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ALMOND BOARD OF CALIFORNIA
ANNUAL REPORT FOR 1989

Project NO. 89-K16 Selection, Maintenance and Monitoring BF-Potential and Genetic True-to-Type Propagation Sources for Almond

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Objectives: (1). to test for virus (indexing), trueness-to-type (vegetative progeny testing), absence of nonproductive genetic disorders (level of BF-potential) of selected source-clones of commercial varieties of almond;

(2). to conduct parallel seedling progeny tests to characterize inherited BF-potential of varieties and source-clones;

(3) to provide material for parallel studies to measure BF-potential, including shoot-tip material.

Interpretive summary. Procedures for nursery selection of propagation sources in almond can be divided into two basic procedures. One involves orchard selection (also referred to as "pedigree selection") in which a large number of trees of a single orchard are utilized as sources of budwood. Individual trees from which collection is to be made are visually inspected to avoid any with undesirable characteristics or evidence of abnormalities. However, at the end of the propagation sequence, all trees are segregated by size and any relationship to individual trees disappears.

The second procedure is to select a number of single tree sources which are themselves "true-to-type" but also whose separate vegetative progeny can be shown to be "true-to-type" when grown out in an appropriate environment. Populations of plants originating from within the variety in this way are called "source-clones" and the process of their identification "source-clone selection". Such source-clones of Nonpareil, Mission, Ne Plus Ultra, Solano, Sonora, Padre, Thompson, Peerless, and some others have been identified

and are maintained in the Foundation Seed and Plant Materials Service (FSPMS) orchard at UCD. These have also been tested for harmful viruses and tested in the RVT plots for productivity.

One of the current objectives of this project has been to extend this selection process to other major commercial cultivars not currently available in the collection. The progress is described below.

Another objective is to verify and extend two kinds of inheritance tests to the same source varieties and source-clones being subjected to vegetative progeny testing. Progress is described.

We have also been concerned with the high incidence of BF trees that appeared in many commercial plantings of Carmel in spring 1989. Several points can be made. a). Both orchard experiences and inheritance studies have shown that Carmel is inherently more sensitive to conditions that produce bud-failure. b). The high incidence and severity of BF in Carmel, as well as other varieties over a wide area and range of source materials can be directly correlated to season and geographical variation in heat accumulation in the summer of 1988. c). On the other hand, we are finding where the pattern of BF development is directly related to the growing conditions that exist early in the life of the orchard particularly during the first 5 to 6 years. We are concerned about the interactions of vigor and growth conditions and the moisture stress conditions of the orchard. Consequently, we believe it will be important to investigate more critically source-site interactions as factors in the induction of BF symptoms.

PROCEDURES AND RESULTS

I. Selection of Source-clone Propagation sources

The selection process began in the summer 1988 with a series of meetings with (a) members of the commercial nursery industry as represented by Nursery Improvement Committee, (b) Foundation Plant Materials Service, UCD, and (c) UC researchers. Recommendations were to add Carmel, Monterey, Fritz, Price, Butte, additional Mission, and Ruby to the cultivars currently maintained in the Foundation Orchard of FPMS. As a second step, nominations were made by individual nurseries or researchers for specific source trees to be candidates for inclusion in the program. Testing was to include (a), propagation for progeny tests, (b). virus indexing, (c) and propagation for inclusion into the FPMS Orchard.

A. The following materials were included in the 1988 Progeny tests:

Carmel	-	6 sources -	Burchell Scion Orchard
Monterey	-	6 sources -	Burchell Scion Orchard
Price	-	6 sources -	Fowler Scion orchard
		2 sources -	Fowler (Price Estate, Durham)
		2 sources -	Sierra Gold Scion Orchard
		1 source -	FSMPS, Davis

Butte	6 sources -	Fowler Scion Orchard
Fritz	1 source -	Dave Wilson Nursery
Ruby	1 source -	Bright Nursery
Mission	source -	Burchell
	source -	Fowler
	3 sources -	FSPMS, UCD
Sonora	1 source -	FSPMS, UCD
Padre	1 source -	FSPMS, UCD

Approximately 25 trees were propagated for each source by June budding at the Burchell Nursery during 1988. Trees were dug and planted into test orchards at the Paramount Orchards, Wasco, Kern Co. and an orchard in Fresno Co. January 1989.

Virus testing has been completed for Price, Butte, Fowler Mission but not for Carmel and Monterey. Fritz and Ruby were positive for ringspot.

B. The following materials were added to the list in 1989.

Carmel	3 sources	- Burchell Nursery (first generation)
	3 sources	- Manteca RVT plot trees which had been previously used as sources for trees planted in the Fresno RVT plot.
Fritz	3 sources	- Burchell Nursery Preliminary tests indicate the source trees are PRSV negative.
Nonpareil	1 source	- FSPMS 3-8-14-76. Source had not been previously progeny tested.
	1 source	- new source from 90 year old Jeffrey orchard, Chico; collected by Joe Connell, Farm Advisor. These trees were PNRS+ and are being sent for heat treatment at IR-2 Repository, Prosser, Washington.

Virus tests are to be started in 1990 to be completed in 1991. Trees are being propagated for Foundation Orchard planting.

Discussion. Several years will be required before we will have sufficient confidence in most of this material to allow release for propagation. This caution applies primarily to the Carmel sources for which the greatest concern is felt for potential susceptibility to noninfectious bud-failure. Not only do the progeny trees need to be able to come into bearing but the trees that are propagated into the FPMS Foundation orchard must come into bearing and observed for trueness-to-type.

II. Seedling progeny tests

Seedling progeny tests are based on previous inheritance

studies with B-affected and non-BF trees and varieties as part of this project.

Series A. In prior almond x almond tests, a severely affected BF tree used as a parent, transmitted a rapid rate of BF symptom development into its seedling progeny. The relative rate of BF symptom development in different progeny was directly proportional to the inherent BF potential of both parents. Consequently, comparative crosses of a series of varieties with unknown BF potential to a known single severe BF parent has the possibility of being a test for latent BF potential.

The following crosses were made:

Nonpareil BF	x	Carmel (combined sources)	28 seeds
	x	Carmel BF	2 seeds
	x	Jordanolo	45
	x	Monterey	2 seeds
	x	Price SG	9 seeds
	x	Price F	20 seeds
	x	Butte	18 seeds
	x	Sonora	2 seeds

The low numbers were mostly due to the depredations by crows on the UCD campus during midsummer in 1989. Additional crosses will be made in spring of 1990.

Series B. In almond x peach, a different pattern occurs, in that there is a more or less segregation of severe BF types up to 50 percent of the population within the first few years after planting. This rapid development was most pronounced from specific cultivars, including Jordanolo, Nonpareil and Carmel with none with progeny from such cultivars are Butte, Price and Mission. Consequently we believe that this test can be used in the future to identify cultivars with relatively high potential for BF. The following crosses were made:

Jordanolo	x	40A-17 peach	26 seeds
Sonora	x	" "	14 seeds
Carmel	x	" "	198 seeds
Sel 1-69	x	" "	58 seeds
Price	x	" "	209 seeds
Merced	x	" "	169 seeds
Monterey	x	" "	60 seeds
Butte	x	" "	31 seeds

Seeds have been germinated and seedlings are growing in a greenhouse where they will remain until planting into the nursery in early spring.

III. Evaluating the Carmel Variety for BF

Spring 1989 brought many reports of high incidence of BF in Carmel in particularly in young orchards. A general summary of the reports suggested that the incidence was common across many different propagation sources as well as sometimes in Nonpareil.

Recognizing that there has been a close relationship between the incidence of BF in particular years and the magnitude of the hot temperatures in the previous summer, we made an analysis of the seasonal pattern of accumulated temperatures above 80oF for the 1988 season compared to the average of the previous four years.

The seasonal trend was plotted against the developmental pattern of shoot growth under various conditions and age of the tree (Figure 1). This interrelationship between shoot development and temperature patterns is believed to be the controlling factors in BF symptom development.

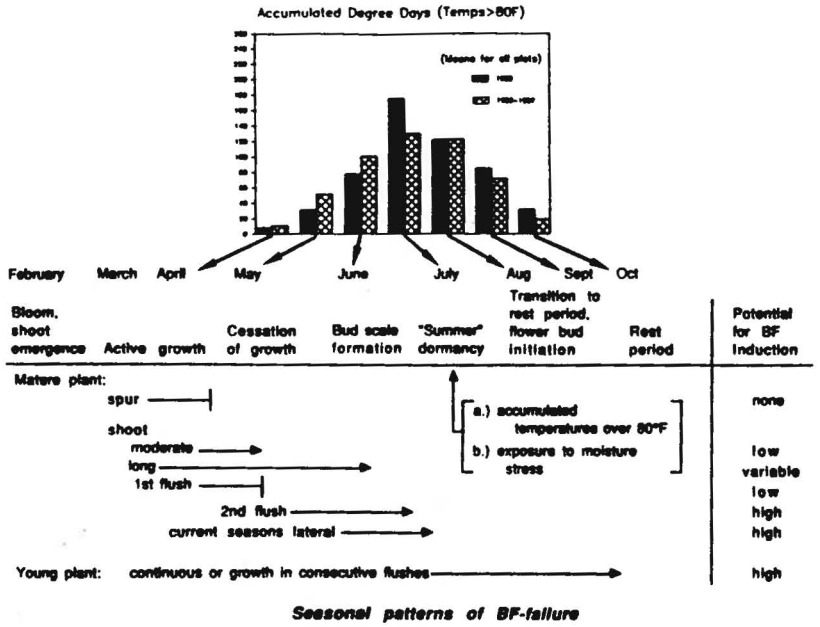
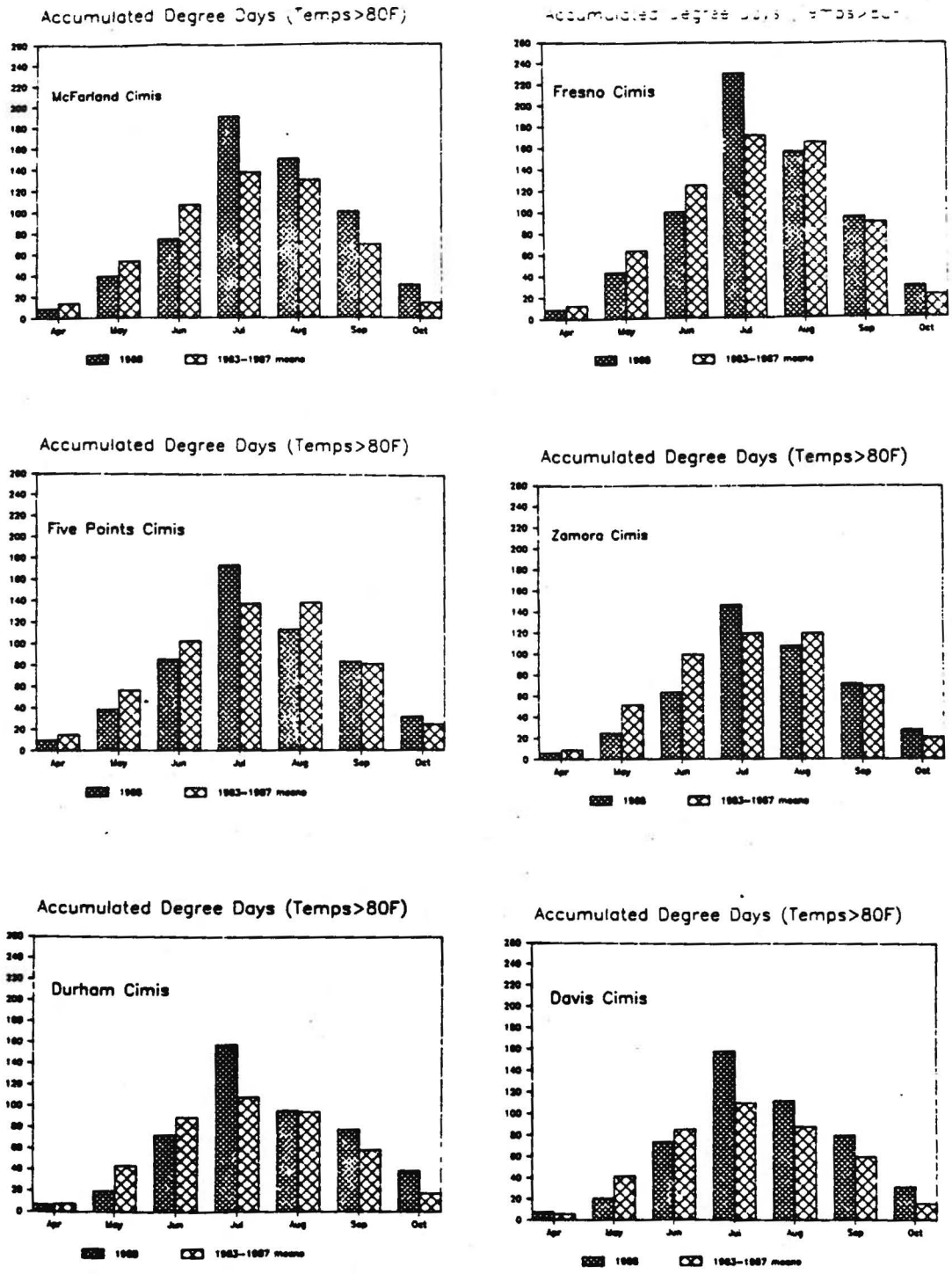


Figure 1. The relationship between seasonal temperature patterns in annual shoot and spur growth is shown for the 1988 season compared to the mean of the previous five years. The relationship between the type of shoot and\or spur growth to their potential for BF induction is also shown.

The pattern for six different locations is shown in the following table (Figure 2).

Fig. 2. Comparative seasonal temperature patterns in six different sites in California (Data from Cimis Stations)



The data of the accumulated temperatures over 80oF. for the six locations in California (Table 1) illustrate how important is the geographical location within the Sacramento and San Joaquin Valley. Fresno and Kern Counties have consistently higher temperatures than the Sacramento valley sites. Nevertheless these vary by different years. The 1989 season was shown to have consistently lower temperatures than other years except in the McFarland site in Kern CO.

Table 1. Accumulated degree days > 80oF for representative sites in California in different years. Data from Cimis stations.

	1983-87	1988	1989
Davis (Yolo)	400	517	330
Zamoro (Yolo)	368	428	337
Durham (Butte)	396	463	411
Fresno (Fresno)	505	670	453
McFarland (Kern)	518	613	590
Mean	437	538	424
% of 5 year average	100	123	97

We have also noted how the amount and severity of BF symptoms is related to the amount of total growth and/or vigor of the shoots of the previous year. The seasonal temperature data (Figure 1 and 2) show that during the months of April, May and June, 1988, mean temperatures were significantly less than that of the previous years. This cool period would have been conducive to a general increase in growth. On the other hand, the temperatures above 80oF during July, August and September were consistently higher, sometimes in the range of 25 per cent greater. The interaction of the two conditions could have accentuated the average level of BF symptoms.

The growth relationship shows up in our BF Model in which a direct relationship exists between the age of the tree and the severity and rate of BF induction. This leads to a general pattern in that the most sensitive time for trees to develop BF is in the first four to five years in the orchard. During this time the trees are growing most rapidly and the basic framework of the tree is being established.

These relationships indicate how environmental and management conditions at the site of the particular orchard can have a major impact on the rate of development of BF. Thus, we can argue that in particular instances site can be equally important to source.

Discussion.

Plans are going forward to make a comprehensive analysis of the pattern of BF development within Carmel both in terms of pedigree potential and in the effect of site conditions where the trees are planted. It may be that the potential for BF within Carmel is

sufficiently high that attention may have to be paid to site conditions that minimize its impact on BF development.

IV. Propagation of shoot-tips

Shoot-tips taken from normal and BF affected source trees of Nonpareil had been maintained for a period of time in aseptic culture as a potential tool for study and maintenance in relation to BF. In addition we have been growing a number of potential rootstocks which are being considered for eventual introduction. During the summer and fall, much of this material became sufficiently contaminated with certain difficult to eradicate pathogens that we had to discard the material. We are undecided about renewing this material with fresh cultures. This would have to be carried out in late winter or early spring.

PUBLICATIONS

Kester, Dale E., in press. Principles of Source Selection. Proceeding of International Plant Propagators Society.