A Century Of Plum Breeding At Geneva

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From the introduction of Stanley plum in 1926 to the four new plums released in 2005, Cornell's New York State Agricultural Experiment Station at Geneva has made significant contributions to plum breeding. We believe there is now a spectrum of first-rate European plums which deserve a wider place in the fresh fruit market.

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 Ag 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'™ released in the 1990's are 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: 'Iroquois' (1966), 'Mohawk' (1966) and 'Seneca' (1972). In 2005 we announced the release of four more Watson-bred plums: 'Jam Session' ™ (formerly tested as NY 111=NY58.911.1), 'Blues Jam' ™ (formerly tested as NY 9041=NY58.904.1), 'Geneva Mirabelle'™ (formerly tested as NY 858), and 'Rosy Gage' ™ (formerly tested as NY101=NY77.610.1). They are described more fully in the article "New York Plum Picks for 2006: Recommended Plum Cultivars" in this issue. Access to them will be through trademark licensing rights which can be obtained through International 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 Plant 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 nutraceutical characteristics of several Cornell-bred plums as well as some other non-Cornell-bred cultivars. Cornell food scientists have collaborated in processing / consumer taste panel evaluations of Cornell-bred plums, which have led to their adoption by major infant food processors 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 research:

1. Comparing different varieties for their processing characteristics.

2. Comparing processing methods to attain higher fruit firmness.

3. Measuring "nutritional" constituents such as antioxidants and anthocyanins in a spectrum of varieties, both fresh and processed.

Some of this work has not been published. Much of what is published is not in trade or grower publications but in scientific journals. We just recently published an article in the *New York Fruit Quarterly* entitled: Phenolics and Antioxidant 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 predominant phenolics in plums are hydroxycinnamic acids and anthocyanidin derivatives. When compared to other common fruits, plums have higher phenolic content and higher antioxidant capacity indicating 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 compare five methods of canning plums to attain greater firmness (Padilla-Zakour et al., 2000). In short this research reports that it is possible to can plums with greater firmness than they have when they are picked. This offers the possibility to greatly improve on the current, mostly mediocre commercial offerings of canned plums in the U.S.

Drs. Dae-Ok Kim and Olga Padilla-Zakour in the Deptartment of Food Science & Technology at Geneva recently published an article on the effect of jam processing in degrading the phenolics and antioxidant capacity in plums and other fruits high in anthocyanins (Kim and Padilla-Zakour, 2004). In the case of the plums, more than half of the anthocyanins are destroyed during processing whereas at least two-thirds of the antioxidant capacity and of the total phenolics were retained in the jam.

We have made high quality plum preserves out of 'French Damson', 'Jam Session' ™ (NY111), 'Blues Jam' ™ (NY 9041), and 'Pozegaca'. Jay Freer has also found in his home kitchen that both 'Blues Jam' ™ 'Jam Session'™ make a very nice plum sauce. We are unaware of any commercially available plum sauce at the retail level in the U.S. It is a highly flavorful, beautifully colored, healthful product. It seems that chefs certainly must have need of such products!

We believe there is now a spectrum of first-rate European plums that deserve a wider place in the fresh fruit market. Most of these European plums are poorly known in the U.S. and obviously command very little market attention compared to the Japanese plums. Here in Geneva we have several thousand plum seedlings, mostly European, which have only begun to fruit. The University of Guelph's Vineland Station in Ontario has a large group of advanced plum elites, both European hexaploids and Japanese diploids, some of which they plan to name soon. Grower interest in plums in Ontario is weak so the newest Vineland plums are emerging to commerce slowly. The University of Guelph's international marketing agent is slow to introduce their new plums to the U. S. Market. This is unfortunate because their earlier policy of making their plum cultivars available as public releases provided 'Valor', a plum that is now gaining prominence in both Europe and the USA. We hope US growers will push our Canadian neighbors to speed up the U.S. marketing of their new releases.

Pollination Considerations for Commercial Plum Production

Self-incompatibility is widespread but far from universal in plum cultivars. It is more prevalent in Japanese plums (*Prunus salicina*) than among commercially important hexaploid plum cultivars of *P. domestica* (so called European-type plums) and *P. insititia* (so called damsons, bullaces and mirabelles). Results of research tests of pollen compatibility between specific cultivar crosses have been reported in a somewhat piecemeal way in pomological literature (Gourley and Howlett, 1941), (Alderman and Wier, 1951), (Johansson, 1962), and (LaRue and Johnson, 1989, Bull. 3331 from 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 (Beppu, et al., 2003) and (Sutherland, et al., 2004). Hence the combination of laboratory and field results can be utilized to design orchards to optimize crop set for specific market purposes in plums.

Bloom emergence times vary among plum cultivars (Table 1). For self-incompatible commercial cultivars, the choice of pollinizer cultivar(s) must take both bloom timing and cross compatibility into account. Stated another way, it is essential that bloom emergence overlap between any self-incompatible cultivar and its pollenizer if crop set is to reach commercially acceptable yield levels. Timing of bloom emergence of plum cultivars has not been well-documented in the literature. This is partially due to regional difference 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 pollinizer 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. It was bred at Vineland (University of Guelph Horticultural Research Station, Vineland Station, Ontario, Canada) and released in 1967 (Tehrani and Dickson, 1968). 'Valor' is gaining substantially in 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 medium-large. Hence oversetting in the orchard should be avoided due to likely size reduction from poor fruit to leaf ratios. Overall commercial plantings of 'Valor' have had both oversetting and undersetting problems but usually not in 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.

Here are some orchard design options that can be considered by growers. The grower should know his/her market requirements and seek to design a pollination strategy that optimizes the likelihood the orchard will yield fruit with the desired quality and size.

Most pomology experts would recommend the use of pollinization plans that risk oversetting with the intent to use mechanical fruitlet thinning to reduce final fruit count to balance fruit to leaf ratios and give satisfactory fruit size. This practice is effective with 'Valor' and most plums. As with peaches and nectarines, and other stone fruits, the earlier one thins, the greater the response to thinning that is achieved. It is not a popular task among Northeastern U.S. plum growers because of labor costs. While we recommend use of mechanical thinning, it is not the focus of this article and will not be covered here.

So what is the pollinizer planning challenge to a grower to have the 'Valor' plum be more successful? The size and quality of NE U. S. grown plums must be superior to competing 'Italian' plums that appear in substantial volume on eastern markets slightly before 'Valor'. If 'Valor' is to be successfully marketed by eastern producers, it must not be allowed to overset. Oversetting will make it later and western-grown 'Italian' will beat it to eastern markets. Manipulating a pollinizer plan after planting a self-incompatible plum (like 'Valor') is a very difficult practice and expensive. It is not as effective as mechanical thinning to quickly adjust crop loads. We advise using an orchard design that optimizes fruit set to minimize thinning expenses. It is tricky to get this right unless you take into account the major factors that were discussed above. Here are some options:

TABLE 1

Hexaploid Plum Cultivar Bloom Timing at Geneva, NY and Compatability Notes

Cultivar	Percent of Full Bloom on May 6, 03	Notes on Self-Compatability
Ariel	70	
Autumn Sweet		Partially self-fertile
Bluebyrd	~60	Self-sterile
Bluefre		Partially self-fertile
Blues Jam™ (NY 111)	90	Self-fertile
Cacak's Best	50	Self-sterile
Castleton™	90	Self-fertile
Empress	~40	Self-sterile, should bloom with Valor
Ersinger	50	Partially self-fertile
French Damson	<5	Self-sterile
Gras Ameliorat	50	Self-sterile
Grengage	80	Partially self-fertile
Improved French		Self-fertile
Italian	<1	Partially self-fertile
Jam Session™ (NY9041)	20	Self-fertile
Longjohn	60	Self-sterile
Mount Royal		Self-sterile
Moyer	~50	Self-fertile
NY 6™	90	Partially self-fertile
NY 9™	50	Self-fertile
Oullins	60	Self-fertile
Polly	<5	Self-fertile
Pozegaca	<1	Self-fertile
President	~50	Self-sterile
Richard's Early Italian	0	Self-sterile, blooms with Stanley
Rosy Gage™ (NY 101)	50	Self-sterile
Seneca	90	Self-sterile
Standard	~50	Self-sterile
Stanley	0*	Self-fertile
Valor	40	Self-sterile
Vanette™	50	Self-sterile, non-reciprocally compatible with Valerie
Valerie	~50	Self-sterile
Veeblue	50	Self-sterile
Victory	80	Self-sterile
Vision		Self-sterile
Voyageur	40	Self-fertile
V33025	50	
V70034 = Vibrant	90	

*On May 6, 2003 the most advanced half of the Stanley flowers were still in tight bud but showing white petal. Bloom time numbers with the about sign (~) are estimates.

Option 1. To achieve larger, higher quality fruit, use a single pollinizer cultivar that blooms simultaneously with the primary variety, 'Valor'; but use a lower percentage of pollinizer trees than normally suggested (use a 1:5 ratio instead of 1:2 or 1:3) and use a very regular pattern of distribution of the pollinizer cultivars to achieve even availability of pollen to insect vectors (pollinators). We present two such 1:5 plans, "No Offset" in adjacent rows and "Offset" in adjacent rows (Figure 1).

Note that in the "No Offset" pattern there are four pollinizers and the "Offset" also has four in each repeating set (with row segments six trees long). Also note that the **V** trees closest to P in "No Offset" are two-fifths of total Vs. These **V**s should set the heaviest crops. Those Vs in "No Offset" that are at twice the distance from the Ps also account for two-fifths of the Valors, and they can be expected to set lighter than the closest **V**s. The final one-fifth of vs. in "No Offset" are also the greatest distance away from the Ps and can be expected to set the lightest. In summary there are three levels of fruiting expected in "No Offset" due to differences in distance down the row from the pollinizers.

Note that in the "Offset" pattern we also expect three levels of set in the 'Valor' trees. They are designated **V**, V and V+. **V** and V should set the same as those trees in the "No Offset" plan. However V+ should have an intermediate level of set between **V** and V since it has one or two pollinizers alongside it in adjacent rows. In summary, the "Offset" pattern can be expected to have slightly heavier total crop yields and slightly smaller average fruit size due to closer proximity to pollenizers.

Option 2. To increase fruit size by reducing fruit set per tree, use a single pollinizer that blooms slightly later (never earlier due to greater frost probability) than 'Valor'. The intent is to cause a slightly poorer pollination condition and reduce set slightly compared to what a simultaneous-bloom pollinizer would achieve.

Option 3. To decrease fruit size by increasing fruit set per tree, use a 1:3 ratio of pollinizers instead of a 1:5 ratio. This increases pollen availability (Figure 2).

Note that in'"No Offset" 1:3 there are two levels of crop set expected but "Offset" 1:3 has three levels of crop set. The overall set in the "Offset" 1:3 is expected to be slightly higher with smaller average fruit size. Note especially that with both cases of 1:3, plans the average fruit size is expected to be smaller due to higher average fruit set than is expected in the two cases of 1:5 plans.

Option 4. To get even higher yields, use a 1:2 plan. This is usually accomplished by using full pollinizer rows in every third row to facilitate harvest efficiency for the pollinizer cultivar,

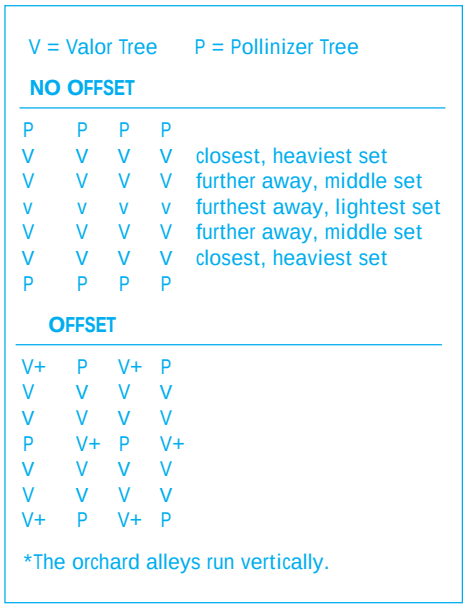

Figure. 1. Orchard Design Diagrams with Pollinizers of Valor planted at a 1:5 ratio comparing effects of offsetting pollinizers within adjacent rows versus no offsetting.

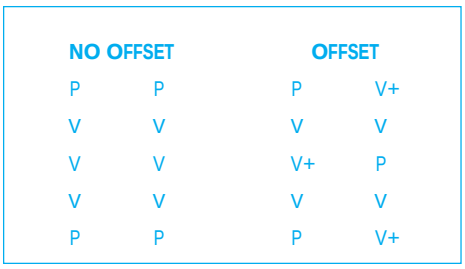

Figure 2. Orchard Design Diagrams with Pollinizers of 'Valor' planted at a 1:3 ratio comparing the effects of offsetting pollinizers within adjacent rows versus no offsetting.

which will need to be harvested and marketed to make this system profitable.

Additional Pollinizer Notes: Remember, pollenizers also have fruit potential. Both 1:2 and 1:3 pollinizer density plans usually dictate that pollinizer cultivar(s) must be marketed (not discarded) as part of the financial return from the block. The 1:5 pollinizer schemes may purposefully plan on discarding fruit from pollinizer trees due to the high likelihood that they will have overset. This leads to a very important point; if pollinizers are self-compatible, their natural crop set potential is high and this dictates that their yields and fruit size will often be excessive unless thinned mechanically. If the pollinizer is self-incompatible, it could be either reciprocally successful in fruit setting between it and the primary cultivar, or it might have only one-way compatibility. This latter case is more rare. It is often designated as a non-reciprocally compatible pollinizer (NRCP). The clever orchardist might attempt to eliminate pollinizer discard fruit by searching out a NRCP so that little or no fruit occur on these trees. This preference for NRCP in plum culture is because brown rot inoculum makes it essential to remove the pollinizer fruit from the orchard even if they are not harvested.

Although specific cultivar-by-cultivar cross-compatibility knowledge has been emphasized here as important to developing a pollination plan for a specific orchard, no such data is presented here. The article "New York Plum Picks for 2006: Recommended Plum Cultivars" in this issue contain information on suitable pollinizers. Comprehensive tables of such data are needed. Piecing together such information from various plum cultivar evaluation programs remains a goal of the Cornell-Geneva stone fruit program. Online access to such information is anticipated as the primary mode of public communication.

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