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 Trickle	TP	1 oz/1000 ft	2	20.8	36.5
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 6/28	TOTAL % WILTED PLANTS	TOTAL YIELD CONVERTED TO TON/ACR
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. AdmireTrickle	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	1.5	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.

We would like to thank the New England Vegetable and Berry Growers Association (along with individual growers who gave donations in 2001 and 2002) and DuPont Crop Production for their financial support of this project, and Gustafson and Bayer Corp for donation of materials.