

## POLYMIK CROSSES FOR RUST RESISTANCE SCREENING

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Abstract--Six slash pine families with different levels of resistance to fusiform rust were crossed with two polymix pollens and tested at the Resistance Screening Center in Asheville, N.C. The polymixes consisted of pollen from disease resistant or disease susceptible clones. Resistance Screening Center scores from the resistant polymix crosses did not agree with family rankings in moderately to heavily infected field tests ( $r = -0.22$ ). However, the susceptible polymix crosses grouped parents in approximately the same order as field trials ( $r = -0.85$ ).

This research supports the assertion that a polymix composed of inferior parents will more accurately separate females if the trait of interest is controlled by dominant genes. Pollen from rust susceptible rather than resistant clones should be used to produce crosses with slash pine parents that are to be tested at the Resistance Screening Center.

Keywords: Slash pine, *Pinus elliottii* Engelm. var. *elliottii*, *Cronartium quercuum* f. sp. *fusiforme*

### INTRODUCTION

Fusiform rust (*Cronartium quercuum* f. sp. *fusiforme*) is the most damaging disease on slash pine (*Pinus elliottii* Engelm. var. *elliottii*) in the Western Gulf region of the United States. In 1980, 55 percent of the slash pine trees in Southeast Texas were infected (Pase 1980). This was a dramatic increase from 1976 when just over 40 percent of the slash pine in the same counties were diseased (Walterscheidt and Van Arsdale 1976). Similar increases in the occurrence of fusiform rust have been reported across the south (Griggs and Schmidt 1977). Because infected trees often die (Nance et al. 1981) or have decreased product value, increased resistance to fusiform rust is the most important trait for slash pine breeding in the Western Gulf Forest Tree Improvement Program (WGFTIP).

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To improve resistance while maintaining selection pressure for growth and form characteristics, the WGFTIP has implemented a two step testing program. All slash pine selections are initially evaluated for disease resistance at the Resistance Screening Center in Asheville, North Carolina, (Anderson and Powers 1985) and only the resistant parents are utilized in the traditional breeding program.

In the past, all seed submitted from the Western Gulf Forest Tree Improvement Program to the Resistance Screening Center was collected from either the ortet or a seed orchard. Under these circumstances, it was assumed that the pollen source was random and that females would be correctly ranked. A moderate correlation coefficient ( $r = -0.73$ ) between Resistance Screening Center scores and field data (Byram et al. 1982) indicated that this assumption was adequate. Most selections currently being tested are located in scion banks where a random pollen source may not be present. This makes it necessary to use either single-parent control-pollinations or polymix crosses to produce seed for testing. Because the only goal is to rank parents, polymix crosses have been chosen.

The objective of this study was to determine if the males selected for the polymix would affect the ability to rank females for resistance to fusiform rust at the Resistance Screening Center.

#### MATERIALS AND METHODS

Twenty-six slash pine clones were selected on the basis of known resistance to fusiform rust. The percent of trees infected with either a limb or stem gall was determined for each family. This percent was converted to standard deviations compared to the average fusiform rust infection in the plantation and averaged across progeny tests. To be included in the clonal evaluation, a minimum of 30 percent rust infection and differences among families at the 10 percent level of significance were required for each test. Families with negative scores had less rust and were considered to be more resistant. Six clones were chosen as female parents. The remaining 20 clones were used as male parents and divided into rust resistant and susceptible polymix groups. Field trial scores and the number of observations included are listed in Table 1.

Polymix pollen was formulated by mixing equal weights of clean dry pollen from each male parent. All six females were crossed with both polymix groups and the resulting 12 seedlots were submitted to the Resistance Screening Center (RSC). Positive RSC scores indicated rust resistance at the Resistance Screening Center. RSC scores for the resistant and susceptible polymix crosses were independently regressed against the field scores.

Table 1. The average field score for fusiform rust expressed as standard deviations (SD) from the test mean and the number of tests in each observation for all parents included in the study.

Females			Resistant Polymix			Susceptible Polymix		
Name	SD	No. of Tests	Name	SD	No. of Tests	Name	SD	No. of Tests
S5PC8	-0.926	2	K-143	-0.726	3	K-141	1.389	4
K-211	-0.492	6	BSS-13	-1.100	5	K-142	1.042	5
D12PC10	-1.226	4	BSS-10	-1.351	4	K-163	0.906	2
S5PC3	0.607	7	C-103	-1.717	1	OI-S-1	0.614	4
S5PC6	0.809	4	OI-S-4	-1.024	6	OI-S-5	0.803	2
D12PC29	0.987	3	OI-S-2	-0.722	3	S6PC1	1.710	2
			S5PC5	-1.319	9	D4PC71	2.050	2
			D5PC44	--	--	D5PC57	1.590	2
			D5PC98	-2.065	2	D5PC228	0.486	2
			D5PC286	-1.419	3	S2PC1	0.212	7

## RESULTS AND DISCUSSION

There was no significant relationship between RSC scores for the resistant polymix crosses and field data; however, the correlation between the RSC score for the susceptible polymix crosses and field data was significant ( $r = -0.85$ ) (Figure 1). The RSC scores for the susceptible polymix crosses correctly separated the resistant and susceptible female parents and ranked them the same as the field tests with only one exception.

Polymix crosses should adequately rank parents for general combining ability. However, the type of gene action controlling the trait of interest will determine which parents should be used for the polymix. If disease resistance is determined by dominant genes, then a resistant polymix would mask differences among females by contributing dominant genes (resistance) to the progeny. In this case, a susceptible polymix should be used because the female's dominant genes for resistance would not be masked by the pollen contribution. If resistance is determined by recessive genes, then a resistant polymix would provide a better separation among females than a susceptible polymix. This data indicated that resistance to fusiform rust in slash pine was controlled by dominant genes and the susceptible polymix was the correct choice.

When a small correlation between RSC and field scores has occurred, it may be partially due to the level of rust resistance in the pollen. Females crossed with resistant pollen or by pollens with varying degrees of resistance may be incorrectly ranked. This incorrect ranking could occur at the Resistance Screening Center, and/or in field tests. Controlling the contribution of the male parent by using

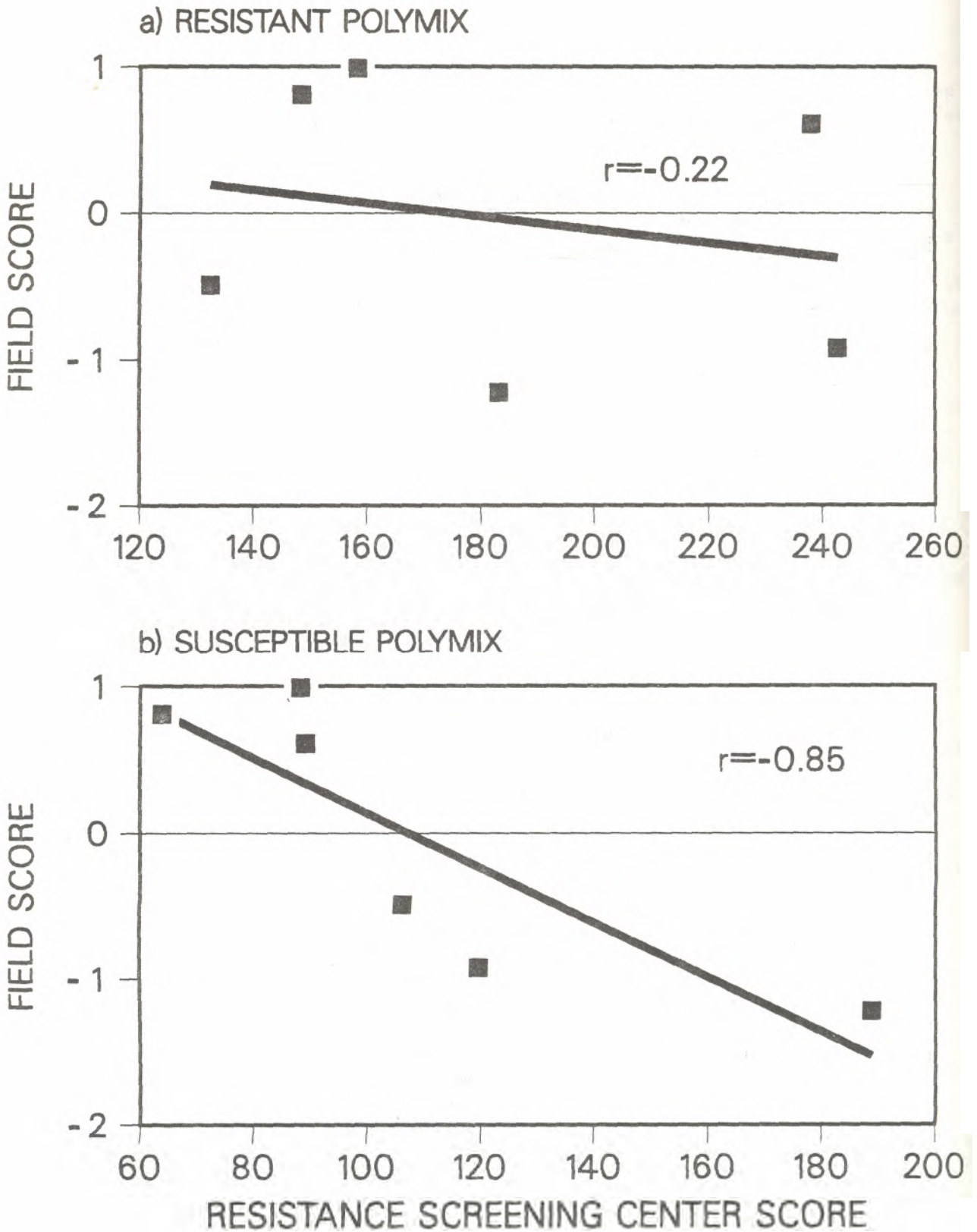


Figure 1. Relationship between rust resistance in the field (standard deviations to the plantation average) and Resistance Screening Center scores for the same six females crossed with a) resistant polymix and b) susceptible polymix.

a standardized polymix also has the advantage of allowing more accurate clonal comparisons across organizations.

A polymix composed of inferior performing male parents should insure that dominant desirable traits in the progeny originated from the female parent. While this theory should apply to other traits and other species, an inferior polymix may not always be desirable in an operational tree improvement program. In cases where the traits of interest are related to seed set, viability or overall fitness, an average polymix may be more suitable. An example is the testing of second generation loblolly pine selections in the Western Gulf Forest Tree Improvement Program. Selections will be ranked for their general combining ability for volume growth based on crosses with a polymix pollen formulated from average parents. If a decision is made to use average or inferior parents for a polymix, the parents should be selected before they are rogued from the program.

#### CONCLUSION

A rust-susceptible polymix provided a better ranking of slash pine families at the Resistance Screening Center than a rust-resistant polymix. This indicated that resistance to fusiform rust in slash pine was controlled by dominant genes. The use of a constant susceptible polymix should provide a better ranking of slash pine families at the Resistance Screening Center and allow for more accurate comparisons among different organizations in the Western Gulf Forest Tree Improvement Program.

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