POLLINATION SUCCESS IN RELATION TO FEMALE FLOWER DEVELOPMENT IN LOBLOLLY PINE

by

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Abstract.--The proper timing of control pollinations is a major element of a successful pine breeding program. Frequently, phenological variability requires (1) pollinations to be completed at times other than maximum female receptivity (stage 5) or (2) multiple pollinations of the same flowers. In this study, single pollinations were completed at 2-day intervals from March 14-25. In addition, multiple pollinations were completed in combinations of flower developmental stages before, during, and after stage 5. Success of the pollination was evaluated by removing sample conelets 2 weeks after pollen application and counting the pollen grains in the pollen chamber of 10 ovules of each conelet. Results indicated that the largest number of pollen grains are found in ovules pollinated at stage 5. However, only slight, non-significant reductions were observed in flowers pollinated 2 days before or 2 days after stage 5. Very early or very late pollintions had significantly fewer pollen grains per ovule. Multiple pollinations were not significantly different from ovules pollinated at only stage 5.

Additional keywords: control pollination, tree breeding, seed orchard, pollen.

A continuing concern among tree breeders is the correct timing of pollen applications to female flowers. Several studies have evaluated this question, and the general consensus is that stage 5 as described by Cumming and Righter (1948) is the optimum time for controlled pollination. Tree breeders, however, may not always be able to pollinate at precisely stage 5. Uncontrolled events, such as atypical spring weather or clonal variation, may result in less than optimum timing of the pollination. Breeders, therefore, ask whether pollinaton success is affected if (1) pollen is applied when receptivity is less than optimum, or (2) if pollen is applied at more than one time to an individual bag? The study reported here addressed these questions.

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METHODS

Treatments in the study were seven timings of single pollinations ranging from female flowers at stage 3 to flowers in stage 6; multiple pollinations of four combinations of the single applications; and, a wind-pollinated control. Two ramets of each of four loblolly pine (Pinus taeda L.) clones in the Georgia Forestry Commission's Arrowhead Seed Orchard were selected as female parents. On each tree, two replications of the 12 timing treatments were installed. Each timing treatment was applied to an individual branch having from one to seven female flowers. Isolation bags were placed on the branches March 1, 1982 and treatments randomly assigned to each branch. Pollination treatments were:

TREATMENT NO.	DESCRIPTION	FLOWER STAGE
1	Very, very early	3.0
2	Very early	4.0
3	Early	4.5
4	Maximum	5.0
5	Late	5.5
6	Very late	5.8
7	Very, very late	6.0
8	Early + maximum	4.5 + 5.0
9	Early + late	4.5 + 5.5
10	Maximum + late	5.0 + 5.5
11	Early + maximum + late	4.5 +5.0 + 5.5
12	Wind	--------

The pollen source was a five-clone polymix of equal volumes from unrelated loblolly pine clones in the Arrowhead Seed Orchard. Pollen was collected in 1981 and stored under vacuum until pollination. The pollen was applied with a cyclone pollinator (Matthews and Bramlett 1980) when flower stages approximated the treatment description.

Bags were removed and conelets collected 2 weeks after pollination. A single conelet from each treatment was collected from each ramet. Ten ovules on each conelet were dissected under a microscope, the nucelli with the pollen attached were removed, and grains were counted (Matthews and Blalock 1981). In all, 960 ovules were examined.

RESULTS AND DISCUSSION

Single Pollinations

In central Georgia in early March of 1982 pine flowers developed rapidly during several continuous days of warm and sunny weather. The controlled pollinations began on March 12 when flowers in the earliest clone had emerged from the bud scales and were in stage 3. Ovules from flowers that were pollinated in stage 3 had an average of 1.15 pollen grains per ovule (Table 1). Two days later, the flowers had developed to stage 4, with approximately one half the ovule-bearing scales exposed. Pollinations at stage 4 produced an average of 1.93 pollen grains per ovule. One or two days later, flowers were in mid stage 4 and had extended to 3/4 of the stage 5 flower size. Ovules from stage 4.5-pollinated flowers averaged 2.89 pollen grains per ovule.

Flowers in the isolation bags reached maximum receptivity (stage 5), as indicated by the complete emergence and extension of the flower from the bud scales, 4 to 5 days after stage 3 began. At this developmental stage, the scales are at approximate right angles to the cone axis and the maximum opening between the scales and the bracts offers the greatest access for pollen. Ovules from flowers pollinated at stage 5 had the highest observed pollen count, averaging 3.71 pollen grains per ovule.

Pollinations 2 days after flowers were in stage 5 were still effective, depositing 3.16 pollen grains per ovule. However, 4 days after stage 5, flower receptivity had markedly decreased and only 0.26 pollen grains were observed in the pollinated ovules. Receptivity decreases as the scales increase in thickness and the opening between the scale and the bract is reduced, restricting the pollen flow to the ovules. Seven days after maximum receptivity, the flowers were in stage 6 in three of the four clones and pollinations produced 0.0 pollen grains per ovule. In one clone (506) a few ovules were pollinated, but pollination at this stage is not practical.

Multiple Pollinations

Although it is generally agreed that pollen should be applied at maximum receptivity, variability of flower development within individual bags may make it difficult to decide when to pollinate. In these cases, many breeders have used multiple pollinations of the same bag. In this study double and triple combinations of early, maximum, and late pollinations were also evaluated.

Multiple pollinations were very effective; all double and triple applications produced more than three pollen grains per

ovule. However, the multiple combinations were not significantly better (0.05 level of probability) than single applications at the same flower development stages used for the combinations. Multiple pollinations in very early or very late stages of flower development were not tested.

Table 1.--Number of pollen grains per ovule observed in loblolly pine following pollination at varying development stages

POLLINATION TIME	FLOWER STAGE	POLLEN GRAINS PER OVULE					
		CLONE					1/
		506	523	557	630	AVG	
Single Application							
Very, very early	3.0	1.10	0.60	1.85	1.05	1.15	b
Very early	4.0	2.15	2.70	0.95	1.90	1.93	b
Early	4.5	3.25	3.55	2.80	1.95	2.89	a
Maximum	5.0	3.40	4.70	2.95	3.80	3.71	a
Late	5.5	2.85	3.40	3.85	2.85	3.24	a
Very late	5.8	0.20	0.15	0.25	0.45	0.26	c
Very, very late	6.0	0.40	0.00	0.00	0.00	0.10	c
Double Application							
Early + maximum	4.5 + 5.0	2.60	4.05	2.80	2.60	3.01	a
Early + late	4.5 + 5.5	3.50	3.45	3.20	2.40	3.14	a
Maximum + late	5.0 + 5.5	3.15	4.65	2.15	3.65	3.39	a
Triple Application							
Early+max+late	4.5+5.0 + 5.5	2.85	3.70	3.65	2.75	3.24	a
Wind Pollinated		3.15	4.10	4.05	3.90	3.80	a

1/ Mean values with the same letters are not significantly different (0.05 level).

Wind Pollinations

Ovules from wind-pollinated conelets consistently had the highest number of pollen grains per ovule and averaged 3.80 for all four clones. This value was not significantly higher than those for early, maximum, late, or multiple pollintions. A high pollen count, however, is to be expected in conelets that are

exposed to a high density of pollen during many days of pollen flight from varying directions. In dissection of the conelets and ovules, large quantities of excess pollen were found between the scales of the conelets that had been control pollinated at receptive stages. Similar quantities of pollen were not observed in wind-pollinated conelets.

RECOMMENDATIONS AND CONCLUSIONS

Although stage 5 appears to be the optimum time to pollinate, pollinations can be successful within + 2 days from maximum receptivity. We recommend pollen application during this period.

Multiple pollinations did not significantly increase the pollen count per ovule when compared to a single application at stage 4.5, 5.0, or 5.5. Such treatment may be profitable, however, in bags where flowers vary widely in stage of development.

LITERATURE CITED

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