1994 Report for project 94-K21 (Noninfectious Bud-Failure)

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Introduction

Noninfectious bud-failure is a serious problem in almond particularly with 'Nonpareil' and 'Carmel'. Previous work under this project has achieved field control in Nonpareil through source selection. That prospect has not been achieved with Carmel. Progress was made in 1993 in establishing the pattern of variability in BF-potential within Carmel and making selection for low BF-potential clonal sources. The number of clonal sources in 1990 and 1991 without some BF progeny have been reduced to 2, but 19 new selections have been propagated for field trials. The irrigation experiment showed that moisture stress increased both the number of BF trees and the level of BF expression in Nonpareil, but the same may not be true for Carmel. Flowering data collected in spring, 1993, indicated that flowering in Carmel was more strongly reduced by BF than in Nonpareil, suggesting that yield in Carmel may also be more sensitive to BF than yield in Nonpareil. Two years of observations have been obtained in both the progeny tests of commercial nursery source material and the irrigation experiment. This report covers data obtained in spring, 1994, for all experiments, including data from a BF stabilization experiment, a seedling progeny test, and an experiment to test rootstock effects on BF development.

Materials and Methods

The established orchard plots of source progeny tests of Carmel which are growing in 3 locations in Kern and Fresno counties were examined and scored for BF symptoms in spring, 1994. The irrigation experimental block in Winters, CA, was also scored for BF symptoms in spring, 1994. Individual tree trunk growth and yield measurements were made in the Paramount orchard in the fall of 1994. The first year grafts in the stabilization experiment were observed in 1994, and a second cycle of consecutive annual grafting was completed.

Physiological markers of BF which have been identified in Nonpareil were tested against new Carmel source clones that have been selected for BF-potential. These markers included response to high temperature of callus cultures, ontogeny of field grown and cultured tissues and timing of dormancy in fall vegetative buds.

Results and Discussion

The 1st project objective was to continue to monitor BF in plantings of clonal selections and establish sources of Carmel. Of eleven clonal (single tree) selections of 'Carmel' progeny tested since 1989, two from the Manteca RVT plot have remained free of BF to date and have passed the requirements to make them eligible for release under the Registration and Certification program. Material has been distributed to nurseries to enable them to build up source blocks preparatory for commercial release. Nineteen additional clonal 'Carmel' selections have been placed into orchard progeny tests in Kern and Fresno Cos.

The 2ed project objective was to continue observations of BF through the 3^{ed} year of Carmel and Nonpareil progeny tests and in the irrigation experiment, including measurement of individual tree yields in the irrigation experiment. Percentages of BF trees almost doubled between 1993 and 1994 in the Paramount test planting of commercial nursery sources. This trend continues a pattern in that essentially all of the new cases of BF this year have low BF ratings with symptoms only in the upper parts of the tree. In contrast, the trees with symptoms the first year (and some the second) have more severe expressions of BF. The three years of Carmel data were subjected to an overall statistical analysis to quantify the

relative importance of the Nursery, the Source Tree, and the Budstick to the expression of bud-failure in each year. The results (Table 1) demonstrated that the most important source of bud-failure was the Source Tree, which accounted for over 40% of the observed bud-failure, followed by Budstick and then Nursery.

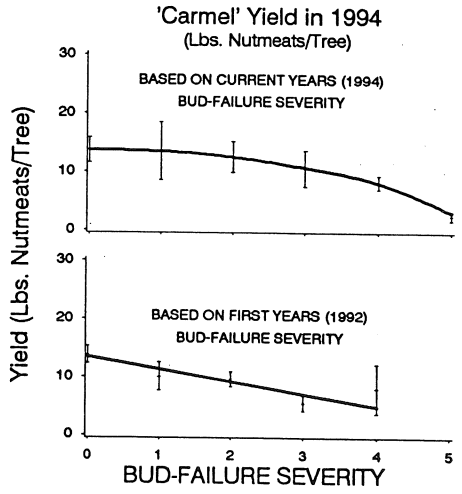
TABLE 1

SOURCE	% OF TOTAL OBSERVED VARIATION IN BUD-FAILURE (CARMEL, PARAMOUNT FARMS)		
	1992	1993	1994
NURSERY	11%	14%	25%
SOURCE TREE	44%	45%	42%
BUDSTICK	24%	24%	17%

All of the sources of variation were statistically significant, but this analysis makes it clear that most of the problem arises from the clonal source, as previously demonstrated for Nonpareil. The importance of the individual tree in the source block has been apparent since the first year and the identity of individual trees that produce BF progeny has been made known to individual nurseries. Although the elimination of these trees should begin to improve the general level of BF-potential throughout the industry, realistically we should not expect BF to disappear immediately because the number of source trees remaining in nursery blocks is not enough to supply the industry and additional sources are needed. Sources of lower BF-potential should include a) the original seedling Carmel tree, (b) individual trees in separate nursery sources which did not produce BF progeny in the Paramount tests (c) individual nursery sources where other progeny information is available separate from this test. In addition to the importance of the source tree, it was found that certain budsticks gave significantly more bud-failure progeny than other budsticks from the same tree, and in many cases budsticks showing high bud-failure came from the same side of the tree. However, there was no consistent pattern related to exposure: for some source trees budsticks from the East or West side would produce the most bud-failure, whereas for other source trees growing in the same location budsticks from the East or West side would produce the least bud-failure. There was no relation of bud-failure potential to bud position on the budstick.

The importance of bud-failure was further emphasized in the yield records obtained this year for the first time. Since the cultural conditions at Paramount Farms were more typical of commercial conditions than those at the Winters plot, the relation of bud-failure to tree yields was evaluated at Paramount. The data (Fig. 1) showed two very important results: 1) that when tree yield was compared to the **current** seasons' level of bud-failure expression, as has been previously reported, yield was clearly reduced only when bud-failure symptoms became moderate to severe but 2) that when tree yield was compared to the **first** seasons' level of bud-failure expression, yield was

Figure 1. The relation of bud-failure severity to yield.



progressively reduced at any level of bud-failure symptoms. These are only first year yield results, but they indicate that earlier bud-failure expression, even with mild symptoms, may be associated with a reduction in later tree yields.

After three years of irrigation differences, there was no clear trend in bud-failure symptoms or in the percent of BF affected trees due to the irrigation treatments imposed (Table 2).

TABLE 2.

IRRIGATION TREATMENT	SYMPTOM SEVERITY SCORE						% BF AFFECTED TREES					
	NONPAREIL			CARMEL			NONPAREIL			CARMEL		
	1992	1993	1994	1992	1993	1994	1992	1993	1994	1992	1993	1994
WET	0	0.4	0.8	0.9	1.5	1.9	0	33	43	39	55	61
MEDIUM	0	0.9	1.1	1.O	1.8	1.6	0	30	44	36	53	48
DRY	0	1.5	1.2	1.1	1.6	1.2	0	64	51	39	65	55

These data are only for the intermediate bud-failure source since, as reported earlier, 100% of the trees from the high bud-failure source exhibited bud-failure symptoms by 1993, and none of the trees from the low bud-failure source exhibited symptoms as of 1994. These irrigation differences were large enough to cause large differences in tree size, but failed to cause any consistent difference in bud-failure symptom development, hence we tentatively conclude that water stress may have little influence on the overall expression of bud-failure.

The 3ed project objective was to obtain first year results of stabilization test and conduct 2^{ed} year grafting experiment. The bud-failure stabilization test compares the bud-failure potential from different positions on a nursery 'mother block' type tree. This is done by budding a bud from the upper portions of bud-failure prone tree to a basal position and then comparing its probability of showing bud-failure as compared to a adjacent basal bud 'pushed' into active growth. The aim is to determine whether lower, more juvenile buds retain a lower bud-failure potential than the higher shoot buds typically used in nursery operations. Due to the mild weather conditions during 1994 at Winters, CA, no significant differences in the bud-failure stabilization experiments have yet been observed. It has proven difficult to manage basal shoots on trees from some of the more vigorous varieties tested since the tree is not cut-back after the desired buds have pushed.

The 4th project objective was to observe BF development in seedling progeny from controlled crosses of almond sources x Nonpareil BF.
Approximately 2,000 seedling progeny from controlled crosses between a high bud-failure 'Nonpareil' source tree and candidate clones for selected almond varieties have been screened for degree of bud-failure in progeny. This data is now being analyzed to characterize clonal sources with the least likelihood of showing bud-failure under evocative environments. Such low bud-failure clonal sources will be identifiable by both the lateness of development as well as the low overall proportion of the seedling progeny ultimately showing bud-failure symptoms.

The 5th project objective was to test Carmel source clones for expression of the physiological markers that have been established for BF in Nonpareil. Callus cultures of both 'Carmel' and 'Nonpareil' clonal sources showing both high and low potential for bud-failure were established and growth rates of individual source clones have been examined for differences either between bud-failure potentials within variety or between varieties. No significant differences were observed among any of the lines tested. Several of the callus lines, however, were later found to be contaminated with slow growing endo-bacterium, which would have masked differences that may have existed.

The 6th project objective was to continue with publication program. Publications summarizing results in both 'Carmel' and 'Nonpareil' are in the review process.

The 7th project objective was to compare rootstock effects on BF in 1994 and 1995.Rootstock effects were evaluated for the first time in 1994. There appears to be a rootstock influence on the expression of bud-failure, but a second year evaluation will be necessary before any tentative conclusions can be drawn.