Lettuce Cultivars for Insect Resistance in Southern Florida[1]

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Introduction

Lettuce is the most popular ingredient in salads and salad mixes consumed in the United States. Lettuce production practices in Florida are unique because the growing season begins in mid-September and harvest finishes in mid-May. Florida's subtropical climate facilitates lettuce production from fall through spring, but the warm, moist conditions are also favorable for insect proliferation and damage.

Banded cucumber beetle (BCB) (*Diabrotica balteata*), serpentine leafminer (SL) (*Liriomyza trifolii*), and aphids (Homoptera: Aphididae) are among the major insect pests that cause significant economic damage to lettuce in southern Florida. BCB is a polyphagous (attacking many plant species) insect with a host spectrum of more than 50 plant species in 23 families (Saba 1970). BCB adults feeding on lettuce foliage leads to decreased photosynthetic area, increased vulnerability to diseases, and reduced market grade (Nuessly and Nagata 1993). SL is also polyphagous and attacks lettuce and other vegetable crops (Drees and Jackman 1999). Plant leaves are damaged as SL larvae tunnel through the inner leaf tissue, producing so-called whitish "mines" that reduce the photosynthetic area. Lettuce becomes unmarketable if infestation is severe (Nuessly and Nagata 1994). Several aphid species affect lettuce, including green peach aphid (*Myzus percicae*), potato aphid (*Macrosiphum euphorbiae*), the species *Uroleucon pseudambrosiae*, and lettuce aphid (*Nasonovia ribisnigri*). The lettuce aphid is a problem worldwide and has recently become problematic in the western United States and Canada (Liu and McCreight 2006; McCreight 2008). However, the first three species of aphids listed above are most economically damaging in Florida (Nuessly and Webb 2010). Although heavy aphid pressure can stunt plants, the major problem aphids cause is head contamination, which makes lettuce unmarketable.

BCB, SL, and aphid control in lettuce production is historically dependent on pesticide application. However, there are disadvantages associated with pesticide use for insect control, including increased production costs, adverse environmental and ecological effects, and development of pesticide resistance in insects. One alternative for effective insect control is the use of host plant resistance, which is an environmentally friendly method that is compatible with other approaches used in integrated pest management (IPM) (Smith 1989).

Host plant resistance in lettuce to BCB and SL has been identified. Nuessly and Nagata (1994) reported that 'Valmaine', a romaine lettuce cultivar, had a high level of resistance to SL. This cultivar was later found to be resistant to BCB (Huang et al. 2002; Sethi et al. 2008) and two lepidopterans, *Trichoplusia ni* and *Spodoptera exigua* (Sethi et al. 2006). 'Valmaine' is an obsolete edible cultivar that was used in lettuce production in the 1970s and then used as a parent for crosses to develop romaine cultivars in

1. This document is HS1196, one of a series of the Horticultural Sciences Department, UF/IFAS Extension. Original publication date February 2012. Reviewed February 2018. Visit the EDIS website at http://edis.ifas.ufl.edu.

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the University of Florida lettuce breeding program (Guzman 1986; Guzman and Zitter 1983). The cultivars 'Short Guzmaine', 'Tall Guzmaine', 'Floricos 83', and 'Floriglade' released in the 1980s (Guzman 1986; Guzman and Zitter 1983) contain 'Valmaine' in their pedigrees but have little SL resistance ('Short Guzmaine') or no resistance to either SL or BCB, indicating that the high level of resistance in 'Valmaine' was not incorporated into these cultivars.

Information about current cultivar response to BCB, SL, and aphids in Florida is limited. UF/IFAS researchers conducted a study to evaluate cultivar response to insect infestation under field conditions and to identify resistance useful for IPM.

Four romaine cultivars ('Okeechobee', 'Manatee', 'Terrapin', and '70096') and three iceberg cultivars ('Gator', 'Raleigh', and '8074') were evaluated in late 2010 and early 2011 for responses to BCB, SL, and aphid infestations in field experiments. All but '70096' are cultivars currently used by Florida growers in lettuce production.

Demonstration

There were significant differences in BCB foliar feeding among the four romaine cultivars. Cultivar '70096' had the least leaf damage (3.7%) from BCB (Table 1). 'Manatee' had more leaf damage (12.1%) than '70096' but significantly less damage than 'Okeechobee' (19.8%) and 'Terrapin' (19.1%). BCB resistance in '70096' was confirmed in laboratory tests. BCB leaf damage in the three iceberg cultivars ranged from 16.9% ('Raleigh') to 17.5% ('Gator'), which were not significantly different (Table 1). There were no significant differences detected for mines created by SL larvae among the romaine cultivars. Likewise, the three iceberg cultivars responded similarly to SL tunneling.

For response to aphid infestation, highly significant differences were observed among the romaine and iceberg cultivars. 'Okeechobee' was the most susceptible romaine cultivar (3.7), indicating two or more dense colonies on most plants, whereas there were no dense colonies observed on 'Manatee', which had the lowest number of aphids (1.2) (Table 1). For iceberg cultivars, there were more aphids on 'Raleigh' than on the other two cultivars, but no dense colonies were seen on any of the iceberg cultivars, suggesting that iceberg cultivars are less susceptible to potato aphids than romaine cultivars.

The plants planted on 7 October with insect control matured in early December. Yield data collected on 8 December are presented in Table 2. Among the romaine cultivars, three ('Manatee', 'Terrapin', and 'Okeechobee') did not differ significantly from one another but yielded significantly higher than '70096'. 'Gator' was superior in yield to the other two iceberg cultivars.

The plants with a planting date of 22 October and without insect control matured in late January 2011. There were significant differences for yield in the three iceberg cultivars, while there were no significant yield differences in the romaine cultivars (Table 2). 'Gator' and '8074' had significantly heavier heads than 'Raleigh'.

Comparisons of the yield data obtained in different experiments show that insect infestations reduced yield by 14% or more in the romaine cultivar 'Manatee' and all three iceberg cultivars. 'Terrapin' and 'Okeechobee' had 3% and 6% lower yields, respectively, when grown in the adverse environment. Interestingly, '70096' yield was 8% higher in the adverse environment than in the normal environment.

Implications

In this study, BCB, SL, or aphid damage was observed on all cultivars. The lowest rating was 3.7% leaf damage for cultivar '70096' in the BCB test (Table 1), suggesting that although this cultivar had the least BCB leaf damage, it was attacked by the insect.

Cultivars varied in their responses to infestations of the three pests. Data suggest that '70096' is resistant to BCB. 'Manatee' seems to be resistant to aphids because low numbers of aphids were on this cultivar (Table 1). The three iceberg cultivars differed significantly only in their responses to aphid infestation, with 'Raleigh' having more aphids (Table 1). Although tested in separate experiments, all romaine cultivars but 'Manatee' had dense colonies of aphids, while there were no dense colonies on the iceberg cultivars, indicating that the iceberg cultivars overall were less susceptible to aphids than romaine cultivars.

Cultivar yield responses to insect damage also varied. Four of seven cultivars had much lower yield in the experiments without insect control than in those with insect control (Table 2). The remaining three cultivars ('Okeechobee', 'Terrapin', and '70096') yielded similarly across the different environments, indicating these cultivars were more stable in yield than the other four cultivars.

BCB is a midseason pest on lettuce in southern Florida. Growers usually apply pesticides to the crop twice to control the insect. This study identified '70096' as a BCB-resistant cultivar and showed that 'Manatee' also had less

BCB damage than the susceptible cultivars. When '70096' is grown in the field, it would be reasonable not to spray any pesticides for BCB control, which could help reduce production costs and protect the environment. If 'Manatee' is used as the cultivar for lettuce production, only one pesticide application may be needed. Since aphids are present from the middle of the season through the end of the season, aphid control is critical to the lettuce industry. The three iceberg cultivars and romaine cultivar 'Manatee' showed less aphid infestation, but each plant still had various numbers of aphids. Although pesticide application to these cultivars may be needed because the market requires that lettuce heads and hearts be free of insect contamination, the number of pesticide applications could be reduced.

References

Drees, B. M, and J. Jackman. 1999. *Field Guide to Texas Insects.* Houston, TX: Gulf.

Guzman, V. L. 1986. *Short Guzmaine, Tall Guzmaine and Floriglade: Three Cos Lettuce Cultivars Resistant to Lettuce Mosaic Virus.* S-326. Gainesville: University of Florida Institute of Food and Agricultural Sciences.

Guzman, V. L., and T. A. Zitter. 1983. *Floricos 83: A Cos Lettuce Cultivar Resistant to Two Viruses, for Florida Organic Soils.* S-305. Gainesville: University of Florida Institute of Food and Agricultural Sciences.

Huang, J., G. S. Nuessly, H. J. McAuslane, and F. Slansky. 2002. "Resistance to Adult Banded Cucumber Beetle (Coleoptera: Chrysomelidae) in Romaine Lettuce." *J. Econ. Entomol.* 95 (4): 849–855.

Liu, Y. B., and J. D. McCreight. 2006. "Responses of *Nasonovia ribisnigri* (Homoptera: Aphididae) to Susceptible and Resistant Lettuce." *J. Econ. Entomol.* 99 (3): 972–978.

McCreight, J. D. 2008. "Potential Sources of Genetic Resistance in Lettuce to the Lettuce Aphid, *Nasonovia ribisnigri* (Mosely) (Homoptera: Aphididae)." *HortScience* 43 (5): 1355–1358.

Nuessly, G., and R. T. Nagata. 1993. "Evaluation of Damage by Serpentine Leafminer and Banded Cucumber Beetle to Cos Lettuce." *Everglades Res. Edu. Ctr. Res. Rpt.* 2: 76–77.

Nuessly, G., and R. T. Nagata. 1994. "Differential Probing Response of Serpentine Leafminer, *Liriomyza trifolii* (Burgess), on Cos Lettuce." *J. Entomol. Sci.* 29 (3): 330–338.

Nuessly, G., and S. E. Webb. 2010. *Insect Management for Leafy Vegetables*. ENY-475. Gainesville: University of Florida Institute of Food and Agricultural Sciences. http://edis.ifas.ufl.edu/ig161

Saba, F. 1970. "Host Plant Spectrum and Temperature Limitations of *Diabrotica balteata*." *Can. Entomol.* 102 (4): 684–691.

Sethi, A., H. J. McAuslane, H. T. Alborn, R. T. Nagata, and G. S. Nuessly. 2008. "Romaine Lettuce Latex Deters Feeding of Banded Cucumber Beetle: A Vehicle for Deployment of Biochemical Defenses." *Entomologia Experimentalis et Applicata* 128 (3): 410–420.

Sethi, A., H. J. McAuslane, R. T. Nagata, and G. S. Nuessly. 2006. "Host Plant Resistance in Romaine Lettuce Affects Feeding Behavior and Biology of *Trichoplusia ni* and *Spodoptera exigua* (Lepidoptera: Noctuidae)." *J. Econ. Entomol.* 99 (6): 2156 –2163.

Smith, C. M. 1989. *Plant Resistance to Insects: A Fundamental Approach*. New York: Wiley.

Table 1. Mean scores of banded cucumber beetle (BCB) feeding, serpentine leafminer (SL) tunneling, and aphids among lettuce cultivars in separate field experiments at Belle Glade, FL.

Cultivar	Type	BCB[1]	SL	Aphids
Okeechobee	Romaine	19.8a[2]	8.5	3.7a
Terrapin	Romaine	19.1a	9.4	3.1b
70096	Romaine	3.7c	9.2	2.8c
Manatee	Romaine	12.1b	8.7	1.2d
Gator	Iceberg	17.5	9.2	0.9b
8074	Iceberg	17.3	10.0	1.0b
Raleigh	Iceberg	16.9	11.5	1.8a

[1] Percentage damage was used for BCB and SL, while a 0–4 scale rating method was employed for aphids as follows: 0 =*no aphids on the plant*; 1 =≤ *10 aphids on the plant*; 2 =>*10 aphids but aphids scattered on the plant*; 3 =*1 dense colony on 1 leaf of the plant*; 4 =*dense colonies on 2 or more leaves of the plant*.
[2] Means in the column followed by the same letter are not significantly different (α = 0.05) using a least significant difference test (SAS Institute, Cary, NC).

Table 2. Yields of lettuce cultivars planted with insect control on 7 October 2010 and harvested on 8 December 2010, and planted without insect control on 22 October 2010 and harvested on 1 February 2011 at Belle Glade, FL.

		Yield (kg/head)		
Cultivar	Type	Insect control	No insect control	No insect control/Insect control (%)
Okeechobee	Romaine	0.93a[1]	0.87	94
Terrapin	Romaine	0.93a	0.90	97
70096	Romaine	0.72b	0.78	108
Manatee	Romaine	1.00a	0.75	75
Gator	Iceberg	0.83a	0.64a	77
8074	Iceberg	0.66b	0.57a	86
Raleigh	Iceberg	0.67b	0.42b	63

[1] Means in the column followed by the same letter are not significantly different (α = 0.05) using a least significant difference test (SAS Institute, Cary, NC).