Powdery Mildew Resistant Zucchini and Yellow Summer Squash Variety Evaluation, New York 2008

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Powdery mildew is an annual production problem for growers of cucurbit crops throughout the United States, reducing yield potential and fruit quality when not controlled. Effective control with fungicides alone has been challenged by the development of fungicide resistance to key chemistries. Recently, several squash varieties have become available that are advertised with resistance to this disease. The goal of this experiment was to determine whether squash varieties with homozygous resistance (e.g., two copies of the main powdery mildew resistance gene, PMRR) are better protected against powdery mildew than varieties with heterozygous resistance (PMR). This was the case in variety evaluations conducted in 2007 but not in 2006. Most commercial resistant squash varieties have PMR. The ability of the varieties evaluated in 2008 to resist powdery mildew, as well as their yielding ability, was determined relative to Spineless Beauty and Gentry, standard varieties lacking powdery mildew resistance.

Materials and Methods
A field experiment was conducted at the Long Island Horticultural Research and Extension Center in Riverhead on Haven loam soil. Fertilizer (N-P-K 10-10-10) at 500 lb/A was broadcast and incorporated on May 5. Black plastic mulch and drip tape were laid on May 6. Seeds were sown on May 25 in the greenhouse. Seedlings were transplanted into beds covered with black plastic mulch on June 12. Water was provided as needed via drip irrigation lines located beneath the mulch. Additional fertilizer (N-P-K 46-0-0) at 30 lb/A was injected through the drip irrigation system on July 2 and 17.

During the season, weeds were controlled between the rows of black plastic mulch by seeding white clover for a living mulch on May 13 after roto-tilling to prepare a seed bed and manage weeds that had already germinated. During the season, weeds were managed by mowing, hand weeding, and applying Select 2E (8 oz/A) with 1% COC on August 8. Cucumber beetles were managed with Admire 2F applied after transplanting as a soil drench around transplants (0.0007 fl oz/plant) on June 21 and Asana XL (9.6 oz/A) applied to foliage on June 13, July 30, and August 14. No fungicides were applied to control powdery mildew. The following fungicides were applied preventively for downy mildew (Pseudoperonospora cubensis) and Phytophthora blight (Phytophthora capsici): Curzate 60 DF (3.2 oz/A) on July 30 and Ranman 400 SC (2.75 fl oz/A) on July 19, and August 14, 23, and 30.

Plots were three adjacent rows each with five plants spaced 24 inches apart. Rows were spaced 68 inches apart. A single plant of Multipik summer squash, a susceptible variety, was planted between each plot in each row to separate plots and provide a source of inoculum. A randomized complete block design with four replications was used.

Upper and lower leaf surfaces of the susceptible varieties were examined for powdery mildew on July 7. Assessments were done on July 15, 22, and 29, and August 8 and 15. Initially, 20-50
older leaves were examined in each plot, with the quantity adjusted based on the incidence of symptomatic leaves. Mid-aged and young leaves were also assessed on August 15 when powdery mildew had progressed to these age groups. Powdery mildew colonies (spots) were counted and severity was estimated when colonies had coalesced or were too numerous to count. Colony counts were converted to severity values using the conversion factor of 30 colonies/leaf=1%. Average severity for the entire canopy was calculated from the individual leaf assessments. These canopy severity values were used to calculate area under disease progress curve (AUDPC) to obtain a measure of severity over the entire assessment period (July 15 – August 15 ). Powdery mildew control was calculated for upper and lower leaf surfaces using AUDPC values relative to the AUDPC value for the susceptible varieties. Powdery mildew severity was also assessed on stems and leaf petioles.

Squash fruit were harvested and weighed on July 20, 23, 26, and 31, and August 2, 7, and 18. Fruit were separated into marketable and unmarketable grades based on length, then weighed. There were no unmarketable fruit with blemishes due to disease or insect feeding. Fruit characteristics were also evaluated and overall appearance was rated on a scale of 1 to 9 with 1=poor, 5=marginal, 7=acceptable, and 9=best.

Average monthly high and low temperatures (°F) were 80/63 in June, 84/67 in July, and 79/63 in August. Rainfall (in.) was 3.88, 3.67, and 3.76 for these months, respectively.

Results and Discussion

Symptoms of powdery mildew were found on the powdery-mildew-susceptible varieties on July 7 at a low level (on 19 of 400 older leaves examined). Symptoms were found in all but one plot on July 15. Among the zucchini varieties, powdery mildew on lower leaf surfaces was suppressed best by Zucchini #8517, a PMRR experimental variety developed by Outstanding Seeds (Table 1). Degree of suppression based on AUDPC values (a seasonal disease severity summation) was 75% and 81% on upper and lower leaf surfaces, respectively. Performance varied among the PMR varieties reflecting differences in modifying genes. A zucchini variety considered to have a medium level of resistance to powdery mildew, Envy, provided only 33% and 31% suppression on upper and lower leaf surfaces, respectively, which was the lowest degree of suppression relative to Spineless Beauty, the susceptible check variety. Payroll, which has more resistance, provided 46% and 43% suppression on the two leaf surfaces, respectively. Amatista, a grey zucchini type with a higher level of resistance, suppressed powdery mildew by 64% and 50%, respectively. Zucchini #8517 and Amatista were both significantly better than Envy for most assessments. The yellow squash susceptible variety, Gentry, did not become as severely affected by powdery mildew as Spineless Beauty. The two resistant squash varieties evaluated, Success PM and Sunglo, are PMRR. They suppressed powdery mildew equally well: 68% suppression on upper leaf surfaces and 70% and 85% suppression on lower leaf surfaces. Better control of powdery mildew was obtained with resistant summer squash varieties in 2008 than in 2007.

Zucchini #8517 out-yielded the other zucchini varieties. Success PM did not yield as well as the susceptible variety, as in previous years; however, in 2008 it was not because Success PM, an OP variety, began producing fruit later than the other varieties. There were marketable fruit in all plots at the first harvest. Fruit quality was very good for all varieties. The lowest overall appearance rating was 7.5 for Success PM.

All varieties produced fruit with acceptable characteristics, which were rated at least 7 out of 9.
Zucchini Variety Fruit Descriptions and Assessments

**Amatista**
Grey zucchini, almost white in coloration due to many white speckles on skin. Small fruit, very uniform in shape with a very bulbous blossom end and tapered stem end. Dark green ridges. Rounded, smooth blossom end. Overall appearance rating of 8 out of 9.

**Envy**
Dark green fruit with a nice length, shape, and size. Very few small, light green flecks on the skin. Slightly bulbous at both ends. Slightly raised blossom end and slight ridging near stem end. Glossy. Overall appearance rating of 8.5.

**Payroll**
Fruit of this variety are very long and slender, with a slightly bulbous blossom end that tapers slightly toward the stem end. Green coloration with light green speckles. Light green peduncle. Slight ridging, small rounded blossom end. Very uniform size and shape. Semi-gloss appearance. Overall appearance rating of 8.5.

**Spineless Beauty**

**Zucchini #8517**

Yellow Summer Squash Variety Fruit Descriptions and Assessments

**Gentry**

**Success PM**
Sunshine yellow. Slightly warty skin. Many slight sutures up and down length of fruit. Light green stem. Bulbous blossom end, short neck, with slight constriction, and then slightly bulbous stem end. Variable size and shape. Overall appearance rating of 6.75.

Acknowledgments
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Table 1. Suppression of powdery mildew and yield for summer squash varieties compared on Long Island, NY, in 2008. The first five entries are zucchini types; Amatista is a grey zucchini, the rest are conventional, green fruit types. Varieties are listed in order of disease control based on AUDPC values. The last three entries are yellow summer squash types; Sunglo is a crookneck type, the rest are straightneck types.

<table>
<thead>
<tr>
<th>Variety (resistance)</th>
<th>Seed Source</th>
<th>Powdery Mildew Severity (%)&lt;sup&gt;z&lt;/sup&gt;</th>
<th>Marketable Fruit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Upper Leaf Surface</td>
<td>Lower Leaf Surface</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Aug. 7</td>
<td>AUDPC</td>
</tr>
<tr>
<td>Zucchini #8517 (PMRR)</td>
<td>OUT</td>
<td>9.0 cd&lt;sup&gt;y&lt;/sup&gt;</td>
<td>93.4 de</td>
</tr>
<tr>
<td>Amatista (PMR)</td>
<td>SY</td>
<td>10.2 cd</td>
<td>138.5 cd</td>
</tr>
<tr>
<td>Payroll (PMR)</td>
<td>SY</td>
<td>29.1 b</td>
<td>206.5 bc</td>
</tr>
<tr>
<td>Envy (PMR)</td>
<td>SY</td>
<td>28.7 b</td>
<td>256.2 b</td>
</tr>
<tr>
<td>Spineless Beauty (Susceptible)</td>
<td>SY</td>
<td>54.1 a</td>
<td>380.1 a</td>
</tr>
<tr>
<td>Sunglo (PMRR)</td>
<td>SY</td>
<td>5.9 cd</td>
<td>34.2 e</td>
</tr>
<tr>
<td>Success PM (PMRR)</td>
<td>HMO</td>
<td>2.1 d</td>
<td>34.5 e</td>
</tr>
<tr>
<td>Gentry (Susceptible)</td>
<td>SY</td>
<td>17.0 bc</td>
<td>108.0 de</td>
</tr>
</tbody>
</table>

<sup>z</sup>Exact colony counts were made when possible and severity was estimated using the conversion factor of 30 colonies/leaf=1%. Data were transformed from percentages by a square root transformation when needed to obtain normality of variance before analysis of variance was performed. The table has de-transformed means.

<sup>y</sup>PMRR indicates homozygous resistance. PMR indicates heterozygous resistance.

<sup>x</sup>HL=Hollar, JS=Johnny’s, OUT=Outstanding Seeds, SI=Siegers, SY=Syngenta, SW=Seedway.

<sup>w</sup>Numbers in each column with a letter in common are not significantly different according to Fisher’s Protected LSD (P=0.05). Yield was analyzed for the two squash types separately. Sunglo was excluded because it is a crookneck type while the other two are straightneck types. Probability <t from the t-test comparing them was 0.0408 and 0.0143 for number and weight of fruit, respectively.