vines to wilt. This disease can be effectively managed only by preventing feeding by the beetle.

### Which vine crops are susceptible to wilt?

We now know that most vine crops are, to varying degrees, susceptible to this disease. The major exception is watermelons – they do not show any symptoms. Trials by Meg MacGrath on Long Island compared beetle numbers and wilt severity among many different vine crops. Among pumpkins, two powdery-mildew resistant varieties, Merlin and Magic Lantern, were highly susceptible, while other varieties such as Howden and Harvest Moon were more tolerant. Among winter squashes, buttercup, hubbard and acorn appear to be moderately susceptible, while butternut is the most tolerant (but not immune). Cucumbers are highly susceptible, except for a new wilt-resistant pickling variety called County Fair. Summer squash, zucchini, and melons are susceptible. Gourds differed with variety: Turks Turban was highly susceptible, while Pear Bicolored was not. Different vine crops also vary in the attractiveness to beetles, but this is not necessarily correlated with their susceptibility to bacterial wilt.

### Early season infection

Plants at the cotyledon and first 1-2 leaf stage are more susceptible than older plants, and disease transmission is low after about the 4-leaf stage. Not all overwintering beetles carry the *Erwinia* pathogen. Studies by Shelby Fleischer in Pennsylvania found from 7% to 10% of emerging, overwintered beetles tested positive for the *Erwinia* bacteria. Disease development is strongly influenced by the dose of the pathogen which the plants receive, which in turn is determined by the number of beetles, how long they feed, and what proportion of them were infected. The higher the beetle density during early plant growth, the more severe the incidence of wilt. Beetles which find a host plant release an aggregation pheromone that calls others to their spot. Groups of beetles feeding, wounding and defecating on a single plant are more likely to transmit disease, and to acquire the pathogen and transmit it to other plants.

### Threshold and controls

Beetle numbers should be kept low, especially before the 5-leaf stage. Crop rotation -- to a field well separated from last year's cucurbits -- reduces beetle numbers significantly. Floating row covers can be used as a barrier to beetle colonization. If kaolin clay (Surround WP) is used, it should be applied before beetles arrive. Control with other foliar insecticides can be accomplished by scouting frequently (at least twice per week) and treating after beetles colonize the field. To prevent bacterial wilt, beetles should not be allowed to exceed one beetle for every 2 plants in susceptible crops. This is a lower threshold than is needed to prevent significant foliar damage. Options include carbaryl, esfenvalerate, permethrin, and endosulfan *(see New England Vegetable Management Guide)*.

### *Imidacloprid (Admire 2F)*

This systemic neonicotinoid insecticide is labeled for striped cucumber beetle in vine crops. It provides another way to achieve cucumber beetle control at the early crop stages, by using banded treatments for direct-seeded crops or transplant drench in transplanted crops. It can also be applied through drip irrigation where crops are grown in a plastic-drip system. When it is taken up by the roots, *imidacloprid* is a systemic which translocates to new leaf tissue and persists through the critical early plant stages. Fields can be scouted to determine if foliar controls are also needed.

#### Using *imdacloprid* in direct seeded crops

*Admire 2 F* can be applied in a narrow band within 2 weeks before planting, as an in-furrow spray or narrow surface band during planting, or as a post-seeding drench. Studies conducted by Meg McGrath on Long Island showed slightly better control with an in furrow treatment. This also has the advantage of one trip through the field and accurate targeting of material. Where it is applied to the soil surface, it should be watered in with irrigation (or rainfall) to move it to root depth for seedlings. The label gives a range of 16 - 24 oz per acre or 0.9 to 1.3 oz per 1000

*(continued page 8)*

feet of row. Studies have found a rate of 1.1 oz per 1,000 feet to be sufficient for controlling cucumber beetle.

Using imdacloprid on transplants:

The best time to treat is about 1 day prior to planting in the field. The rate used per transplant is very low: 0.02 ml/plant. To treat a flat of 200 transplants with *Admire* at this rate, a grower would need to dilute 4 ml (0.135 oz) of *Admire* in a volume of water sufficient to soak to soil mix evenly. A plastic syringe, available from the local drug store, can help ensure that these small measurements are accurate! To help make other conversions: multiply 0.02 ml per plant times the number of plants in your flat. For example, use 20 ml to treat 1000 transplants. You can convert ml to oz by dividing by 29.6 (there are 29.6 ml in a fluid oz). Be careful of phytotoxicity (burning the plants) at higher rates. In Pennsylvania, burning of leaf margins was observed at 0.04 ml/melon plant at the 2-leaf stage, although these plants did grow out of this in about 2 weeks. The transplant treatment may be sufficient to carry the plants through the early crop stages, but scouting can determine if any foliar applications are needed.

*Admire* can also be used for Colorado potato beetle or flea beetle control on tomato, pepper and eggplant transplants. Again, be cautious not to use too high a rate, as phytoxicity can result. The suggested rate for tomato transplants is 15 ml - or 0.5 ounce - per 1000 transplants.

Drip application:

A drip system can be used for *Admire* applications to either direct seeded or transplanted crops. Apply early enough to allow root systems to take up the material before beetles arrive. The system should be primed with water first, and imidacloprid injected slowly. More emitters provide a more even distribution of product.

Note:

The foliar form of imidacloprid, *Provado* 1.6F, is not labeled on vine crops. This may be due to toxicity to bees, which could come in contact with treated flowers after a foliar application later in crop growth. Translocation into flowers from soil applications is reported to be below levels that would cause toxicity to bees. □

# LIVING ON THE EDGE OF RESISTANCE: COLORADO POTATO BEETLES AND IMIDACLOPRID

*Mitchell B. Baker, David N. Ferro*
*Entomology, University of Massachusetts*

This will be the 7th season of widespread *imidacloprid (Admire* and *Provado)* use in Massachusetts potato fields, and the warning signs are out there that resistance in Colorado potato beetle (CPB) is widespread and may soon threaten its effectiveness as a control. Last summer we surveyed 26 Connecticut Valley potato fields. We collected clutches of potato beetle eggs from each field, reared them out to four days of age, and applied a range of concentrations of imidacloprid to groups of larvae to find out how much *Admire* was needed to kill half the beetle larvae. We found that there was a 25-fold range in resistance, that it took 25 times as much *Admire/Provado* to kill half the larvae in the most resistant field than in the least resistant field. There was wide variation among even neighboring fields, suggesting that the treatments that each individual field receives will have a significant effect on resistance in that field. Non-resistant beetles are a resource, like soil or water. This resource must be conserved if we want to continue to use *Admire/Provado* to control beetle populations. In this article we discuss how "refuges" for susceptible beetles can be created within fields to prolong the effectiveness of imidacloprid or other treatments.

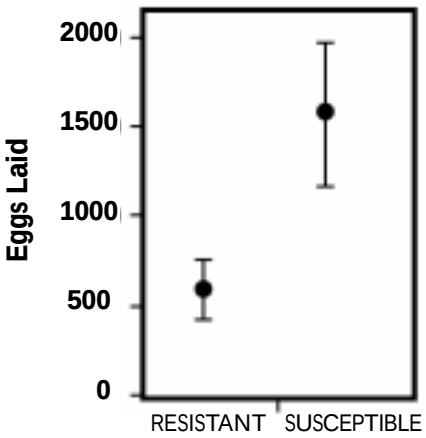
There is a struggle going on in each field between genes for resistance to *Admire* and genes for susceptibility. Every treatment of *Admire* or *Provado* kills the most susceptible beetles, leaving more resistant beetles alive to pass on their genes for resistance to the next generation. However, this selection doesn't act in only one direction. As it turns out, being resistant to imidacloprid has its costs. In a study last year, we found that resistant females laid fewer eggs. **(Figure 1).** The eggs of resistant parents were also less likely to hatch successfully. These costs can delay the spread of resistance in populations. It's likely that the costs of resistance are the main reason *Admire* and *Provado* have lasted as long as they have. However, resistance will still increase quickly unless beetles are not exposed to *Admire* or *Provado* for some part of the season. Systemic insecticides like *Admire* kill more beetles, but they select for resistance more strongly, because the whole plant is treated. There must be some refuge for susceptible beetles, an area where they are not exposed to selection.

**Refuges**

One refuge is already built into the system as it now exists, and that's the winter. Beetles underground are free from exposure to insecticides. Our lab has shown that beetles resistant to other insecticides, *Bt* sprays *(Raven, M-trak, Novodor)* for example, have lower survival through the winter. We expect that beetles resistant to

*(continued page 9)*

**Figure 1:** Beetles resistant to *Admire™/ Provado™* lay fewer eggs than susceptible beetles, and fewer of them survive to hatch.




*Admire* and *Provado* also have lower overwinter survival, and we will learn if this is actually the case when we collect data on resistance this spring. Despite the winter refuge, no insecticide used against CPB since lead arsenic prior to *WW II* has remained effective even as long as *Admire/ Provado*, and further steps are needed to provide a refuge for susceptible beetles. The challenge is to provide that refuge while at the same time keeping population numbers low enough to prevent crop damage.

The greater the area of the untreated refuge, the more effectively it will delay resistance. The most successful refuge would be to take a break for an entire season away from *Admire* and *Provado*. *Bt* sprays *(Novodor)* can provide good control of populations, though there is more effort involved due to the number of sprays, and some risk of rain interfering while the larvae are small and most susceptible. Even though *Bt* spray kills few of the adults, it interferes with their feeding and reduces the number of eggs they can lay. Other possible insecticides include *Spintor, Agrimek,* or others. Rotated fields (greater than 500 yards from previous year's field) have small colonizing populations, and treatments that attack eggs and larvae are sufficient to control populations, and colonizing adults do not damage young plants very much. In non-rotated fields, edge treatments, by reducing the size of that initial population, can protect the plants as they first emerge.

**Edge Treatments**

Edge treatments can reduce the numbers of beetles first colonizing fields in the spring. We've all seen the beetles coming in to fields from surrounding woodlots and field borders. Overwintering beetles are concentrated in the woodlots surrounding last year's fields. Most overwintering beetles enter the fields by walking from the edge, and even beetles flying in from distant fields stop close to the fields' edge **(Figure 2)**. The significance is that most of the colonizing population can be controlled by treating only the field edges, leaving the interior to act as a refuge. Edge treatments also can lower grower costs because less expensive insecticides can be used in the interior. A range of edge and center treatments vary in their convenience and effectiveness in preserving refuges for susceptible genes. Here are some field treatments that provide refuges for susceptible beetles.

Plastic lined trench:

One edge treatment is physical, laying trenches around the field, or between the field edge and surrounding woodlots **(Figure 3)**. The trench needs to be 1/2 to 1 foot deep, and lined with black plastic (mulching plastic). The trench should be placed anywhere the field edge borders woodlot, and must be maintained so that tears are repaired and weeds don't over-grow. Our lab found that trenches reduced the number of colonizing adults by 3/4 at a distance of 30 feet from the field edge and by 1/2 at a distance of 100 feet from the field edge.

*Admire* border:

*Admire* is an effective border treatment because the beetles don't avoid treated plants. Some insecticides are so distasteful that the beetles keep moving and leave the treated edge. Five rows treated on the field margins will control a large proportion of the colonizing generation. The eggs and larvae from the remaining spring generation can be controlled with *Bt* sprays or other insecticides that do not contain imidacloprid, and populations never reach a high level. Use of the border treatment of *Admire* keeps initial population levels low enough to prevent much damage to young plants. Use of a 5 row border treat-

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**Figure 2:** The density of adults colonizing a highly rotated field declines sharply after the 3rd row. Adults were censused twice before June 15 in a field planted for the first time in at least 20 years in potato in South Deerfield, MA. The graph shows row mean densities from 11 counts along each 440 meter long row.

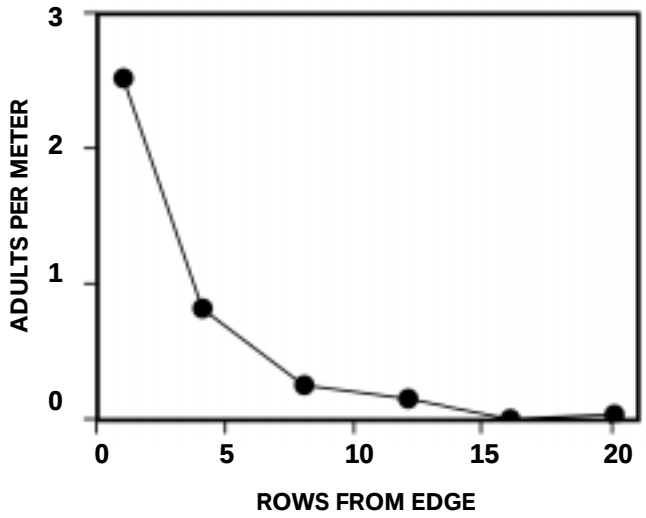

**Figure 3:** Trenches dug around a large, non-rotated field trapped about 1,000 beetles/meter in a 1995 study.

ment of *Admire* can also save money, if less expensive treatments are used inside. The larger the field, the smaller proportion of edge to center, and the greater the cost savings of an edge treatment. For example, *Spintor* costs about a quarter what *Admire* costs at the labeled rates of application. Assuming one or two treatments of *Spintor* and a 5 row edge treatment of *Admire,* savings can vary from $37 to $114/acre using an edge treatment rather than treating the entire field with *Admire* **(Table 1)**. The *Bt* sprays are much cheaper, but require more applications depending on the weather and population density, so savings are similar.

Row mixtures:

The easiest way to create a refuge is to shut off the delivery tube on every 2nd, 3rd or 4th row. Researchers at University of Maryland planted plots with all or no rows treated with *Admire,* and row mixtures of every other or every third row left untreated, and found that defoliation in plots with only half the rows treated was just over one quarter the damage on untreated plots. Potato yields (Atlantic and Red Pontiac) were not significantly different between fully treated and 3/4 treated plots, but were lower in plots with half the rows left untreated. Beetles moved enough that most of them spent at least some time feeding on treated rows, so that treating only half the plants did not lead to twice the damage, as might be expected. Most of the damage in the study took place in the untreated rows closest to the field edge. Treating the five outer rows on every side (this requires touch up on the sides where the row ends point out of the field) and then treating only half the rows in the interior of the field will control the population while providing a refuge for some susceptible beetles.

Whichever treatments are chosen, some refuge for susceptible individuals must remain to slow the increase in resistance. If the whole field is going to receive the same treatments, one treatment of *Provado* on the first generation and imidacloprid alternatives on the second generation will provide a refuge for the second generation. Using *Admire* as an edge treatment kills the majority of the population as they enter the field and before they damage many plants, and preserves the center of the field as a refuge. Using *Admire* on entire fields will rapidly lead to loss of imidacloprid as a control. We already have some fields that are 25 times as resistant as others. If we manage that level of resistance and slow its increase, we may be able to keep imidacloprid as a useful material for several more years. If we do not, we will lose it. □

**Table 1:** Savings per acre for edge treatment compared to whole-field treatment with *Admire.* For this example, current prices for *Admire and Spintor* at either the low or high labeled rate of application were used. The range is due to using high or low application rates, and using one or two treatments of Spintor.

| FIELD ACREAGE | ACRES TREATED WITH ADMIRE (5 YARD EDGE TREATMENT) | SAVINGS PER ACRE, LOW LABELED RATE |
|---|---|---|
| 1 | 0.3 | $37-$86 |
| 2 | 0.4 | $41-$95 |
| 5 | 0.6 | $44-$103 |
| 10 | 0.9 | $46-$107 |
| 20 | 1.3 | $47-$110 |
| 50 | 2.0 | $48-$112 |
| 100 | 2.9 | $49-$114 |

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# SPINTOR AGAINST SWEET CORN INSECTS: AN IN-FIELD GROWER TRIAL

*John Mishanec, Cornell University, Area Vegetable IPM Educator, Eastern NY*

A number of low toxicity, biological insecticides have come onto the market over the last ten years. Trials of these products have not always shown good results against all three main sweet corn insects, **European corn borer (ECB)**, **Fall armyworm (FAW)** and **Corn earworm (CEW)**. *Spintor*, produced by *Dow*, is a fermented product, which originally came on the market in 1999. A trial was set up with four participating commercial sweet corn growers to see if *Spintor* would work. Since *Warrior* is the standard insecticide used by sweet corn growers, it was used as the comparison product. Fields ranged from 1 to 5 acres in size.

Our results showed *Spintor* was comparable to *Warrior* in effectiveness against both European corn borer and corn earworm. Unsprayed checks showed unacceptable levels of damage while the *Warrior* and *Spintor* fields were equal in insect control. With our insect populations, it appears *Spintor* is just as effective as *Warrior* under most situations. Caution should still be used when monitoring insect flights. When corn earworm flights are extremely heavy, (15-20/night neighborhood) it might be a good idea to switch from *Spintor* to another effective corn earworm product.

*Spintor* at the rates used in this trial, is as effective as *Warrior*. Using those rates makes *Spintor* somewhat cost restrictive. All the participating growers said they would definitely use *Spintor* on their farms if not for the cost. (Low toxicity comes at a high price.) Future trials will be conducted to see if the *Spintor* rate can be reduced and still provide effective control.

## The in-field trial

Same age sweet corn fields were divided into three sections. One section was sprayed with *Warrior*, the second section was sprayed with *Spintor* and the third section was left unsprayed as a check. We carried out the trial with both early-season fields and late-season fields. Pheromone insect traps were put out in the fields to monitor insect flights. ECB flights occurred in June but an early CEW flight started around the 4th of July. The first sprays were applied at 40% tassel. Normally, in early season corn without CEW, two sprays five days apart at tassel are enough to control ECB. Because CEW was present, two additional sprays were applied before harvest. A rate of 4.5 oz. of *Spintor* was used. *Warrior* was used at a 4 oz. rate.

Something that was not expected was the population of aphids on the early corn. One grower felt it necessary to apply *Metasystox* before harvest in the *Spintor* section. *Warrior* is an exception in that it does a good job against aphids. *Spintor* is not very effective against aphids. The early fields were harvested in mid to late July. Harvest evaluations showed both sprayed fields had less than 2% damage while the unsprayed check fields had 8% damage (mostly from ECB).

For the second planting, since corn earworm was in flight, spray applications were started at silk. Five applications of *Warrior* or *Spintor* were made. One grower made an additional *Metasystox* application in his *Spintor* field as he felt the aphid populations were too high. Midway through the second planting, CEW trap catches jumped up to an average of between 10 and 15/night for less than a week. The trap catches then dropped down to under 5/night for the rest of the season. Harvest evaluations were done. With *Warrior* or *Spintor*, damage was less than 2%. In the unsprayed checks, damage was between 10 and 15%, mostly from corn earworm.

## Cost analysis – *Warrior* vs. *Spintor* (based on 2000 prices)

**First planting** (Average CEW trap catch = less than 2 per night)

- 4 applications of *Warrior* (4 oz/A) $12.50 per application.

Total spray cost = $50/acre/planting

- 4 applications of *Spintor* (4.5 oz/acre)

*Spintor* at $23.89 per application = Total spray cost = $95.40/acre

**Second planting** (Average CEW trap catch = approx. 5 per night)

- 5 applications of *Warrior*

Total spray cost = $62.50/field/planting

- 5 applications of *Spintor*

Total spray cost = $119.25/field/planting (Addition of one application of *Metasystox* = $10.60 per application) □

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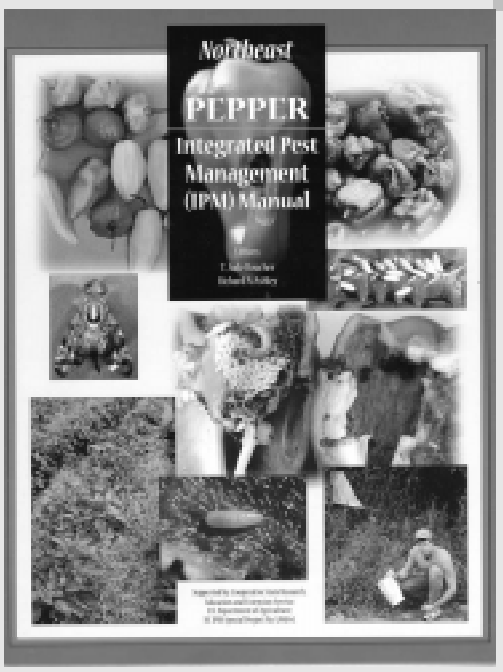
## NEW BOOK

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