Vegetable Notes
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This issue of Vegetable Notes highlights some of the research that the UMass Extension vegetable team has been working on over the past two years. Of particular interest is the article for our greenhouse tomato growers because of a significant change in the chemicals that will be allowed this year. It is very timely, as growers will need to make adjustments now to their disease management plans for greenhouse tomatoes this year.

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In this Issue:

Evaluation of Management Strategies for Clubroot Disease of Brassica Crops
2002 Flea Beetle Research Update
Diagnostic Kits Workshop
Management strategies for striped cucumber beetle & bacterial wilt in pumpkin, 2001 & 2002
Loss of Exotherm tRMIL in Greenhouse Tomatoes Forces Growers to Make New Decisions
Transferring the Farm Workshop Offered Throughout NE
Plant Preview Days
Thank you to these Farms, Companies & Individuals Have Donated This Campaign

EVALUATION OF MANAGEMENT STRATEGIES FOR CLUBROOT DISEASE OF BRASSICA CROPS

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Clubroot Disease, caused by the pathogen Plasmodiophora brassicae, is the most devastating disease of *Brassica* crops worldwide. It is especially significant in areas of intensive production of *Brassica* crops such as East Asia, Northern Europe, Australia, and North America. The disease can affect all types of cruciferous crops including vegetable (cabbage, cauliflower, radish, turnip, Chinese cabbage) and oil crops (rape seed), as well as weeds such as the wild mustards.

Disease occurs when the soil-borne club root pathogen invades the plant's root system. The infected roots become swollen, forming galls or "clubs" that interfere with the plant's water and nutrient transport. In mild cases wilting and stunting occurs, and in severe cases, the plant dies. Galls begin as small legions, often on lateral roots, and grow over time, often affecting the entire root system of the host **(Figure 1)**.

Figure 1: Healthy roots of Chinese cabbage grown in disease free soil (left) and clubbed roots of mustard greens grown in contaminated soil.

Disease Management: One of the most documented treatments for clubroot is raising the soil pH to 7.2. This creates an unfavorable soil environment for the pathogen, most likely by disrupting the release of zoospores.
It is unclear whether the suppressive effects of this treatment are due solely to an increase in pH, the associated increase in soil calcium and magnesium, or some interaction between these three factors. It is only a partial solution, however, since given optimal soil moisture, temperature, and spore load, severe clubbing will develop even in alkaline soils. Application of boron to the soil has also been used to manage clubroot for more than 60 years. Research has shown a significant decrease in disease by applications of borax at 20kg/ha.

Fungicides have been used for many years to treat fields infested with *P. brassicae*. However, most have required high application rates making them prohibitively expensive. In addition, many fungicides have given inconsistent control, and shown adverse environmental effects as well. For these reasons, no single fungicide has emerged as a truly effective and practical management tool. Pentachloronitrobenzene (PCNB) is currently the recommended fungicide for control of clubroot *(New England Vegetable Management Guide, 2002)*. PCNB has shown somewhat erratic performance and may cause phytotoxicity in high concentrations. However, when combined with liming it can be an effective control.

For cultural control options, crop rotations are the most frequently recommended management strategy. *Plasmodiophora brassicae* is an obligate parasite, unable to complete its life cycle in the absence of a host plant. It is recommended that infested fields be rotated out of *Brassica* family crops for a minimum of 5-7 years. This strategy is limited for several reasons. The pathogen is capable of infecting some cruciferous weed hosts, thereby completing its life cycle and maintaining a population of resting spores within the field even in the absence of a *Brassica* crop. Resting spores allow the disease to remain dormant in a field for many years, meaning that in cases of severe infection, a field may need to be permanently rotated out of *Brassica* crops for truly effective control. Therefore, crop rotation is only an effective management strategy when combined with

other treatments or in situations where continuous, intensive production of *Brassica* crops is not a necessary part of the agricultural system.
P. brassicae thrives in saturated soil conditions where zoospores swim freely to new hosts and resting spores are protected from desiccation. Reducing soil moisture by increasing field drainage, deep plowing, sub-soiling, or using raised-beds reduces disease pressure. Disinfesting equipment is another management technique. The pathogen must be physically moved in order to enter new fields, and this occurs via tractor tires, implements, and shoes of farm workers. Plowing or cultivating infested fields last can limit carry-over to new sites. All farm equipment should be thoroughly washed down after working infested fields. These practices will not eliminate clubroot, but can prevent the movement to new areas.

An emerging chemical control for clubroot is the use of non-ionic surfactants, commonly used as wetting agents in greenhouse systems. The exact action of these products on the pathogen has not yet been determined, but appears to be due to a lytic effect on zoospores. Surfactants are attractive due to their relatively low cost and ease of use, and have been tested by several researchers for control of clubroot. Several of these products have exhibited significant control in both field and greenhouse trials. They are available in both liquid and granular formulations, and both formulations have proven effective. However, none of these products are currently labeled for field use.

A promising new approach to control clubroot is the use of calcium cyanamide fertilizer. Calcium cyanamide fertilizer, a by-product of plastics manufacturing, is 19.8% nitrogen (as nitrate, cyanamide, and other soluble forms) and 50% lime expressed as CaO. This control measure exhibits two desirable properties. It has fungicidal and herbicidal effects, and can thereby significantly reduce fungal spores while also eliminating weed seeds. Furthermore, the degradation of hydrogen cyanamide results in urea, a nitrogen source, and dicyandiamide, which inhibit nitrification by *Nitrosomonas* bacteria. This action slows the breakdown of ammonia into nitrate in the soil over a period of 6-8 weeks, providing a slow release source of nitrogen.

In Massachusetts, clubroot is a significant disease problem for growers of *Brassica* crops, especially for an increasing number of new-entry Asian farmers who devote a relatively large percentage of their acreage to Brassica species due to their importance in their cuisine. Since Brassica crops make up the majority of their crop mix and available land is often limited for these growers, crop rotation is not always an option and new alternatives need to be evaluated. We have initiated a research program to develop an integrated approach to managing clubroot. A preliminary report is summarized below.

Plant materials: Chinese cabbage 'Rubicon' (Johnny's Selected Seeds, Albion, ME) was used as the clubroot-susceptible cultivar and 'Chorus' (American Takii Seed Co., Salinas, CA) was used as the clubroot-resistant cultivar. Transplants were planted in the field after seven weeks in a greenhouse.

Experimental Sites: The experiments were carried out at two commercial farms in Western Massachusetts on land with a history of *Brassica* cultivation and clubroot

disease. Farm 1 represented a conventional production system and Farm 2 an organic production system. In each case the farmer prepared the fields, fertilized, irrigated, and managed pests according to their respective practices. The experimental area at Farm 1 had a soil pH of 7.1 as a result of heavy liming the previous year for management of clubroot. Farm 2 had a soil pH of 6.2.

Treatments: At Farm 1, replicated plots of the following treatments were established: 1) bait crop, clubroot-resistant leafy daikon (cv. CR-1, Nakosu Seed Co., Japan) was broadcast and allowed to grow for 4 weeks and then incorporated into the soil; 2) calcium cyanamide was broadcasted and incorporated into the soil 1 week prior to planting at a rate of 1000 lbs/acre; (not in farm 2) 3) immediately prior to planting, the surfactant AquaGro-2000G was applied as a banded application in the row and was incorporated into the soil; 4) PCNB (Terraclor) was applied after planting as a transplant drench; 5) boron (Solubor) was also applied as a transplant drench after planting, and 6) an inter-planted treatment with a 7:3 ratio of resistant to susceptible plants, planted with each susceptible plant surrounded by resistant plants.
Data Collection: After 7 weeks, the plants were harvested and clubroot data were taken. Whole plants were removed from the soil, and the roots were cut off, washed and scored for disease severity. Clubroot severity was assessed on a scale of 0-3, with 0 = no clubbing; 1 = lateral roots only clubbed; 2 = <50% of tap root clubbed; and 3 = >50% of tap root clubbed. The remainder of the plant was weighed to assess the affect of clubbing on plant growth.

Results and Discussion: The results for the experiment can be found in **Table 1 and 2**. At both farm sites, the resistant cultivar showed good promise for control of clubroot with very low relative disease severity scores. This cultivar was selected after it was shown to be the most resistant among four cultivars screened in greenhouse tests the previous winter. Genetic resistance has proven to be somewhat unstable for this pathogen, however, as repeated cultivation of a resistant cultivar will select for virulent strains within a field population of the pathogen that typically shows a broad genotype. This, coupled with the small number of resistant Asian *Brassica* cultivars available, may limit the effectiveness of this treatment. However, it would certainly be of use as part of a comprehensive management plan, especially if used in conjunction with crop rotation. The calcium cyanamide treatment also showed very promising results and merits further testing to determine the optimal application rate and timing. As other researchers have reported (Dixon and Williamson, 1985), some phytotoxicity was observed in this trial, which may account for the reduced weights seen with this treatment. This treatment is expensive in the U.S., so finding the minimum application rate necessary would also be important. In addition, calcium cynamide is not labeled for control of clubroot; however, it is a legal source of fertilizer.

The surfactant treatment also showed positive results and is worthy of further refinement. Prior research has shown that as a granular product, AquaGro 2000G seems to have a longer period of activity than some of the liquid formulations. The granular product, in combination with a liquid surfactant applied during the crop growth, might show even more improved performance. One complication will be getting these products labeled for

field use as they are currently only labeled for greenhouse production.

For the organic treatments, only the resistant cultivar showed good control. In general, the soils at Farm 2, the organic farm site, had poorer fertility and the plants were put in during an extended period of drought with limited irrigation. The soil pH at Farm 2 was also significantly more acidic, making it more hospitable to the clubroot pathogen. These additional stresses may have influenced the results and it would be worthwhile to repeat these treatments in a more favorable environment. In addition, there was some incidence of Xanthamonas and *Erwinia* soft rot at both field sites that contributed to plant stress, possibly making them more susceptible to the clubroot pathogen.

Management Recommendations for Clubroot: If possible, avoid planting cruciferous plants in soil known to contain the clubroot organism. Do not raise transplants in soil known to contain the clubroot organism. If planting into contaminated soil, ask your seed source if they have resistant cultivars. Chisel plow if drainage is poor. Apply PCNB at the labeled rate and in accordance with the label. Lime to bring the pH up to 7.1 to 7.2. When working in fields known to be contaminated, hose down equipment before moving into new fields.

Table 1: Disease severity of clubroot as affected by eight treatments on two farms in Massachusetts in 2002.

Disease severity rating y

Treatments	Farm 1	Farm 2
Control	2.57 az	2.91 a
Boron	2.57 a	3.00 a
Calcium Cyanamide	1.17 b	----
PCNB	1.92 ab	----
Aqua-Gro 2000G	1.31 b	----
Bait Crop	1.65 b	3.00 b
Resistant Plant	0.17 c	0.11 c
Interplanting	1.34 b	1.54 b

Notes: y Clubroot severity was assessed on a scale of 0-3 with 0 = no clubbing; 1 = lateral roots only clubbed; 2 = <50% of tap root clubbed; and 3 = >50% of tap root clubbed.
z Mean separation within columns and years by Duncan's multiple range test at P=0.05.

Table 2: Yield of Chinese cabbage as affected by eight treatments for clubroot management on two farms in

Massachusetts in 2002.

Treatments	Farm 1	Farm 2
	Plant Weight (kg/plant)	
Control	1.5 ABZ	0.1 C
Boron	1.5 AB	0.1 C
Calcium Cyanamide	1.7 AB	----
PCNB	1.5 AB	----
Aqua-Gro 2000G	2.0 AB	----
Bait Crop	1.9 AB	0.0 C
Resistant Plant	2.1 A	2.0 A
Interplanting	1.4 B	0.9 B

Notes: z Mean separation within columns and years by Duncan's multiple range test at P=0.05.

2002 FLEA BEETLE RESEARCH UPDATE

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In early spring, the brassicas being grown on the University of Massachusetts agronomy farm, and many local farms, are inundated with high numbers of flea beetles. We are currently investigating strategies for controlling adult flea beetles on brasscia crops. In 2001 and 2002 we ran two sets of trials, and have identified several compounds that may be of interest. Among the methods tested, spun-bonded row cover and carbaryl (Sevin XLR Plus) were the most consistently effective. However, several other compounds showed their potential as a management tool. Spinosad (Spintor 2SC, which will be available in a new organic formulation, Entrust, in 2003) and capsaicin (Hot Pepper Wax) significantly reduced the amount of damage to the leaves of the plants. The systemic pesticide thiamethoxam (a neo-nicotinoid insecticide, currently not labeled for brassicas), which was applied as a furrow drench at seeding, provided good protection of the plants early in their growth, and a large number of dead flea beetles could be seen in the plots. Plants treated with thiamethoxam had a significantly higher weight than untreated plants, but the large leaf surface was very attractive to beetles, and by the time the leaves were harvested, there was a large amount of damage. Imidacloprid (Provado), neem (Ecozin 3%) and pyrethrum (Pyganic Crop Protectant) did not provide control of beetles.

In 2002, a series of experiments aimed at elucidating various aspects of flea beetle ecology and its life cycle in the field was started. Flea beetles overwinter as adults. Winter sampling of habitats at the borders of a field planted with brassicas revealed that

flea beetles preferred to overwinter in the brushy or wooded areas surrounding the field, rather than the grassy areas immediately adjacent to the field. In the early spring, the overwintered beetles emerge from their overwintering sites and beginning feeding on any available brassica weeds or crop plants. They then lay their eggs at the base of the stem of brassica plants, and the larvae feed on the roots. Soil sampling of crop roots revealed that the flea beetle larvae **(Figure 1)** are voracious feeders on the roots of brassicas, and can easily kill young plants. The increased yield of thiamthoxam-treated plants may be a result of the thiamethoxam protecting the roots from larval feeding. The larvae that are feeding on the roots of the plants emerge as adults (most likely in late July), which may result in significant flea beetle damage to crops in August. Some local growers have reduced or eliminated their flea beetle problems by no longer growing brassicas early in the season (before mid-July).
Further research will be conducted in 2003.

Figure 1: Flea beetle larva feeding on root hairs of a seedling brassica plant.

DIAGNOSTIC KITS WORKSHOP

On Thursday, March 20, from 10:00 AM - 1:00 PM, the UMass Waltham Center in Waltham, MA
will host a Diagnostic Kits Workshop.
Participants will learn to diagnose disease right in your own greenhouse using disease diagnostic kits. Disease diagnostic kits are available for several diseases (Impatiens Necrotic Spot Virus, Tobacco Mosaic Virus, Xanthomonas, Rhizoctonia and Pythium) found on greenhouse crops. Growers will have an opportunity to learn more about disease diagnosis, taking proper samples and how these test kits work. Each participant will use various test kits for several diseases and observe their outcome.
Three contact hours for pesticide recertification will be offered.
For more information, contact: Tina Smith, 413-545-5306 or Paul Lopes 508-295-2212 ext. 24
UMass Extension Floriculture Program.
The cost is $50.00 per person.

MANAGEMENT STRATEGIES FOR STRIPED CUCUMBER BEETLE &

BACTERIAL WILT IN PUMPKIN, 2001 & 2002

Ruth Hazzard, Tim Andenmatten, John Howell, Robert Wick, University of Massachusetts Extension Vegetable Program.

Introduction: Bacterial wilt, caused by *Erwinia tracheiphila,* has in recent years become a more serious problem in pumpkin and some winter squash types, causing wilting of leaves and vines and loss of whole plants. Striped cucumber beetle *(Acalymma vittata)* adults carry the pathogen over the winter and infect subsequent crops. Beetle feeding and defecation on cotyledon and young leaves transmits the bacteria *Erwinia tracheiphila*. Bacteria multiply in the plant's vascular system, blocking water uptake and causing the plant to wilt. Plants are most susceptible in early growth stages. Preventing feeding damage from infected beetles is the primary means to control the disease. The project objective was to evaluate new materials and application methods to control the striped cucumber beetle and reduce losses from bacterial wilt.

Experimental Treatments: A randomized complete block design with four replicates was used. Plots consisted of a single twenty-five foot row of 12 plants spaced two feet apart in the row and fifteen feet between rows. Treatments were applied to both transplants (TP) and to direct-seeded (DS) pumpkins. Foliar sprays were applied weekly after beetles arrived until flowering. Seeding and transplanting occurred on June 6 in both years. 'Merlin', a wilt susceptible pumpkin variety, was used in 2001 & 2002. This is a powdery-mildew tolerant variety, which has been shown to be more susceptible to bacterial wilt than some older pumpkin varieties such as Howden (McGrath and Shishkoff 2000).

The imidacloprid (Admire 2F) transplant drench was applied to flats 24 hours prior to transplanting in the field. Weekly foliar treatments (Avaunt, Sevin XLR Plus, and Surround WP) and the single Admire furrow drench treatment were applied using a backpack sprayer. The single Admire trickle treatment was applied through the trickle irrigation using a venturi injector. Separate trickle lines were used to apply the imidacloprid trickle treatments. The same amount of water was applied to all other treatments. In 2001, trickle treatments were not equally dispersed through the row. In 2002, Admire was applied with sufficient water to reach all plants equally.

In 2001, three action thresholds for Sevin applications were tested in addition to weekly sprays: 10% of plants with fresh feeding damage; 20% with fresh damage; and an average of 1 beetle per 2 plants.

Bioyield is a mixture of several strains of plant growth-promoting bacteria, which have been shown to reduce feeding damage by cucumber beetle in cucurbits, and to induce greater resistance to disease. Bioyield was applied as a seed dip (2001 DS, 2002 DS & TP) or mixed into the potting media (TP, 2001) before seeding.

Sampling Methods: Live and dead beetles were counted weekly on three randomly selected plants per plot. The same plants were assessed for cumulative damage from beetle feeding. Each leaf was rated for % damage with a rating scale of 0-5: 0 = no damage, 1 = 1-25% eaten, 2 = 26-50%, 3 = 51-75%, 4 = 76-100%, 5 =

dead/shriveled/missing. Damage ratings taken two weeks after beetles arrived, following two foliar sprays, are presented here. At harvest (Sept 19-21), pumpkins over 5 lbs were counted and weighed. Yields were converted to ton/acre assuming 250 square feet/plot.

Results: Beetle numbers: Small plot work tends to underestimate efficacy because beetles re-colonize treated plots from unsprayed plots in the field. Beetles arrived in the field on June 11 in both years. The second year we planted into a field adjacent to the previous year and beetle numbers were two-five times higher. Average beetle counts for the season in unsprayed TP (controls) were 0.31 per plant in 2001 and 1.54 per plant in 2002. Average counts for the season in DS control plots were 0.46 per plant in 2001 and 0.92 per plant in 2002.
Beetle counts were not a particularly good indicator of how well treatments worked: there were no significant differences in beetle counts among treatments on any date. In both years, dead beetles were found in higher numbers in the Admire treatments (significantly higher on some dates).

Leaf damage: In 2001, in TP and DS, Admire drench and Surround consistently had the lowest damage ratings. Admire trickle/DS, Sevin/DS and Bioyield/DS had lower ratings than the control but the differences were not significant. Transplants consistently had higher damage ratings than direct-seeded plants; however, DS plants emerged after beetles were in the field, so they were fed upon from the day they came up. In 2002, feeding damage was more severe. After the first week, all Admire treatments and Bioyield II DS had damage ratings lower than the control, while other treatments suffered damage equal to untreated plants.

Losses to bacterial wilt: In 2001, among transplants, losses to wilt showed no difference between treatments. Among direct-seeded plots in 2001, losses were significantly lower in the Surround and Sevin (weekly and 20% threshold) treatments compared to the control. In 2002, Admire applied through trickle or as a furrow drench had significantly lower losses from wilt compared to other treatments and to the control. In both years, testing across all treatments, losses from bacterial wilt did not differ between the two methods of planting (transplant vs. direct seed). However, untreated DS plants had more loss to wilt than untreated TP.

Table 1: Treatments and Results, 2001

* Significantly different from control (P<0.05, Duncan's) within TP or DS.

Treatments	Plant Method	Rate/Method of Application	Damage Rating on 6/25	Total %Wilted Plants	Total Yield converted to ton/acre
1. Admire Drench	TP	0.02 ml/plant	0.9	12.5	31.2
2. Admire	TP	1 oz/1000	2	20.8	36.5

Trickle		ft			
3. Bioyield	TP	250 ml/ 10 L media (1:40 V:V)	1.5	18.8	37.1
4. Sevin XLR Plus	TP	1 qt/acre	1.4	25	29.8
5. Control	TP	--	1.4	16.7	32.9
6. Surround	TP	0.5 lb/gallon, sprayed to cover	0.9	18.8	40.3*
7. Admire Drench	DS	1 oz/1000 ft	0.1*	12.5	32
8. Admire Trickle	DS	1 oz/1000 ft	0.3	26.5	32.6
9. Bioyield	DS	seed dip, full strength	0.4	14.6	32
10. Sevin	DS	1 qt/acre	0.2	8.3*	32.3
11. Control	**DS**	**--**	**1**	**37.5**	**26.6**
12. Surround	DS	0.5 lb/gallon	0.1*	8.3*	29.7
13. Avaunt	DS	3.5 oz/acre	0.8	16.7	39.2*
14. Sevin 20%	DS	1 qt/acre	0.7	6.2*	37.6
15. Sevin 10%	DS	1 qt/acre	0.1*	14.6	27
16. Sevin 1per 2	DS	1 qt/acre	0.2	14.9	30.4

Yield: In both years, testing across all the treatments, total yield did not differ between the two methods of planting (transplant vs. direct seed). In untreated controls, yields were lower in DS in both years, but not significantly so. Fruit size was significantly higher in transplanted treatments in 2001.

In 2001, only Surround (TP) and Avaunt (DS) produced yields that were significantly higher than the control. In 2002, Admire applied through trickle on DS or TP or as a furrow drench on DS at planting produced yields that were significantly higher than the control.

In these small plot trials, only one threshold treatment (20%) resulted in fewer sprays (3 in the 20% threshold vs 4 in all others including weekly sprays). Only the 10% threshold showed less leaf damage than the control. Despite fewer sprays, the 20% threshold treatment had less wilt and somewhat higher yield. The only difference in this treatment was that the first spray was applied 3 days later. This rather puzzling result is difficult to explain, but suggests that timing may be as critical a factor in spray efficacy as the number of sprays.

Table 2: Treatments and Results, 2002

* Significantly different from control (P<0.05, Duncan's) within TP or DS.

Treatments	Plant Method	Rate/Method of Application	Damage Rating on 6/25	Total %Wilted Plants	Total Yield converted to ton/acre
1. Admire Drench	TP	0.02 ml/plant	0.7	42.5	21.6
2. Admire Trickle	TP	1 oz/1000 ft	0.3*	17.5*	32.5*
3. Bioyield	TP	seed dip	1	55	14.5
4. Bioyield II	TP	seed dip	0.9	67.5	13.6
5. Sevin XLR Plus	TP	1 qt/acre	1	57.5	11
6. Surround	TP	0.5 lb/gallon	1	55	19.9
7. Avaunt	TP	3.5 oz /acre	1	60	18.7
8. Control	**TP**	**--**	**1.1**	**65**	**13.8**
9. Admire Drench	DS	1 oz/1000 ft	0.4*	15*	34.4*
10. Admire Trickle	DS	1 oz/1000 ft	0.2*	5*	35.2*
11. Bioyield	DS	seed dip	1.9	75	9.2
12. Bioyield II	DS	seed dip	0.9*	50	15.2

13. Sevin XLR Plus	DS	1 qt/acre	0.5	62.5	21.8
14. Surround	DS	0.5 lb/gallon	1.6	75	14.3
15. Avaunt	DS	3.5 oz/acre	1.6	60	9
16. Control	**DS**	**--**	**1.8**	**72.5**	**9.4**

What does this mean for growers?: The good news is that there are a number of effective options for both conventional and organic growers for managing cucumber beetle and bacterial wilt. This study also supports what we have seen in farm fields: crop rotation to an adjacent field - different land, but close to last year's cucurbits -- **does not** help reduce beetle numbers. Not only beetle numbers but the impact of beetles on the development of bacterial wilt were more severe in our second year trial. In the first year, differences in feeding damage did not always translate into differences in losses to wilt or in yield differences.

In the second year, with higher pressure and possibly a higher proportion of bacteria-infected beetles, controls that had done well in the first year broke down. Thus, one could conclude the insecticides are most effective when used in conjunction with good cultural practices.

The conventional foliar material carbaryl (Sevin XLR Plus) provided protection to DS plants in 2001 but not to TP in 2001 or either TP or DS in 2002. This may be related to timing: in both years, there was a 2-3 day delay between beetle arrival and the first spray, which allowed some feeding to occur. Growers who have used this method are aware that timing is important and often difficult, because beetle numbers (and leaf damage) increase rapidly in mid-June.

Indoxycarb (Avaunt) reduced feeding damage and gave significantly higher yield in 2001, but was not effective in 2002. This material is very effective against caterpillars in cole crops and whorl-stage corn (eg for fall armyworm control) but is currently not labeled for cucurbits.

Kaolin clay (Surround WP) provided significant reduction in feeding damage, less loss to wilt, and higher yield in 2001 - but not in 2002. I would recommend this product to organic farmers, particularly in combination with other tactics that can reduce the number of beetles or susceptibility of the crop, such as rotation, row cover, using transplants (so plants are bigger when beetles arrive), and delaying planting until late June to avoid beetles. Surround can be applied to transplants prior to setting in the field.

Bioyield Flowable (2001) and Bioyield II (2002) as a seed treatment provided suppression of feeding damage and an improvement in plant survival and yield, though not necessarily significant statistically. Further work on this is needed to explore strains, rates and success in different soil conditions. Plant growth promoting bacteria perform

differently in response to varying soil conditions. This could be a promising component of a broad control strategy. Seed treatments are an efficient application technique. It could be useful for organic growers if this material gains approval in the National Organic Program. Bioyield is currently available from agricultural suppliers and is marketed as a growth-promoting compound.

Imidicloprid (Admire 2F) was effective applied as furrow drench at 1oz/1000 ft in both years. Given the variable row spacing used in cucurbits, calculating rates in terms of ounces per row 1000 feet gives consistent rates at the root zone, and reduces per acre cost at wide row spacings. Admire was also effective through trickle when the full row was saturated with water as in 2002, even under high beetle pressure. This can be accomplished by charging the system with water first, then making the injection, then running more water to clear the system and ensure wetting of the entire row. The pre-transplant drench provided suppression and reduced wilt but was not as effective as other methods of application. It is possible that slightly higher rates would be more effective, but growers should use caution because excessive rates cause burning. Rates of 0.04 ml per plant have been shown to cause burning in melon seedlings.

THERE IS STILL TIME TO BE COUNTED IN THE 2002 AG CENSUS!!

Have you been counted in the USDA's 2002 Census of Agriculture that is currently underway? Report forms will be accepted through June 2003 as the USDA reviews and summarizes the data. If you are not counted, your industry will not be properly represented. Thus far, reporting numbers are down in the Northeast. This is a big problem. Many federal programs and dollars
are determined by state and regional census figures.

If you did not receive a Census report form, please call 1-888-424-7828 to get a copy. You may call the New England Agricultural Statistics Service, USDA
in Concord, NH at 1-800-642-9571, if you have questions.

LOSS OF EXOTHERM TERMIL IN GREENHOUSE TOMATOES FORCES GROWERS TO MAKE NEW DECISIONS

Robert Wick and John Howell

The most important fungal diseases of greenhouse tomatoes are Leaf mold *(Fulvia fulva)*, Botrytis blight *(Botrytis cinerea),* and Powdery mildew *(Oidium lycopersicum)*. Any one of these pathogens can be very destructive when environmental conditions are favorable for disease.

The compelling reason for writing this article is that we have recently lost the fungicide Exotherm Termil (chlorothalonil) as a management tool for controlling these diseases. Tomato was taken off of the Exotherm Termil label because a new ingredient was added to the fungicide, and it does not have clearance on vegetables. Also, an additional ignitor chemical was added which does not have clearance to be used on plants to be consumed as food. **Do not use this new formulation of Exotherm Termil on greenhouse**

tomatoes or other food crops.

Leaf Mold: This disease is caused by the fungus *Fulvia fulva;* in older literature it was called *Cladosporium fulva*. It is common on greenhouse tomatoes and uncommon on field grown tomatoes. The pathogen is restricted to tomato. The disease is first apparent as pale yellow spots randomly scattered on the surface of the leaves. Older leaves are affected first. The underside of the leaf, opposite the yellow spots, reveals a greenish felty crop of spores. Affected leaves generally dry up and die. Relative humidity above 85% and temperatures between 70 and 75 degrees Fahrenheit are ideal for disease development. Personnel moving through the greenhouse and working with plants easily dislodge spores and spread the pathogen. Typically, the crop is uniformly affected in a relatively short period of time.

After an episode with leaf mold, remove all tomato debris from the greenhouse. Consider steaming the soil and disinfecting all surfaces. The fungicide Manex (maneb, an EBDC) is registered for this disease on greenhouse tomatoes, however, this material is thought to increase susceptibility to *Botrytis* (see *Botrytis information).*

If your greenhouse has a history of leaf mold, consider growing resistant cultivars. Try several below representing resistance to different Fulvia strains:

FULVIA RESISTANT TOMATO CULTIVARS

CULTIVAR	FULVIA STRAIN
Buffalo	C5
Capello *	C5
Caruso*	C5
Cobra*	C5
Dombito	C1, C2
Furon	C2
Junbo	C1, C2
Pink KR15	C5
Pink C4-864	C5
Trend	C5
Ultra	C7

Pink	
Ultra Sweet	C7
Laura	C2
Vetomold	C2
Vision I*	C5

* From the Netherlands.

Botrytis Blight: Botrytis blight, or Gray mold, is caused by the fungus *Botrytis cinerea.* It is a common greenhouse inhabitant and has a very wide host range. Most growers recognize this disease by the fuzzy, gray crop of spores that develops on lesions. Generally, the fungus attacks old or young tissues and not usually healthy vigorous growth. However, on tomatoes it is common at pruning wounds, older foliage and occasionally at the calyx end of the fruit. It can also cause "ghost spot" of the fruit, a condition where spores infect the fruit but disease is stopped. Temperatures from 65 to 75 degrees Fahrenheit are ideal for disease but humidity above 91% is also necessary. Horticultural oils applied during cool, humid weather, and EBDC fungicides are thought to increase susceptibility to Botrytis
.
Managing humidity and reducing leaf wetness is critical to controlling Botrytis (see Controlling relative humidity section). Currently, Armicarb 100 (potassium bicarbonate) is the only fungicide registered for greenhouse tomatoes but it may not be effective for this disease. An on-line publication http://www.nysipm.cornell.edu/publications/greymold.html listed Armicarb as a product that increased leaf disease. The same publication reported that Mycostop S drenched into the soil significantly decreased leaf disease. Mycostop is primarily for root diseases, and no claims for Botrytis management occur on the label.

Powdery Mildew: Powdery mildew is a relatively new disease of tomato in the Northeastern US. The disease occurs in other parts of the country but the powdery mildew pathogen is not the same. Researchers at the Connecticut Agricultural Experiment Station have identified *Oidium lycopersicum* as the cause of powdery mildew in Massachusetts and Connecticut. The disease can be moderate to very destructive. Research carried out at the CAES http://www.hort.uconn.edu/ipm/veg/htms/pmildton.html indicated that Quadris and Kocide reduced powdery mildew on leaves but did not significantly increase yield. The Quadris label does not specifically mention greenhouse use. Armicarb (potassium bicarbonate) is registered for powdery mildew on greenhouse tomatoes.

Controlling relative humidity: The only practical way to control RH in a greenhouse is by ventilating to exhaust warm, humid air and replace it with cooler air with less moisture. Warm air holds more moisture than cool air. In fact, for every 20 degrees

Fahrenheit increase in temperature, the moisture holding capacity of air nearly doubles. During warm day temperatures, the air contains more moisture than during the cooler evening temperatures. At 75 degrees Fahrenheit, and 100% RH a cubic meter of air holds about 20 grams of water vapor, but at 65 degrees Fahrenheit it can hold only about 15 grams. As air-cools, its ability to hold moisture is reduced and the RH goes up. During the day, a temperature of 75 degrees Fahrenheit and 90%, RH are typical. As the temperature cools in the evening the air becomes saturated (100% RH) at about 72 degrees Fahrenheit. As air-cools further to a typical night temperature of 65 degrees Fahrenheit, water condenses on surfaces including pipes, plastic and plant leaves. To avoid this, RH should be reduced before or while the air is cooled to the night temperature. Exhausting the moist warm air and replacing it with cooler outside air that has less water vapor can reduce humidity. Activate the exhaust fans for a short period, and then heat the greenhouse to raise temperature to the desired nighttime level. This may have to be repeated. While the exhaust fans are running, the furnace must not come on or else flue gases can be drawn back into the greenhouse. You can simply turn the furnaces off while venting or install a lockout relay to prevent the heat from coming on until the exhaust fans shut off. With a lockout device, you can use timers to automatically vent and heat during the night. Set the timers so that the exhaust fans come on for 20 to 30 seconds, two to three times per hour if needed. This seems like a waste of fuel and money, but very little fuel is used to reheat the air. High relative humidity can lead to devastating disease loss, which is much more expensive.

Using horizontal airflow (HAF) can also reduce condensation. HAF fans keep air moving in the greenhouse, helping to minimize temperature differentials and cold spots where condensation occurs. Air that is moving is continually mixed and this reduces condensation on plant surfaces. HAF should be used in addition to proper ventilation, not in place of it.

References: 1. Compendium of Tomato Diseases. 1991. Jones, J. B., Jones, J. P., Stall, R. E. and Zitter, T. A. APS Press, www.shopapspress.org St. Paul, MN 100 pp.; 2. Diseases and Pests of Vegetable Crops in Canada. 1994. Howard, R. J., Garland, J. A., and Seaman, W. L. The Canadian Entomological Society of Canada, Ottawa, Ontario (613) 725-2619. 554 pp.

TRANSFERRING THE FARM WORKSHOP OFFERED THROUGHOUT NEW ENGLAND

During March 2003, farm families will have the opportunity to learn about transferring the farm in a daylong workshop offered in 5 locations throughout New England, thanks to a grant from the Northeast Center for Risk Management Education. The workshop will help farmers navigate the farm transfer process and will include presentations by farmers, extension specialists, attorneys, and land link and land trust personnel. Topics will include: elements to consider when transferring the farm to the next generation whether they be related or not; communicating for success; goal setting with the family and farm in mind; keys to estate and retirement planning; tools to transfer labor, management and farm assets; and the roles that farm link programs and land trusts can play in farm transfers. The program will also include a panel of farmers who will share their personal

experiences with farm transfers. The workshops are offered by a partnership of the following organizations: Univ. of NH Coop. Extension, Univ. of VT (UVM) Ext., Land Link Vermont at UVM's Center for Sustainable Agriculture, CT Dept. of Ag., ME Farm Link, the New England Small Farm Institute, and the Univ .of ME Ext.

Transferring the Farm will be offered in five sites:

Clarion Hotel and Conference Center in Northampton, MA on March 12
Zenny's Restaurant in Storrs, CT on March 13
the Benton Grange in Benton, ME on March 18
Makris Lobster and Steak House in Concord, NH
on March 19; and the Charlmont in Morrisville, VT on March 20
Each workshop is scheduled from 9:00 a.m. to 3:30 p.m.
The workshop fee, which includes registration, a workshop packet and lunch, is $15 per person if postmarked before March 5. After March 5, the fee is $20 per person. Checks should be made payable to: UNH Cooperative Extension and mailed to: Transferring the Farm Workshops, UNH Cooperative Extension, 320 James Hall, 56 College Road, Durham, NH 03824. For a workshop brochure or more information, please contact Debra Heleba at (802) 656-0233 or debra.heleba@uvm.edu.
Anyone requiring special accommodations or scholarship help to attend should call (802) 656-0233.

PLANT PREVIEW DAYS: APRIL 8, 15, 22
Looking for sources of spring plants? "Tuesdays in April are Tour Days" on April 8, 15, 22 from 8:30 am - 4:00 pm. The event, which is co-sponsored by University of Massachusetts Extension and the Massachusetts Flower Growers' Association will offer garden center operators, farm stands, landscapers, chain store buyers, plant brokers/salesman, municipalities, sellers of plants for fund-raisers and other industry buyers a chance to visit participating family-owned, wholesale greenhouses on Tuesdays in April.

Take a peak at this season's spectacular crop of flowers. The goal is to connect plant buyers with wholesale plant growers in Massachusetts to help keep agriculture viable in the Massachusetts. Fourteen participating wholesale greenhouses throughout Massachusetts will open their greenhouses for viewing. Participating wholesale growers specialize in a wide assortment of products for spring, including annuals in packs and pots, perennials, hanging baskets, patio planters, herbs, ornamental grasses, geraniums and more. For more information and to receive directions to participating greenhouses, contact:
Tina Smith 413-545-5306 or Paul Lopes 508-295-2212 x 24,
University of Massachusetts Extension Floriculture Program.

THANK YOU TO THESE FARMS, COMPANIES & INDIVIDUALS WHO HAVE DONATED THIS CAMPAIGN:

We would like to express thanks to the nearly fifty farms, businesses and organizations that have donated this winter to the UMass Vegetable Program. You are helping to keep us strong and growing, able to serve farms throughout the region. Thanks to the following:

Achinback Farm Agricultural Consulting Services Bartlett's Ocean View Farm, Inc. Bemben, J. E. Berberian Farm Brookdale Fruit Farm, Inc. C.N. Smith Farm, Inc. Calabrese Farms Charlton Orchards Group LLC CISA (Community Involved in Sustaining Agriculture) Cook's Valley Farm Cournoyer Vegetable Farm Dick Kelly's Farm Stand Dupont Crop Production Dubl-Jay Farm Ferncol Friends, Inc. Ferolbrink Farms Fine Farms Four Town Farm Golonka Farm Gove Farm Greenview Farm Griggs Farm Hampshire/Hampden Farm Service Agency Hibbard Farm	Houlden Farm Howden Farm, LLC Hutchins Farm Indian Head Farm JR Hallene Farm Products Koran's Farm Kristo, J. J. Land's Sake, Inc. Marini Farms Matte Orchards, Inc. McGuire, E. D. McKinstry's Market Garden Morning Glory Farm Out Post Farm, LLC Pleasant Valley Gardens Reich, N. Stonfield Farm Sweet Berry Farm Teddy C. Smiarowski Farm The Stand at Brox Farm Walker's Roadside Stand Weinack Farm Wilder Brook Farm Wilson Farm, Inc. Young Family Farm, LLC

Vegetable Notes is a publication of the University of Massachusetts Extension Vegetable Program, which provides research based information on integrated management of soils, crops, pests and marketing on Massachusetts farms. Subscriptions to Vegetable Notes include the IPM Newsletter, published weekly during the growing season. For subscription information call (413)577-0712 or visit our website at http://www.umass.edu/umext/programs/agro/. For more information about the Vegetable Team's research and UMass Extension programs call Ruth Hazzard at (413)545-3696.

TOP