FLOWER PRODUCTION ON CLONAL ORCHARDS AT OCONTO RIVER SEED ORCHARD IN WISCONSIN

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ABSTRACT.--The Eastern Region, USDA Forest Service has been establishing and managing seed orchards to produce improved seed for the National Forests in the Lake States since 1969. This paper presents a review of the female flower production for the past 4 years in the white pine, white spruce, and black spruce clonal seed orchards.

The tree improvement program being conducted on the National Forests in the Lake States has been described in detail (Miller and Murphy 1976). The Lake States National Forests have been divided into nine seed collection zones and four breeding zones (fig. 1). Beginning in 1969, seed orchards were established by breeding zone for selected species at the Oconto River Seed Orchard complex located near Langlade, Wisconsin. The number of ramets required to produce anticipated seed needs in the various orchards were based on research information (Nienstaedt and Jeffers 1970) and best estimates of potential production. Information on cone production, frequency of crops, and flowering of individual clones is needed to make better estimates of potential cone production in large scale seed orchards for white spruce, black spruce, and white pine. Female flower data collected between 1973 and 1977 will be reported for two white pine, four white spruce, and two black spruce clonal seed orchards.

SEED ORCHARDS

Following is a brief description of the plant materials included in the seed orchards (table 1).

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Table 1.--Individual seed orchard statistics

Species	Orchard no.	Breeding zone[1/]	Clones	Grafts	Acres	Year of establishment	Year of first flowering
			- - - Number - - -				
White pine	1	All	798	3,612	40	1969	1973
White pine	3	All	36	830	10	1969	1973
White spruce	4	A	56	903	21	1969	1974
White spruce	6	B	50	1,128	21	1969	1974
White spruce	14	C	40	1,128	14	1973	1974
White spruce	16	All	39	220	5	1973	1974
Black spruce	8	A	50	1,501	21	1971	1974
Black spruce	10	B	47	778	20	1973	1974

1/ Breeding zones are shown in figure 1.

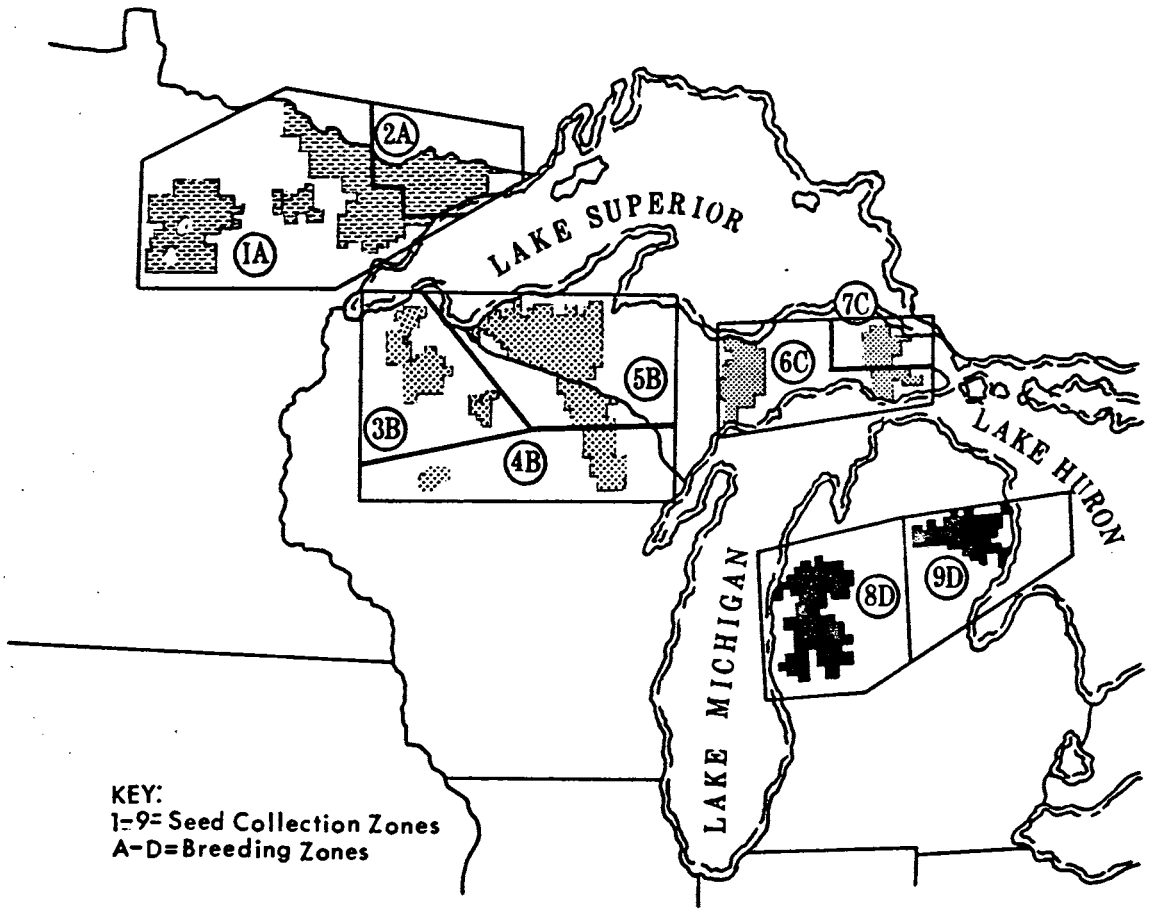

Figure 1.--Seed collection zones and breeding zones.

White Pine Orchards 1 and 3

Orchard 1 (white pine breeding arboretum) contains ramets from 798 ortets selected for their apparent resistance to white pine blister rust. The majority of the ortets came from the Lake States; however, a few came from Eastern States.

Orchard 3, which is an interim seed orchard, contains five clones selected by Drs. Riker and Patton, University of Wisconsin, and 31 clones selected by Drs. Heimburger and Zsuffa, Maple, Ontario, Canada. The majority of orchard 3 was established in 1969 whereas orchard 1 was established over a 5 year period.

White Spruce Orchards 4, 6, 14, and 16

The plants in orchards 4, 6, and 14 were selected on National Forests in breeding zones A, B, and C, respectively. The material in orchard 16 was selected by personnel of the North Central Forest Experiment Station in Rhinelander, Wisconsin, from ortets originating from seed collected in the Ottawa River Valley in Ontario, Canada, and growing in provenance tests. All of the white spruce orchards have had ramets added each year since the original planting. Orchard 4 suffered large losses following the second year planting, resulting in much more age variation than the other white spruce orchards.

Black Spruce Orchards 8 and 10

Plant materials in orchards 8 and 10 were selected on National Forests in breeding zones A and B, respectively. Both of the black spruce orchards have had ramets added each year since the original planting.

DATA

Collection

The flowering data for white pine and white spruce were collected in the spring as part of the breeding program. The black spruce flowering data were determined by cone collections in the fall with the possibility of some flowers being lost due to frost. All flower data are recorded as 1: none, 2: female, 3: male, and 4:male and female for each ramet and then summarized using the Region 9 tree improvement computer programs. The data do not account for the quantity of flowers produced, but only whether a ramet has produced one or more flowers.

Computation

The number of living trees and number of clones represented in all the orchards varies from year to year because the orchards were established

over a period of time. Therefore, the data were converted to percent of trees and percent of clones that produced female flowers. The data represent the following years: white pine, 1973-1976 (table 2); white spruce, 1974-1977 (table 3); and black spruce, 1974-1976 (table 4). The frequency of clones producing flowers during the data collection period was calculated for orchards 3, 4, and 6 (table 5).

Table 2.--Living ramets and clones with female flowers for white pine

(In percent)

Orchard no.	Type of material	Year			
		1973	1974	1975	1976
1	Ramets	19	18	4	4
	Clones	36	34	10	11
3	Ramets	21	31	18	6
	Clones	69	83	69	39

Table 3.--Living ramets and clones with female flowers for white spruce

(In percent)

Orchard no.	Type of material	Year			
		1974	1975	1976	1977
4	Ramets	24	17	12	33
	Clones	79	46	39	92
6	Ramets	20	19	9	75
	Clones	85	82	60	100
14	Ramets	71	20	16	55
	Clones	91	89	80	98
16	Ramets	34	8	5	44
	Clones	64	41	21	66

Table 4.--Living ramets and clones with female flowers for black spruce

(In percent)

Orchard no.	Type of material	Year 1974	1975	1976
8	Ramets	(No data)	28	29
	Clones	(No data)	94	90
10	Ramets	41	33	21
	Clones	92	74	89

Table 5.--The frequency of clones producing flowers over a 4-year period

(In percent)

Seed orchard and species	Number of years out of four 4	3	2	1	0
3 White pine	30	39	6	11	14
4 White spruce	29	23	34	9	5
6 White spruce	46	42	8	4	0

Correlation coefficients were computed between percent of living trees with flowers and ortet age for orchards 4 and 6 (table 6).

Table 6.--Correlation coefficient of percent of living trees with flowers and ortet age[1/]

Orchard no.	Year 1974	1975	1976
4	+.04	-.22	-.25
6	+.24	+.16	+.28

1/ Not significant at the 95 percent level.

For the data available for each orchard, correlations were computed between a month's total rainfall by year and the following year's percent of ramets producing flowers. This was done for the months May through September (table 7).

Table 7.--Correlation coefficient of percent of living ramets with flowers and the previous years rainfall by months

Species and flower data year	Orchard no.	Month				
		May	June	July	Aug.	Sept.
White pine (1973-1976)	1	+.23	-.96[1/]	+.64	+.28	-.08
	3	+.67	-.73	+.40	-.09	-.70
White spruce (1974-1977)	4	+.24	-.81	-.56	-.82	-.86
	6	-.19	-.48	-.78	-.72	-.73
	14	+.77	-.97[1/]	-.17	-.80	-.62
	16	+.41	-.88	-.53	-.91	-.76
Black spruce (1974-1976)	10	+.91	-.95[1/]	+.78	-.40	-.91

[1/] Significant at the 95 percent level.

DISCUSSION

The flowering trend for the eight seed orchards between 1973/74 and 1976 shows a decline in the number of ramets and number of clones that produced flowers. The decline may be due to normal cyclic production. A review of the amount of seed produced from the flowering years indicated similar results. In all four of the white spruce orchards a total of 3.00 lbs. of seed was produced in 1974, 0.25 pounds in 1975, and 0.002 pounds in 1976. However, 1977 was the best flowering year to date in the white spruce orchards. Data on white pine and black spruce for 1977 flowering have not been tabulated, but observations indicate that flowering is good in these orchards as well.

A review of the computer data summaries for each of the orchards revealed a large amount of variation among clones in year-to-year production. Many clones produce consistently but a few clones never have and maybe never will produce flowers. Correlation coefficients for age of ortet (22 to 135 years) and flower production ranged from +0.28 to -0.25 (table 6), indicating that for this age group there was no relation. However, this data does not reflect the ages (3 to 6 years) of the ramets within orchards.

It is known that moisture stress can be an important factor in flowering and cone production (Sweet 1975). Correlation coefficients were computed to determine if there was a relation between total rainfall for a given month and the next year's flower production. During the summer of 1976, the seed orchard was subject to a prolonged drought. Weather records for 1976 show that the May through September rainfall was 46 percent below the average of the previous 4 years. We hoped that the drought would stimulate flower production in the seed orchards for 1977; the white spruce data show that flowering was dramatically increased in 1977 (table 3). The results for the seven orchards indicate that a correlation between June rainfall and flower production may exist (table 7). However, one must consider that this data only includes a single severe drought year and the results may be due to normal cyclic flower production.

CONCLUSIONS

Although the data presented here only covers a few years of production, it is encouraging to note the number of clones that have produced cones. Within a few years these orchards should produce sufficient seed to meet the needs of the National Forests in the Lake States.

The possible correlation between flowering and rainfall must be considered with other factors when selecting seed orchard sites, and will be useful in planning breeding work and cone collection operations. This relation could also become the basis for determining when to apply a flower induction treatment such as fertilizer. This may be a key to producing large amounts of flowers for breeding and production needs on a more regular basis.

In the future we will continue to observe the flowering-moisture relation. We may find that in order to be useful, correlations will have to be established for each individual orchard and perhaps even for individual clones.

LITERATURE CITED

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