PÆONIA

AN INTERNATIONAL NEWSLETTER FOR PEONY HYBRIDIZERS

Volume 29, No. 3 **Summer 1999**

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Subscription Rates:

U.S.	Outside U.S.
5 yrs. -- $25.	$35.
10 yrs. -- $45.	$65.

THOUGHTS AND OBSERVATIONS ON BAGGING, SELF-CONTAMINATION AND POLLEN WETTING

by Don Smith

In 1997 I tried a somewhat different approach with most of my intersectional crosses and ended up paying the price often associated with experimentation, failure. On the other hand, experimentation is often the only way to gain new insight and knowledge.

The experiment I conducted was a simple one that tested the effects of not bagging flowers following pollination. Prior to this experiment, I had always been quite meticulous about stripping, pollenating, bagging and tagging all of my intersectional crosses. As a result, contaminated seedlings have been almost non-existent for me over the years.

Before I continue with this discussion, it is probably necessary at this point to provide a little additional background information concerning my breeding stock. I have several plants of the lactiflora variety *Martha Washington* which I use exclusively for making intersectional crosses. In addition to a large plant growing in my garden at home, I also have three other plants of this variety growing on a separate parcel of land where no other lactiflora peonies are growing near-by. The only peonies growing within several miles of these plants are all tree peonies (mostly lutea hybrids). As a consequence of this landscape setting, the only real fear of contamination (in making the intersectional cross on these three plants) was from other tree peony pollens.

In 1997, I was particularly hurried in my hybridizing work and to save time I decided not to bag any of my crosses on these plants. I reasoned that since there was little risk of contamination from unwanted pollens, the bagging step was probably unnecessary. As in previous years all flowers were carefully stripped one to two days prior to opening and pollenated immediately. All stems were tagged as usual to identify the pollen that was used. Only tree peony pollens were used on these plants.

In the fall when it came time to harvest the seeds from these plants, there were very few seeds to be had. I won't go into all the details here, but on average there were 5X fewer seeds than normal. The same pollens used on *Martha Washington* in my home garden (with bagging) gave a normal amount of seed.

This experience has raised several interesting questions and has changed my view about a number of issues related to the pollination process. The common wisdom on pollination procedures states that flowers should be stripped one or two days prior to opening and then bagged immediately to prevent contamination until the stigma are ready for pollination 1-2 days later. According to the standard procedure, the hybridizer should return to the flower in 1-2 days time, remove the bag, pollinate the flower, then replace the bag. Personally, I have never followed this advice and instead have always pollenated immediately after stripping. My excellent seed production over the years had convinced me that waiting to pollinate was unnecessary. The results of this experiment, however, suggest that the stigma are not, in fact, receptive at the time that stripping of the stamen must occur to avoid self-contamination. These results suggest that bagging the flowers after pollination is somehow very important to the successful completion of the fertilization process, not just to the prevention of contamination. Clearly, for my method of pollination, bagging seems essential for a good rate of success.

So, what did happen that reduced the seed production so dramatically? One possible explanation is that much of the pollen was removed from the flowers before fertilization could occur, by bees or other insects. Another possibility is that rain (or dew) washed away or ruined the pollen prior to fertilization. I suppose that some pollen could even have been carried away by the wind. On the other hand, maybe the pollen simply got dried-out in the hot sun thus causing the pollen to rapidly lose its viability. In either case, it seems clear that the bags (in my case, paper envelopes) do more than simply guard against contamination. It would appear that they also allow the pollen to remain on the stigma (and stay viable) long enough for fertilization to occur.

In this regard it is interesting to note several statements on the subject of pollen wetting made by Prof. Saunders more than eight decades ago. The following quotes are taken from "The Preservation of Pollen for Hybridizing" by A.P. Saunders (APS Bulletin, No. 6, May 1918).

> "It is sometimes supposed that rain washes off the viscid juice from the stigma, and so makes fertilization impossible. The fact appears to be that the female part of the flower is not seriously affected by rain; but the pollen is so: and since the period of receptivity of the stigma is not very prolonged --- a few days at the utmost -- if rain is persistent it may prevent the dispersion of the pollen until the stigmas have passed the time when they could be fertilized."

> "Wetting is very injurious to pollen, and diminishes its vitality a great deal. The longer the wetting continues, the more disastrous the effect. The flowers try their best to prevent the wetting of the pollen and stigma by furling up tightly when rain comes and at night, when dew forms."

Whatever the cause of the reduced effectiveness of the pollination process without bagging, it seems clear that bagging is important to achieving optimum results with the intersectional cross. I suspect that this is true more generally for other crosses as well.

In most cases bagging is essential to prevent contamination from unwanted sources of pollen (including self pollen) and is therefore not really optional. Without bagging, there will simply be too many seeds. Most, if not all, of these seeds will be from unwanted pollen and thus will be of little value to the hybridizer. There are other times, however, when bagging seems unnecessary or at least much less essential. For example, when working with F1 lutea hybrids as seed parents. I have never protected these type crosses, since seeds are rarely found as a result of open pollination. However, my success rate with these crosses has been extremely low. Maybe there is a "cause and effect" relationship here. In the future, I will begin bagging these crosses to see if seed production is improved.

A COMPARISON OF INTERSECTIONAL HYBRID PARENTS

by Don Smith

It has been some time since I reported on the comparison of various intersectional hybrid parents (Pæonia, Vol. 25, No. 2, p. 1 and Vol. 25, No. 3, p.1). Therefore, I thought it might be appropriate to revisit this subject at this time. Since these initial reports I have gradually shifted away from the use of *Golden Era* as my principal pollen parent for the intersectional cross. In fact, for the last two seasons I have not made a single cross using *Golden Era* pollen. In recent years, I have instead experimented with several other tree peony pollens including one from a plant of my own breeding which has proved to be a very effective parent. In addition to my own seedling (garden name: *Smith Family Yellow*). I have also used several of Reath's other advanced generation hybrids (e. g., *Alice in Wonderland*, *Ruffled Sunset* and *A-198*). The results obtained from crosses on *Martha W.* through 1998 are compared to those for *Golden Era* from previous years in Table 1. These pollens were also used on several other lactiflora seed parents in addition to *Martha W.* The results for two of these varieties are given in Tables 4 and 5. The combined results for a number of these (other) lactiflora parents are shown in Table 6. It is clear from the data in Tables 1 and 6 that I have found another tree peony (lutea) hybrid that appears to have fertility comparable to *Golden Era* when used as a pollenator in the intersectional cross. However, due to its superior fully double flower, I am hopeful that it will yield a good percentage of intersectional progeny with high-quality double flowers similar to that achieved using *Alice Harding*.

In addition to these hybrids, I have also tried several of the advanced generation Daphnis hybrids that have a 3/4 Moutan to 1/4 Lutea genetic make-up. These hybrids are the result of backcrosses to Moutan in both directions. As a group, these 3:1 hybrids are far less effective as intersectional parents (by at least a factor of 7) than the more usual 1:1 hybrids listed in Table 1. The results of crosses with these hybrids on *Martha W.* are shown in Table 2. In this group, only *Nike* and *Zephyrus* have produced hybrids so far, with *Nike* proving to be the most successful of the group. In fact, *Nike* gave results quite comparable with two of the fertile hybrids listed in Table 1 (*Alice in Wonderland* and *Ruffled Sunset*). It is interesting to note that although *Zephyrus* gives nearly four times as many seeds as *Nike*, these seeds often do not germinate well and the majority of the seedlings produced to date have not survived. The net result is that *Nike* produces nearly twice as many surviving hybrids per cross. This value is referred to as the plant production rate and is a true measure of a plants effectiveness as a parent.

My interest in these hybrids stems directly from their unique genetic make-up. I believe that the 3:1 Moutan/Lutea ratio is close to the ideal mix for the hybrid tree peony group. By using these 3:1 hybrids as pollen parents in the intersectional cross we can produce new intersectional hybrids with a different (and hopefully better) genetic mix by simply transferring this ratio to the intersectional hybrid group. Assuming that the standard intersectional hybrids are triploids*, then the normal genetic ratio of the three species (Moutan/Lutea/Lactiflora) represented in these hybrids is 1:1:1. By using the 3:1 tree peony hybrids as pollen parents, however, this ratio can be changed to what should be a more optimum ratio of 3:1:2. Only time will tell whether this combination actually produces intersectional hybrids of superior overall quality. Although the ratio of total tree peony to herbaceous chromosomes remains the same (2:1) in these hybrids, Moutan would become the predominant species in the mix and this could result in some interesting new hybrids.

By combining the results for all of the better tree peony pollens, we can obtain a fairly accurate measure of the relative effectiveness of the various lactiflora varieties as seed parents in the intersectional cross. A summary of these data is given in Table 7. These results are in excellent general agreement with those from my two earlier reports. They confirm my previous conclusions that *Martha W.* and HP1-61 are vastly superior to other lactiflora varieties as seed parents in the intersectional cross. Of the "also rans", *Alice Roberts* comes in a very distant third. The best of the rest are nearly 20X less effective than the first two. Although *Martha W.* and HP1-61 give similar results overall, *Martha W.* has been an extremely consistent performer year after year, whereas HP1-61 has proved to be frustratingly erratic.

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*Although the phenotypical evidence seems to support this conclusion, I am not aware of any definite evidence (i.e., chromosome counts, etc.) that substantiates this assumption.

Table 1. Comparison of various hybrid tree peonies as pollen parents on the lactiflora var. Martha W. (M.W.)

	Crosses	No. of seeds	Seeds/cross	No. of surv. plants	Plants/cross
M.W. x Golden Era	39	184	4.7	55	1.4
M.W. x Smith Family Yellow‡	17	130	7.6	22	1.3
M.W. x A-198	19	78	4.1	19	1.0
M.W. x Alice in Wonderland	11	68	6.2	3	0.3
M.W. x Ruffled Sunset	4	3	0.8	1	0.3
M.W. x All above t. p.'s	90	463	5.1	100	1.1

‡ *Smith Family Yellow* is the garden name for an advanced generation tree peony hybrid (TP-91-02) from the cross (*Golden Era x Alice Harding*). This cross is the reverse of the one which produced Reath's *Alice in Wonderland*. Plant habit is quite upright and generally similar to *Golden Era* although not as tall. Flowers are large (6") and bright yellow, similar to the pollen parent *Alice Harding*. The fully double flowers have a high ball-shape form and are generally held (facing out) well above the foliage on strong, erect stems similar to *Golden Era*. This plant combines the best characteristics of both parents and thus is superior to both plants. Although this hybrid exhibits some fertility both ways, it is not especially fertile as a seed parent. Fortunately, it appears to have inherited *Golden Era's* excellent pollen fertility when used on various lactiflora varieties. However, this pollen is only moderately effective when used on other hybrid tree peonies.

Table 2. Comparison of various advanced generation (3:1 M/L ratio) hybrid tree peonies as pollen parents on the herbaceous lactiflora var. Martha W. (M.W.)

	Crosses	No. of seeds	Seeds/cross	No. of surv. plants	Plants/cross
M.W. x Nike	15	17	1.1	4	0.27
M.W. x Zephyrus	7	27	3.9	1	0.14
M.W. x D-67	4	12	3.0	0	0
M.W. x Leda	8	0	0	0	0
Totals for Adv. Gen. Hybrids (with 3/4 Moutan make-up)	34	56	1.9	5	0.15

There is some question about whether the plant I have listed above as D-67 is correctly identified. This plant has single yellow flowers with small red flares and attractive finely-cut foliage. It was sent to me as D-63, which is supposed to have small pink flowers. In either case, the parentage is listed as F2B x Choni which makes it similar to the others in this group, since Choni is pure Moutan.

Table 3. Comparison of various species and F1 hybrid tree peonies as pollen parents on the herbaceous lactiflora var. Martha W. (M.W.)

	Crosses	No. of seeds	Seeds/cross	No. of surv. plants	Plants/cross
M.W. x Helene Martin	6	5	0.8	0	0
M.W. x Thunderbolt	4	0	0	0	0
M.W. x Age of Gold	2	0	0	0	0
M.W. x Moutan	6	0	0	0	0

Table 4. Comparison of various advanced generation hybrid tree peonies as pollen parents on the herbaceous lactiflora var. HP1-61 (HP1).

	Crosses	No. of seeds	Seeds/cross	No. of surv. plants	Plants/cross
HP1 x Golden Era	7	22	3.1	12	1.7
HP1 x Alice in Wond.	3	12	4.0	6	2.0
HP1 x A-198	4	0	0	0	0
HP1 x Smith Fam. Yellow	2	0	0	0	0
HP1 x All tree peonies	16	34	2.1	18	1.1

Table 5. Comparison of various advanced generation hybrid tree peonies as pollen parents on the herbaceous lactiflora var. Alice Roberts (A.R.).

	Crosses	No. of seeds	Seeds/cross	No. of surv. plants	Plants/cross
A.R. x Golden Era/198	13			7	0.54
A.R. x Smith Fam. Yellow	4			2	0.50
A.R. x Zephyrus	3			1	0.33
A.R. x Alice in Wond.	5			1	0.20
A.R. x All tree peonies	25			11	0.44

Table 6. Comparison of hybrid tree peonies as pollen parents on the lactiflora varieties Miss America, G. Allen, and A. Roberts for 1993-98.

	Crosses	No. of seeds	Seeds/cross	No. of surv. plants	Plants/cross
Lacti x Golden Era	51			10	0.20
Lacti x Smith Fam. Yellow	15			3	0.20
Lacti x A-198	8			1	0.13
Lacti x Zephyrus	8			1	0.13
Lacti x Alice in Wond.	18			1	0.06
Lacti x All Tree Peonies	100			16	0.16

Lacti. = Miss America, Gertrude Allen and Alice Roberts

Table 7. Comparison of various herbaceous lactiflora varieties as pod parents in the intersectional cross with advanced generation hybrid tree peonies.

	Crosses	No. of seeds	Seeds/cross	No. of surv. plants	Plants/cross
M.W. x Tree Peony	90	463	5.1	100	1.10
HP1-61 x Tree Peony	15	34	2.3	16	1.10
A. Roberts x Tree Peony	25			11	0.44
G. Allen x Tree Peony	44			3	0.07
Miss Am. x Tree Peony	31			2	0.06
M.W./HP1 x Tree peony	105	497	4.7	116	1.10
Other lacti x Tree peony	100			16	0.16

Plant Production Ratio [(M.W. + HP1) ÷ Other Lacti.] = 1.10/0.16 = 6.9