It is more prevalent in Japanese plums (Prunus salicina) than among commercial important hexaploid prunus var. P. domestica (so called European-type plums) and P. insititia (so called damson, bullaces and mirabelles). Most of results of tests of pollen compatibility between specific cultivar crosses have been reported in a somewhat parallel meal way in pomological literature (Gourley and Howell, 1941), (Aldermer and Wier, 1951), (Johnson, 1962), and (Lazar and Johnson, 1989, Baltimore, courtesy of UC Davis). Recent advances in molecular genetic techniques allow laboratory experiments to predict the compatibility that will result in the field between various parental combinations (Bergou, et al., 2003) and (Sutherland, et al., 2004). Hence the combination of laboratory and field results can be utilized to direct growers toward optimizing specific market purposes in plums.

Bloom emergence times vary among plum cultivars (Table 1). For self-incompatible commercial cultivars, the choice of pollinator cultivar(s) must take both bloom timing and compatibility into account. Stated another way, it is essential that bloom emergence overlap between any self-incompatible pollinator and its pollinizer if crop is to reach commercially acceptable yield levels. Long-term and reliable bloom emergence times for commercial cultivars has not been well-documented in the literature. This is partially due to regional presence in this trait brought about by differences in chilling requirements between cultivars and how this affects bloom emergence in lower chilling climates.

The pattern of pollinator placement within orchards and the frequency of pollinizer trees are both important pomological variables growers can use to control crop set and fruit size and quality, as well as biennial bearing cycles. The following example of how a grower can utilize knowledge of these pollination factors for the ‘Valor’ plum should be instructive. ‘Valor’ is a fresh market, dessert plum that is hexaploid and of European type. ‘Valor’ was bred at Vineland (University of Guelph, Vineland Station, Vineland, Ontario, Canada) and released in 1967 (Tehrani and Dickson, 1968). ‘Valor’ is gaining substantial market share for mid-late plum wholesaling in both North America and Europe. It is self-incompatible. The market wants large plums of ‘Valor’ and its genetic size is rated naturally as large. Hence oversetting in the orchard should be avoided due to likely fruit size reduction in the competition with the same orchard. Both conditions are serious. Oversetting leads to smaller size bland taste and biennial bearing, while undersetting leads to low economic yields and can increase split pits and brown rot.

When the decision to replant is made, growers should not forget a problem that could severely hinder their new orchard – apple replant disease. Though pre-plant soil fumigants, have mitigated replant disease in the past, our results indicate that these efforts may not be necessary in some sites. Instead, selecting tolerant rootstocks, like ‘CG.6210’ and ‘G.30’ may be the best defense against replant disease. Studies to relieve problems with ARD have investigated various methods of control. Chemical fumigation has sometimes been found effective and economically-feasible (Mai and Abawi, 1981), and ARD-tolerant rootstocks have emerged from the New York State Agricultural Experiment Station in Geneva (Isuura and Merwin, 2000).

The three management categories – chemical control, rootstock selection, and alternative methods – have been tested together at Cornell Orchards since 2001. The site for this field trial had sustained apple trees for more than 90 years, and the ARD-symptoms were evident after its first replanting in 1981 (Mai et al., 1994). Our trial had three variables of interest: four pre-plant soil treatments, two planting densities, and six dwarfing to semi-dwarfing rootstocks. We were interested in learning whether fumigant or compost treatments would affect tree growth, whether growth would differ between the old orchard rows and old grass lane, and whether differences among rootstocks would be observed. Our objectives were to study these variables alone and in combination, and provide practical solutions for New York growers faced with ARD in their fields.

Materials and Methods

In this experiment, we investigated four pre-plant soil treatments, and a combination of the first two treatments that were propagated with ‘NY-674’. The orchard was managed according to typical management procedures, and the trees were measured annually for changes in growth and yield. Soil nematode and nutrient levels as well as leaf nutrient levels were also monitored.
A Century of Plum Breeding at Geneva

Robert Andersen, Jay Feer and Courtney Weber

Department of Horticultural Sciences, NYSAES, Cornell University, Geneva, NY

As one browses antique shops you will find beautiful color plates of plum varieties from Professor U. P. Hedrick’s book, The Plums of New York. These plates help to emphasize the plum contributions of Cornell’s New York State Agriculture Experiment Station. The ‘Stanley’ variety released in 1926 is by far the most important of Cornell’s plums. At various times others have found favor e.g. ‘Longjohn’ and ‘Castleton’ that were included in the 1900’s used by New York growers with farm marketing operations. In 2004 we announced the release of ‘NY 6™’ and ‘NY 9™’ two processing plums which were initially hybridized by John Watson. Watson was also instrumental in releasing ‘Irquisis’ (1966), ‘Mohawk’ (1966) and ‘Senock’ (1972). In 2005 we announced the release of four more Watson-bred plums: ‘Jam Session™’ (previously tested as NY111=NY58.911.1), ‘Blues Jam™’ (previously tested as NY901=NY58.901.1), ‘Geneva Mirabelle™’ (previously tested as NY856), and ‘Rory Gage™’ (previously tested as NY101=NY77.610.1). They are described more fully in the article “New York Plum Pucks for 2006: Recommendations for Plum Cultivars” in this issue. Access to them will be through trademark licensing rights which tree plant breeders, fruit growers and Interna- tional Plant Management, Inc., Lawrence, Michigan.

Currently eight other plums from Cornell breeding are classified as Elite Test Selections. The Cornell Center for Technology, Enterprise & Commercialization (CCTEC), formerly known as the Cornell Research Foundation) owns all of them. CCTEC has an exclusive license with Wallace Heuser’s and Wanda Heuser Gale’s International Plum Management, Inc. This company’s contract with CCTEC provides for the control of the distribution of test trees and for marketing any of these eight that are subsequently released. Recent Department of Food Science & Technology at Geneva research collaboration with the Horticultural Sciences stone fruit program has demonstrated the favorable nutri- tional characteristics of several Cornell- bred plums as well as some other non- Cornell-bred cultivars. Cornell food scien- tists have collaborated in processing/ consumer taste panel evaluations of Cornell-bred plums, which have led to their adoption by major infant food pro- cessors as well as jam processors. In 2004 Dr. Bob Andersen retired and Courtney Weber has assumed leadership of plum breeding for Cornell.

Plum Processing and Marketing

We have collaborated with both Dr. Cy Lee’s group and Dr. Olga Padilla-Zakour’s group in the Department of Food Science & Technology at Geneva for about ten years on stone fruits. There have been three primary veins of re- search:

1. Comparing different varieties for their processing characteristics.
2. Comparing processing methods to attain higher firmness.
3. Measuring “nutritional” constitu- ents such as antioxidants and anthocy- annins in a spectrum of varieties, both fresh and processed.

Some of this work has not been pub- lished. Much of what is published is not in trade or grower publications but in scientific journals. We just recently pub- lished an article in the New York Fruit Quarterly entitled: Phenolics and Anti- oxidant Capacity in Selected New York State Plums (Kim et al., 2004). Below is the brief synopsis of that article:

“Plums may be good sources of natural antioxidants due to their high levels of phenolic phytochemicals. The predomin- ant phenolics in plums are hydroxycinnamic acids and anthocyanin deriv- atives. When compared to other common fruits, plums have higher phenolic con- tent and higher antioxidant capacity in- dicating that an increased consumption of plums in our diet is highly desirable for the associated health benefits.”

This information may eventually help plums command a more prominent position in a revised USDA Food Guide Pyramid. Our knowledge of how the various constituents of plums affect human health is still meager.

Dr. Cy Lee’s and Dr. Olga Padilla- Zakour’s groups collaborated to com- pare five methods of canning plums to attain greater firmness (Padilla-Zakouret al., 2000). In short this research reportsthat

Results and Discussion

Tree Growth and Yield: Over the first three years of this study, the rootstock and tree planting position affected tree growth most strongly and steadily. The rootstock ‘CG.6210’ consistently performed well, and trees on this rootstock were often the largest overall (Figs. 1A, 1C, 1D, 2A, and 3A). This rootstock also had the greatest root development, survival, and density at lower soil depths (Yao, 2005), and itsubstantially improved yield in the thirdleaf, ... 4B). The ‘G.30’ rootstock generally produced the second largest trees (Figs. 2B and 3B). Both ‘CG.6210’ and ‘G.30’ are semi-

<table>
<thead>
<tr>
<th>Rootstock</th>
<th>Mean Growth (cm)</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
<th>90</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>CG.6210</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G.30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G.16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M.26</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M.36</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

We have collaborated with both Dr. Cy Lee’s group and Dr. Olga Padilla-Zakour’s group in the Department of Food Science & Technology at Geneva for about ten years on stone fruits. There have been three primary veins of re- search:

1. Comparing different varieties for their processing characteristics.
2. Comparing processing methods to attain higher firmness.
3. Measuring “nutritional” constitu- ents such as antioxidants and anthocy- annins in a spectrum of varieties, both fresh and processed.

Some of this work has not been pub- lished. Much of what is published is not in trade or grower publications but in scientific journals. We just recently pub- lished an article in the New York Fruit Quarterly entitled: Phenolics and Anti- oxidant Capacity in Selected New York State Plums (Kim et al., 2004). Below is the brief synopsis of that article:

“Plums may be good sources of natural antioxidants due to their high levels of phenolic phytochemicals. The predomin- ant phenolics in plums are hydroxycinnamic acids and anthocyanin deriv- atives. When compared to other common fruits, plums have higher phenolic con- tent and higher antioxidant capacity in- dicating that an increased consumption of plums in our diet is highly desirable for the associated health benefits.”

This information may eventually help plums command a more prominent position in a revised USDA Food Guide Pyramid. Our knowledge of how the various constituents of plums affect human health is still meager.

Dr. Cy Lee’s and Dr. Olga Padilla- Zakour’s groups collaborated to com- pare five methods of canning plums to attain greater firmness (Padilla-Zakouret al., 2000). In short this research reportsthat...
yields a very nice jam or sauce if you pay attention to managing the astringency.

Mirabelle de Metz – This variety is extensively used in Europe for production of high value brandy. We have not grown it recently at the Geneva Experiment Station.

References

Robert Andersen is a recently retired emeritus professor of Horticulture at Cornell's Geneva Experiment Station who specializes in the breeding and culture of stone fruits. He led Cornell's breeding, culture and extension program on stone fruits from 1990 to 2005. Jay Feer is a research technician that works with Bob Andersen and Courtney Weber. Courtney Weber is a research and extension professor at Cornell's Geneva Experiment Station who currently leads Cornell's research and extension program in breeding plums and berry crops.

The pre-plant soil treatments, unlike the rootstock and planting position factors, did not lead to growth or yield differences, as reported in some previous replant experiments (Hostink and Faby, 1986; Mai and Ahavi, 1981). There was a trend toward improved tree growth in composted plots in the second year, but this difference was not significant compared with the growth of trees in the control plots receiving no pre-plant treatment (Fig. 3C). Compost quality or stability could explain this lack of change; nonetheless, we concluded that compost did not improve replant conditions or establishment at this site. Soil fumigation with Telone-C-17 may actually have impeded growth, as trees in fumigated plots occasionally grew worse than those in the control plots (Figs. 1B and 3C). This may have resulted from inadequate time for dissipation between the application of the fumigant and the date of tree planting. Another explanation is that fumigation may have harmed beneficial microbial populations in the soil, thus reducing tree growth (Rumberger et al., 2004; Yao et al., 2006).

Soil and Leaf Analyses: Soil and leaf nutrient levels and soil nematode populations were also monitored at this site (data not shown). Compost treatments enhanced macronutrient and organic matter levels in the soil. Similar responses were also evident in the old grass lane positions. Nonetheless, nutrient levels were observed at satisfactory levels across all pre-plant soil treatments and planting positions (Stiles and Reid, 1991). The increased macronutrients and organic matter resulting from compost treatment and the old grass lane position did not translate into enhanced tree nutrition, as measured by leaf nutrient levels, or improved tree growth or yield.

Root lesion nematode populations varied across the pre-plant soil treatments and planting positions, though overall numbers were low according to published damage thresholds for replant sites (Jaffee et al., 1982). Compost treatments reduced populations of root lesion nematode, and the potential for compost as a suppressant of nematodes and pathogens has been noted in previous research (Hostink and Faby, 1986). Fumigation eliminated this nematode pest. Root lesion nematodes were found in greater number in the old grass lanes than in the old tree rows, which would suggest an affinity for grass roots over apple roots. Nonetheless, because of their low overall numbers and the improved tree growth in the old grass lanes, we concluded that root lesion nematode was not a major factor at this replant site.

Parallel ‘M.9’ Experiment: Because of the experimental design, ‘M.9’ performance was analyzed separately from the other five rootstocks, and it provided a separate case study of the four pre-plant soil treatments. Its performance across the four pre-plant soil treatments showed no differences, with growth and yield in the compost and fumigation plots similar to the control. These results provide further evidence against the time, effort, and expense of pre-plant soil treatments in mitigating the replant problem.
This plum has fruit slightly larger than Damson. It has a moderate level of astringency, lower than Damson. The skin is purple-blue with greenish-yellow coloration. It looks like a Damson plum, but 1-1/2" larger. It ripens in late September in Geneva. It is self-incompatible and requires a pollinizer. Recent French literature recommends as pollinizers: Stanley, Prune d’Ente 303, Monseur Hatel, and Rodolte de Montauban (Audubert et al, 1995).

Gros Romanes = (probable name) This plum was formerly called Herrenhausen Mirabelle by us in error. Maroon/purple skin with green/amber flesh that often exceeds 25% soluble solids when tree ripe. The fruit is round-elongate and averages about one inch in diameter. Texture is somewhat crisp when eaten at best fresh market maturity level. It stores very well with sugar increasing in storage. Fruit ripen in mid-September in Geneva, and is self-incompatible. It is pollinated effectively by French Damson and Castleton™.

Gros Ameliorat = This may not be a Gage type by ancestry, but it seems to fall into this group by fruit character. It was bred in Romania by V. Cociu. The fruit are about 45 grams, round with a purple-red skin, over a golden ground color. The flesh is yellow, clings to the pit, and has a pleasing texture with excellent flavor and a high sugar level. Pollination requirements are not clear, but it is not self-compatible. It ripens in the last half of September in Geneva. This variety is firm enough to store and ship to commercial markets.

As growers begin to think about orchard replanting this spring, it is important that they consider the impacts of apple replant disease on their operations. Pre-plant fumigation, and compost amendment are not only necessary for successful tree establishment, but may also mitigate the severity of future disease symptoms. As growers begin to think about orchard replanting this spring, it is important that they consider the impacts of apple replant disease on their operations.

Michelle Leinfelder recently completed her Masters Degree at Cornell University with Dr. Ian Merwin who is a research and teaching professor at Cornell and who leads Cornell's research program in orchard ground cover management.