An important component of successful cucurbit production is effectively managing powdery mildew. This disease occurs commonly every year in the northeast. When not managed, affected leaves die prematurely resulting in reduced yield and or fruit quality. Powdery mildew management program often needs adjustments each year as the pathogen and management tools change. An integrated program with fungicides applied to resistance varieties is recommended to minimize selection pressure for pathogen strains able to overcome either plant resistance genes or fungicides. The pathogen has exhibited adaptation to both tools.

Resistant Varieties. A new pathogen race (S) has been detected in GA able to affect melon varieties with resistance to races 1 and 2. Athena, a popular variety with resistance to both races, has been much more severely affected by powdery mildew in recent years than previously. Fortunately Athena and other varieties with resistance to both races usually have provided good suppression in variety trials conducted recently on Long Island. However, Athena did not exhibit good suppression in one of two experiments in 2009.

The resistance genes in squash and pumpkin are different from those in melon. With most crop types (exception being butternut), varieties with resistance from both parents (homozygous; PMRR; some times referred to as ‘resistant’) have been less severely affected by powdery mildew in recent variety trials than varieties with resistance from one parent (heterozygous; PMR; aka ‘intermediate resistance’ or ‘tolerant’), which have not always provided effective suppression. Most commercial plant breeders are using the same source of resistance, which was obtained from a wild cucurbit relative by the Cornell Breeding Program. Varieties from Hollar Seeds are thought to have a different major gene for resistance. In variety trials conducted on LI in 2009, PMRR summer squash varieties (Sunray and Sunglo) and PMRR acorn squash varieties (Honey Bear, Sweet REBA, and Table Star) were significantly less severely affected by powdery mildew than the susceptible standard variety whereas PMR squash, as well as PMR zucchini in an adjacent trial, were not. The PMR varieties often had numerically lower severity values than the susceptible variety they were compared to, but the values were not significantly different. Resistance in pumpkin has not been providing as good suppression as in squashes. PMRR pumpkin varieties have provided better suppression than PMR varieties for several years whereas PMR squashes use to be as effective as PMRR varieties. In the 2009 trial, powdery mildew severity was low through mid-Aug, then it increased substantially. Trophy was the only resistant pumpkin that was significantly less severely affected by powdery mildew than Sorcerer, the susceptible standard variety.

Fungicides. Mobile fungicides currently recommended for powdery mildew are Quintec (FRAC Code 13), Procure (Code 3), and Pristine (Codes 7 + 11). The Quintec label was expanded in 2009 to include pumpkin, winter squash, and gourd. Melon was labeled in 2007. Quintec will not be labeled for use on edible-peel cucurbits due to concerns about phytotoxicity occurring. It is critical to apply mobile fungicides in alternation and also tank-mixed with a protectant fungicide for resistance management and to comply with label restrictions. For example, the Quintec label specifies no more than 2 consecutive applications plus a crop maximum of 4 applications.

Every year on LI research is conducted to examine pathogen sensitivity to mobile fungicides and to determine efficacy of currently registered and new mobile fungicides. Testing individual fungicides every year can reveal impact on control of resistance development. Two procedures are used to determine pathogen sensitivity to fungicides. A seedling bioassay is used to examine pathogen populations. Pumpkin seedlings are treated with fungicides and put with non-treated
seedlings for several hours in field plantings that have powdery mildew, then the plants are kept in a greenhouse for 7 to 10 days until powdery mildew develops. Amount of symptoms on seedlings treated with different concentrations of mobile fungicides are compared to non-treated seedlings to estimate the proportion of the pathogen population able to tolerate each concentration tested. Additionally, individual pathogen isolates obtained from field-grown plants are tested in the laboratory. This second procedure is much more time-consuming and costly to conduct, but provides information about individual isolates.

The bioassay is being conducted most years in spring-planted commercial and research squash plantings to obtain information about the pathogen population at the start of powdery mildew development for the season. In 2009, a high percentage of the population was estimated to be resistant to Topsis M (FRAC Code 1) (77%) and QoI fungicides (Code 11) (60%). Similar results were obtained in previous years, which is why these fungicides have not been recommended. The cucurbit powdery mildew fungus exhibits quantitative resistance to these fungicides, which means isolates are either sensitive or completely resistant. Resistance to the other fungicides is qualitative, thus isolates exhibit a range in sensitivity. Based on the results from the seven fields where the bioassay was conducted on 29 July, the pathogen population on LI in 2009 was estimated to consist of an average of 20% able to tolerate 175 ppm boscalid, an active ingredient in Pristine, 32% able to tolerate 80 ppm triflumizole (Procure), 18% able to tolerate 80 ppm myclobutanil (Rally), and 8% able to tolerate 10 ppm quinoxyfen (Quintec). Quintec was predicted to be the most effective fungicide for powdery mildew in 2009. Pristine, Procure and Rally were predicted to also be effective.

The fungicide efficacy experiment conducted on LI in 2009 revealed that Quintec was again the most effective of the fungicides tested that are labeled for controlling cucurbit powdery mildew. It provided 99% and 86% control on upper and lower leaf surfaces, respectively, which was not significantly different from a new experimental fungicide that was also tested. Quintec has been consistently highly effective. However, it was not significantly better than Procure (97.5% and 80% control) and Pristine (96% and 72.5%), the other registered fungicides evaluated that have been recommended used in alternation with Quintec. Performance of Procure and Pristine has oscillated from year to year in previous efficacy experiments on LI. While powdery mildew severity did not differ significantly for these two on any assessment date, severity was numerically higher on lower leaf surfaces of pumpkin treated with Pristine. Procure applied at its highest label rate was more effective for controlling powdery mildew on lower leaf surfaces than two other DMI fungicides (FRAC Code 3): the new fungicide Inspire (difference was significant on the last assessment date), and Rally, which at its highest labeled rate contains almost half the rate of active ingredient as Procure. Rally provided 37% control and Inspire 40%. Similar results were obtained in GA. It was anticipated that Inspire, being a new generation DMI fungicide, would be inherently more active than Rally and Procure, just as these are more effective than the first DMI fungicide Bayleton, which is no longer labeled. Pristine was as effective as Procure in 2009 in both the LI and GA efficacy experiments. Both fungicide programs tested on LI in 2009 with Procure and Pristine or Quintec and Rally provided excellent control of powdery mildew. But Pristine did not perform well in an experiment conducted in NJ.

A bioassay conducted at the end of the season (24 Sep) in research plots of pumpkin and in commercial pumpkin fields revealed presence on LI of pathogen strains completely resistant to a Code 7 fungicide and documented that sole use of a fungicide with resistance risk can select for tolerant strains during one growing season. Proportion of the pathogen population tolerating 500 ppm boscalid was 100% for a plot treated every week with Pristine and 17-20% for a plot and the commercial pumpkin fields receiving a fungicide program (mobile fungicides applied in alternation and tank-mixed with a protectant fungicide). Strains able to tolerate this high concentration, which is the same as a field application rate, would not be controlled with Pristine. Control of powdery mildew in commercial pumpkin crops was moderate to excellent in 2009.
Isolates of the powdery mildew pathogen collected at the end of the season from commercial and research fields were tested in the laboratory to determine fungicide sensitivity of pathogen individuals. Most isolates tested were resistant to FRAC Code 1 and 11 fungicides. Complete resistance to boscalid was detected in 86% of the isolates from the NJ research field, which explains why Pristine was ineffective in the fungicide evaluation, but only in 10% of the isolates from LI tested to date. These resistant isolates came from a research field at LIHREC and two commercial fields. In previous laboratory testing, a few isolates of the pathogen collected in PA and LI in 2008 were found to be completely resistant to both active ingredients in Pristine. Also, the pathogen was documented to be less sensitive to difenoconazole than to triflumizole and myclobutanil, the active ingredient in Rally. This explains differences in fungicide efficacy detected in field evaluations of FRAC Code 3 fungicides.

Several new fungicides were available in 2009 for powdery mildew or are expected to be available in NY in the near future. Switch (FRAC Code 9 and 12) is not considered as effective as other registered products, therefore it currently is not recommended. The other new fungicides are in Code 3. Only one fungicide from each FRAC Code should be included in a fungicide program and Procure (triflumizole) is still considered the best choice. A few new fungicides contain the active ingredient tebuconazole (e.g. Tebuzol and Folicur). Inspire Super (difenoconazole) currently is labeled for use on pome fruit. It was not as effective as Procure in the fungicide evaluation conducted on LI in 2009.

There are new, highly effective fungicides in development for powdery mildew. Hopefully these will be registered before the pathogen has developed resistance to Quintec so that all can be used together in a fungicide resistance management program.

**2010 Recommendations.** In conclusion, manage cucurbit powdery mildew by:

1. growing resistant varieties,
2. applying mobile fungicides in alternation and tank-mixed with a protectant fungicide starting at or before first symptoms. Quintec is anticipated to be the most effective fungicide for non-edible peel cucurbits. Procure and Pristine are also good choices. It is critical to use mobile fungicides in alternation to manage resistance and ensure effective control. Detection of pathogen strains completely resistant to Pristine is a concern and warrants limiting use of this fungicide; however, based on 2009 research results, Pristine is expected to provide some control of powdery mildew in 2010 when used in a fungicide program and to contribute to resistance management for the other fungicides.

Please Note: The specific directions on fungicide labels must be adhered to -- they supersede these recommendations, if there is a conflict. Any reference to commercial products, trade or brand names is for information only; no endorsement is intended.