Project Number 76-K3

Title

Tree Research: Part 1. Noninfectious bud-failure
Part 2. Variety evaluation

Prepared By

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Objectives

Part 1. The primary emphasis at present must be to obtain better understanding of the B.F. phenomenon, how it affects the basic physiology of the tree, how it is transmitted to offspring plants both in seeds and during vegetative propagation and how its distribution is affected by environment.

Part 2. To obtain a better understanding of the biological basis of specific characteristics, including such factors as pollen compatibility, N.O.W. resistance, and harvesting capabilities, thus providing a basis for precise selection criteria.

Interpretive Summary

A. Part 1. Noninfectious bud-failure

Noninfectious bud-failure (BF) has two direct, but separate applications to almond production. One is the development of specific symptoms on orchard trees, which is a direct concern to orchardists because it affects yield. The second is the potential of a bud to produce BF trees when used in propagation. This directly concerns nurserymen by determining his selection of propagation material and ultimately the orchardists who obtains the trees.

All the information we have developed to date points to the fact that symptoms result from exposure of susceptible shoot buds to a particular pattern of high temperatures. The confusing picture that one sees in the variability in symptoms within trees, between trees, between orchards, and between regions is a consequence of the interaction of these two factors. Specifically we can cite the following as important current developments.

1. In orchard plots established since 1970 we have established that the BF level is not only directly associated with summer temperatures in the region, but also the level of symptoms of any one year can be associated with the prevailing temperatures of the preceding summer. Obtaining these results requires that one has susceptible trees.

2. Attempts to modify the effects of BF on symptoms or yield by application of Alar have not been successful and we will curtail further tests in this research area until we know more about how and when BF affects the plant. Procedures to

modify the environment in the orchard or to modify the tree by culture or pruning also need to be explored, and new work will start this year.

3. This year we studied more critically how and when symptoms develop. What is apparently the first visible stages of breakdown in cells of the bud was found in late July and August and studies are continuing to reconstruct the sequence of what happens before and after the symptoms develop.

However, the principal control for BF will continue to be the replacement of affected trees and the selection of non-susceptible trees for planting. The problem continues to be identification since the potential BF in a bud source tree cannot be predicted by appearance on the tree. Furthermore, the level of BF potential can increase with time in higher temperature areas. Shift to lower temperature areas can reduce symptom expression, but not necessarily reduce propagation potential. Since no specific indexing tests exist to identify BF-potential in a symptomless tree, we must rely on performance testing trees originating from a known source tree, but conducted in a high temperature area. Developments in this research area may be cited as follows:

1. We have now demonstrated that differences in BF potential can be established in specific bud source 'Nonpareil' trees. Single propagation source trees originally selected as free of known viruses are currently maintained by Foundation Seed and Plant Materials Service (FSPMS) at Davis. These trees and their vegetative progeny are referred to as "clones".

   Five of these 'Nonpareil' clones have been performance tested at West Side Field Station (Fresno County) since 1971 and have not developed BF symptoms; in contrast a BF test clone began to produce symptoms in 1 year. One of these clones - labeled FSPMS 3-8-2-70 is being distributed, but like all other 'Nonpareil' sources should not be considered proven free of BF. Trees from several nursery sources were included in the test and also demonstrate that differences in BF potential exist and can be recognized if proper performance tests are made.

2. The potential for BF continues to appear in many new varieties. This year BF trees and propagation lines have been identified for the first time in 'Thompson', 'Harvey', and 'Arboleda'. This underscores the fact that most new varieties, particularly those originating as "chance seedlings", are offspring of 'Nonpareil'. We are continuing to study the transmission of BF from both "normal" and BF almond varieties through the seed to their seedling offspring. The possibility of virus involvement continues to be negative.

Controlled environment studies. All of the results described in the first of this summary were obtained with orchard trees. We are now bringing the problem into controlled environment facilities where we can

study separately the effects of a) different temperatures on single clonal lines with known BF potential and b) susceptibility differences among clones at known temperatures. Much of the effort this year has been to develop the procedures and facilities to grow small plants in containers in greenhouses, in controlled growth chambers and in test tubes. The work is too new for us to cite results.

B. Part II. Variety evaluation

Currently, ideas on almond variety selection are changing rapidly such that there is much interest and need for comparative information on performance and characteristics of "new" varieties. We expect that the three Regional Variety Trial (RVT) plots will help to supply that need. These are now established in Kern, Colusa, and Butte counties, and a fourth is scheduled for San Joaquin County by Spring 1978. The plots include "clones" of major varieties, new patented varieties of private breeders and nurserymen, new unnamed selections from UC and USDA and some rootstocks.

The group of new selections of UC and USDA has now been reduced to about 15 with the prospects that at least one will be introduced in the near future, perhaps within the coming year.

The environmental and genetic factors affecting the hardness and tightness of the shell as a basis of resistance to navel orangeworm is being studied, but no results are available. A second emphasis is pollination characteristics both for cross-pollination and in certain experimental self-fertile selections.

Part I. Noninfectious bud-failure

Project 1. Identification of differences in BF potential among 'Nonpareil' clones and other propagation sources in orchard tests. (D.E. Kester, R.A. Asay)

Procedure. Individual source trees of 'Nonpareil' (as well as other major varieties) which have been previously identified as free of known viruses by Plant Pathologists and established in the FSPMS[1] orchard at UCD, are being performance tested for BF. These performance tests have involved planting budded trees in replicated blocks (3 x 20 trees) at the West Side Field Station, Five Points in 1971 and 1972 and observing trees annually for BF symptoms. Plants of these clones are also being established in each of the RVT orchards (see Part 2). In addition, donated trees originating from special propagation "sources" of some commercial nurseries have been included for comparison (but not to test individual nursery sources).

Environmental effects on BF expression in orchards has been tested by propagating plants originating from a single symptomless, but BF-susceptible 'Nonpareil' clone (FSPMS 3-8-1-63) and growing trees in randomized plots located in 8 locations in California. These plots were planted in 1970 and have since been examined annually. Some of these (Chico, Escalon) are still being examined and the plots at Winters and Davis, in conjunction with trees of other 'Nonpareil' clones at Davis, are being used as the basic sources of material for many of the BF experiments to be described.

BF in individual trees is identified in these orchards by visual observations in the spring for bud-failure of shoot buds and other associated symptoms.

Results. Six clones of 'Nonpareil' have been undergoing performance tests at West Side Field Station (Fresno County) since 1972. FSPMS 3-8-1-63 (Farnham clone), earlier found to be BF-susceptible, was included as a check and by 1976 showed BF in all trees. However, no tree of any other clone being tested shows any symptoms to date. FSPMS 3-8-2-70 (Washington clone) has been tested additionally in the same location since 1971. Nine lots of trees from commercial nurseries produced percentages from 0 to 46. From this commercial source group, 5 additional "new" clones have been established in the FSPMS orchard.

Of the 12 total clones, only FSPMS 3-8-2-70 is currently available for distribution and it should not be considered as proven to be BF-free.

The percentage of BF trees and the severity of the symptoms in 8 plots of FSPMS 3-8-1-63 has been not only directly associated with the total quantity of summer heat which is associated with that region, but also the greater

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[1]Foundation Plant and Seed Foundation Service. In this discussion a clone refers to a single tree selection within a variety plus the vegetatively propagated offspring of that tree. These are identified by a number as FSPMS 3 (almond) - 8 ('Nonpareil') - 1 (clone no.) and 63 (year entered foundation orchard. These are also being identified by name.

Project 1. (continued)

severity of symptoms in any one year can be associated with higher temperatures the previous summer. A complete analysis of these results are being prepared for publication.

Project 2. Chemical control of BF. (D.E. Kester, R.A. Asay, Hellali Rachid)

Procedure. Alar has been applied for 3 consecutive years to normal (Davis) and affected (Winters) 'Nonpareil' trees of the FSPMS 3-8-1-63 clone at 3 rates (0, 1000 ppm, and 3000 ppm) and 3 or 4 timings from early April to early June. There were 3 trees for each treatment, and 3 limbs measured/tree. Data was obtained on shoot length, numbers of spurs, buds, flowers, fruit set, failing buds, and lateral branching.

Results. Alar treatment under the procedures tried did not produce significant benefit in increasing yield of nuts or decreasing bud-failure symptoms. There was a trend of increasing flower buds and number of spurs in some treatments, but the results were too inconsistent to be of value.

What was useful was the ability to analyze the growth and production of normal and BF affected plants in terms of shoot length, number of spurs, lateral "flushing" and number and distribution of flower buds.

The conclusion was that more information on the timing and physiology of symptom development was needed before further tests should be made of Alar or other materials.

Project 3. Virus studies. (Dr. G. Nyland, Sunny Lowe, J. Negueroles, R.A. Asay)

Procedure. Scions from normal and BF trees of 'Nonpareil', 'Jubilee' and 'Jordanolo' were grafted to rootstocks in small containers. The plants were grown in the greenhouse from January to August and then placed in heat chambers at 100°F for 5 weeks (thermotherapy). Plants were then removed and individual buds propagated into nursery plants.

Electron micrographs were made of tissues of normal and BF 'Nonpareil' plants to search for pathogens, as virus, or virus-like organisms.

Results. When the original plants which were propagated from BF source trees and subjected to thermotherapy were later examined, either all buds were dead or the entire top was killed down to the graft union, with one exception. One BF 'Nonpareil' was only partially killed and new healthy shoots from the base of the scion were produced. None of the nursery propagated buds survived.

On the other hand, all plants propagated from "normal plants" survived. Only the buds propagated from the "normal" 'Jordanolo' survived in the nursery.

Electron micrographs made from cells of normal and BF plants showed no evidence of submicroscopic organisms such as virus, mycoplasm, etc.

Project 4. Anatomical studies of buds in BF plants. (Hellali Rachid, Dr. J. Lin, D.E. Kester).

Procedure. Buds from normal and BF shoots were collected at 2 week intervals beginning in April. Gross changes in weight and appearance were measured and microscopic sections prepared and examined for evidence of "bud-failure".

Results. The beginnings of breakdown in the BF bud can be first observed in a few cells in the very tip of the growing points. Eventually the entire bud is affected and literally is "walled off" from the rest of the plant. In samples collected at Winters these morphological stages were first observed in significant numbers in mid to late August, but appear to have begun in some buds earlier. A large loss of moisture in the buds was found to occur during late July, early August suggesting that this was a critical time for the failure to develop in the plants being studied.

Project 5. Test tube cultures. (micropropagation) (D.E. Kester, Lea Tabachnik)

Procedure. Two kinds of plant material are being grown in artifical media in test tubes under sterile conditions. One kind includes small shoots established from a < 2 mm section of the shoot tip removed from inside a bud. Buds are sterilized, most of the bud scales removed and a short section of the shoot tip, about 1 mm long, is removed with a scalpel and placed on a medium of nutrient agar.

The second kind of material is a mass of almond tissue which grows as callus. Short (1 inch) sections of almond stem are sterilized and placed on nutrient agar. The mass of whitish cells that grows is the "tissue culture". To propagate the culture further, a small piece of the tissue of 50-100 mg weight is cut off and transferred into a tube of fresh culture medium. Cells divide and the new material grows in volume. Reculturing is done every 1-2 months depending on the conditions.

Results. This effort so far has been devoted to the development of procedures. Shoot tip culture is primarily a method of vegetative propagation in which the growing point of the bud is handled like a very small cutting. Most of the initial developmental work on shoot tip has been done with a peach-almond hybrid clone (PA 2-16-8-63) because it was more suitable than almond to learn procedures. However, by fall, the procedure was sufficiently successful, that studies of shoot tip cultures of almond were begun. We now have shoot tips of normal and BF plants started in culture.

The procedure involves 4 stages. First, the initial culture (explant) must be established free of contaminating microorganisms. We now have small shoots about an inch long. These do not have roots, but produce a swollen callus mass at their base which appears to act as an absorbing organ for water and other material from the medium. This first stage takes 4-6 weeks. The second stage, is to initiate multiple shoots so that many small plantlets are produced within a single culture tube. This can then be cut into sections to provide the amount of material that can be used for the experiments that we wish to do. We are now in this phase.

Project 5. (continued)

A third stage, would be to change the nutrient medium and cause roots to form. This step has been difficult to do for woody plants and would be necessary if propagation is planned. We do not think we need to reach this phase to do our experiments, but will continue such work as time permits.

The fourth stage, would be transplanting of rooted shoots from test tube to pots and eventually to the field.

Tissue cultures have been established from different clones of 'Nonpareil' with and without BF. Also cultures of some other varieties, species, and hybrids have been established for comparative studies.

A basic culture medium has been determined and some preliminary experiments have been started to determine how tissue cultures of these clones differ in growth and response to test conditions in high temperatures. However, it is too early to make generalizations.

Project 6. Inheritance of BF. (D.E. Kester, R.A. Asay)

Procedure. The transmission of a BF factor from specific almond varieties is being studied in seedling families of almond x peach hybrids. Pollen of peach Sel 4-6-9 is used to pollinate the almond. Seeds are collected in early July, stratified in glass flasks at low temperatures (36°F) for 1-2 months, then transferred to 50°F where germination occurs. As individual seeds sprout, they are removed and planted in the greenhouse. Plants are transplanted outdoors at Winters in March. Individual plants are examined for BF symptoms in the following spring. Plants are scheduled to be removed at that time or in some cases are grown for a second year.

Results. Progeny families are now being examined annually for BF symptoms. One group established in 1973 had been examined for 3 consecutive years, and was eliminated this year. Additional groups were planted in 1975 and 1976 and will be examined next spring. A new group of seedling families was produced this year and is now growing in containers to be planted in the spring (see Table 1).

So far, we have been able to produce BF offspring from any 'Nonpareil' plant tested as well as from a number of other varieties. A complete tabulation and analysis of results will await completion of examination of the present progenies.

Table 1. Crosses made in 1976 to produce hybrid progeny for BF transmissions studies.

Variety	Clone	Phenotype	Pollen source	No. of flowers	% set	No. of seeds to be planted
Nonpareil	3-8-1-63 WEO	BF+	40A-17 pch	748	22	100
↓	3-8-1-63 WEO	Normal	↓	1121	26	100
	3-8-1-63 Davis	Normal		834	11	85
	Wells, UCD	Normal		1628	15	100
	B-4, UCD	Normal		302	21	63
	B-6, UCD	Normal		452	13	51
	B-18, UCD	Normal		859	21	100
Mission (Texas)	3-6-3-67, UCD	Normal		1199	20	100
Sel 5A-3	UCD	Normal		1168	32	100
Vesta	UCD	Normal		867	25	100
Thompson	WEO	Normal		1316	5	40
Merced	WEO	BF		989	4	14
Milow	UCD	Normal		605	8	43
CP 5-33	WEO	Normal		1978	2	33
Sel 1-100	UCD	Normal		1731	<1	0
CP 5-58	WEO	Normal		827	2	22
Sel 3-24E	UCD	Normal		953	4	33
Sel 2-55	UCD	Normal		1466	<1	0
Sel 2-62	UCD	Normal		821	4	20
Sel 2-17	UCD	Normal	↓	948	6	38

Part II. Variety evaluation

Project 1. Evaluation for potential commercial, use breeding potential or research studies of unnamed almond selections originating from UC and USDA variety improvement programs.

Procedure. UC test plantings have been made since 1966 at Kearney Field Station (Fresno County), Department of Pomology orchards at Davis or Wolfskill Experimental Farm (Winters). Two or three trees have been planted/item. Rootstocks were 'Nemaguard' peach seedling at KFS and WEO, but at UCD almond seedling were used initially and later some 'Nemaguard' and 'Lovell'. Information has been obtained on bud density, time and amount of bloom, fruit set, tree growth characteristics, disease and insect susceptibility and ease of pruning. Data has been obtained on yield (where feasible), ripening, harvesting and hulling characteristics. Samples have been taken and measurements and ratings obtained for hull, shell and kernel characteristics on a 25 nut sample. Accumulated tree and nut data of approximately 100 selections and varieties was assembled and samples presented in May to a panel of the following people for evaluation:

Department of Pomology, UCD: D.E. Kester, R.A. Asay, J. Doyle
Ag. Ext. Service, UCD: M. Gerdts, W. Micke, D. Rough
USDA: D. Ramming, E. Soderstrom
Industry: D. Morrison (Almond Board)
S. Hendricks (CAGE)
B. Hoobler (California Almond Growers)

Material destined for possible release is being presented to FSPMS for virus indexing. The latter procedure involves a preliminary indexing test into 'Shirofugen' cherry of 4 week duration to detect Prunus ring spot virus (PRSV) and certain other virus diseases. Those negative for PRSV are submitted to be indexed on 6 other host plants to determine presence of other important viruses. This latter procedure requires 2 seasons to complete. Propagating material from trees that index virus negative are placed in the FSPMS Foundation orchard at UCD and eventually will serve as commercial propagation source trees.

Selections found positive for viruses are submitted to FSPMS for thermotherapy to remove viruses and then resubmitted to FSPMS for indexing and planting. The thermotherapy procedure involves subjecting small plants in containers to 100°F for five weeks, after which single buds are propagated.

Results. A summary of evaluation and the status of varieties is given in Table 2. One selection CP 5-58 was selected for early release. If the virus tests continue to be negative during 1977 and unforeseen problems do not arise, we anticipate that limited quantities of propagating material could be made available by Fall 1977 and possibly by June.

Project 2. Regional variety trials (RVT).

Procedure. Orchard plots have been established to test orchard performance of "clones" of old varieties, newer varieties and selections not yet introduced commercially. Each plot was established in conjunction with a local grower or organization who will have major management responsibilities. Each plot has 'Nonpareil', or 'Mission' as single rows alternately with test varieties which are the pollinizers. Virus tested varieties have been included as much as practical, but this was not always possible either because of lack of information or unsuitable material.

Results. The status of each of the plots is as follows:

Kern County. Warren Carter orchard, McFarland. Set up in conjunction with UC Agricultural Extension Service, Kern County (Ken Hench). Trees were propagated by Dave Wilson Nursery in 1973. First planting was made in summer 1974 with additional trees added later. Nemaguard rootstock has typical climate and soil in southern San Joaquin Valley. Includes a rootstock test.

Colusa County. Nickels Estate Research Farm, Arbuckle. Management through Colusa County UC Agricultural Extension Service (Tom Aldrich). First planting was made in Spring 1975 and a second will be made Spring 1977. Typical climate and soil of western Sacramento Valley. Includes tests of drip irrigation, pre-plant back hoeing and rootstocks. Trees were propagated by Fowler Nursery on Lovell peach rootstock.

Butte County. California State University at Chico Teaching Farm. In cooperation with Dr. Richard Baldie (CSU) and Clem Meith (UC Agricultural Extension Service). Planting was made in Spring 1976 and a second will be made in 1977. Trees were propagated by Sierra Gold Nursery on Lovell peach rootstock. Soil and climate is typical of northern San Joaquin Valley.

San Joaquin County. San Joaquin Delta College, Stockton, California. Will be located on Teaching Farm and will be established in cooperation with Gary Blomgren (SJDC) and Don Rough (San Joaquin County - UC Agricultural Extension Service). Planning is scheduled for Winter 1976-77, trees are to be propagated in 1977 and planting is scheduled for Spring 1978.

In each case, contributions in planning and development have been made by UC Agricultural Extension Specialists, Warren Micke and Marvin Gerdts. Also advice from local growers and industry personnel has been solicited.

Table 3 lists the varieties, clones, and selections that have been established to date. No data from these plantings is being presented as yet.

Project 3. Shell characteristics of almond as a factor in resistance to NOW.

Procedure. Nut collections to make a working sample of 25 nuts are routinely collected from selection blocks for examination (see Project 1, this report). Varieties are rated for type of shell (very hard, hard, semi-soft, soft and paper), shelling percentage, number of completely sealed, size of opening (if unsealed), and amount of outer shell absent.

The adaptation of the Seal Quality Meter (Fibre Board Corp.) to nut shell analysis by Dr. Ed Soderstrom in 1975 has provided a tool to measure more precisely the sealing qualities of almond shells on an individual nut basis.

A similar machine was obtained by us this summer and has been utilized in evaluating shell characteristics. A 7/32 in. hole is drilled into the side of an individual nut and some of the internal nut meat is removed with a needle.

Air is injected through this hole through a single needle inserted through a tapered rubber stopper which seals the hole. The amount of air escaping through openings in the shell can be measured. This is similar to the procedure used by Dr. Soderstrom.

Results and Discussions. Although the positive relationship between NOW susceptibility and softness and inadequate sealing properties of almond shells has been recognized (Crane and Sommer, Calif. Agric. 1971; Kester and Asay, Advances in Fruit Breeding 1975). The development of the Seal Quality Meter for this purpose, by Soderstrom (J. Econ. Entomol., in press) has provided an important quantitative tool for analyzing this property.

Comparison was made between the leakage values (cc/mim) obtained by Dr. Soderstrom for 85 variety samples in 1975 and the shell character ratings obtained by us in comparable nut samples. These included shelling %, numbers of sealed shells, size of opening, and no./oz.

Table 4. Comparison of cc/min data from Seal Quality Meter to other shell characteristics.

Soderstrom Data 1975

Range in cc/min	No. in group	No. with shelling %			No. sealed in 25		
		<50	50-60	>60	25	20-24	<20
100 or less	16[1]	7	5	2	10	6	
101 - 200	17	4	10	3	8	7	1
201 - 300	7[1]		4	2	0	1	6
301 - 400	10		4	6	2	2	6
401 - 500	10	1	7	2		2	8
501 - 600	7		5	2		1	6
601 - 700	10		3	7	1	0	9
701 - 800	8		2	6			6

[1] Some samples not cracked.

The results show that a relationship exists between the sealing properties as shown by cc/min leakage and shelling percentage and the no. of visibly unsealed shells. To demonstrate how closely the resistance of the nut to NOW infestation is related to the particular shell class as measured by the criteria in Table 4 is not the objective of research in this project. Our objectives will be to investigate how the shell properties differ as a function of genetic, environmental and management factors.

The program for 1976 was planned to gain experience with the seal tester as a routine phase of our variety testing, to examine the variability within and between samples, and to determine the effect on sealing properties of various factors that we have previously observed to affect shell character, including rootstock, nut size and tree vigor. Differences between varieties will be determined but we have not established how many samples will be measured.

Samples have been obtained and some data has been obtained, but because of incompleteness of our testing no 1976 data will be included in this report.

Project 4. Pollination studies.

Procedure. The ability of specific almond varieties to self-pollinate each other was tested in both field tests pollen applied by hand to emasculated blossoms and by laboratory tests where pistils were collected at specific times after pollination (either in the orchard or in the greenhouse) and the presence of the pollen tube determined by microscopic examination of the pistil. Details of this years procedures are as follows:

Orchard pollination tests. Flowers are emasculated in the "popcorn" stage by cutting away the petals. Pollen is collected by extracting anthers from unopened flowers, dried, stored in glass vials and then applied to the tip of the pistil (stigma) 1-4 days after emasculation. Counts of fruits setting are made at about 1 month and then about twice during the summer.

Greenhouse pollination tests. Branches with flowers in proper stage for emasculation were brought into 70-75°F greenhouse and placed in cans of water. Water was changed regularly. Flowers were emasculated and pollinated as in the field. Pistils were collected after 3 days, except in some time sequence studies, where daily samplings were made.

Pollen tube studies. Complete pistils were removed from the flower and placed in small vials in a solution of 5% sodium sulfite and autoclaved for 20 minutes at 250°F. This material was stored in a refrigerator until used. For examination, a single pistil was placed on a glass slide, the outer hairy layer of tissue pulled away by needles and discarded leaving a transparent soft core of tissue which contains the pollen tubes. Two examinations of procedures were used: (1) Lacmoid: a few drops of lacmoid blue[1] stain is placed on the pistil, allowed to soak for 4 minutes and then washed away with 30% alcohol which is then blotted away. A drop of water is added and a cover slip placed over the pistil and pushed down to flatten and spread the pistil. Examination is made through a light. Plugs of hard callose material in the tubes stain bright blue, but the tube is sometimes difficult to see. (2) Fluorescent light: the inner core of pistils is prepared as described above but then aniline blue[1] stain is applied. Examination is made with a fluorescing microscope using ultra violet light. The tubes and callose plugs show brilliant yellow on a dark background.

[1] Details of recipe can be provided.

Results. Table 5 shows the results of orchard tests and confirm previous data that Sel 2-55 is incompatible with 'Nonpareil', but is compatible with 'Mission'. Sel 2-62 is compatible with both. The tests further show that a new selection of 'Nonpareil' claimed to be self-fertile can neither be self-fertile or be a new "mutation" which could cross pollinate with 'Nonpareil'.

The other tests were made to study known self-fertile varieties. We have previously identified by hand pollination tests about 10 self-fertile selections from seedlings populations produced by crossing almonds and peaches and some other species. These have been used in breeding. Sel 56-98 is one of these. Rafael Socias, a recent graduate student studied pollen tube growth in these varieties after self- and cross-pollination and found that rate of tube growth depended on temperature and that the rate of growth after selfing was fast for some selections and slow for others (see literature cited). Griggs and Iwakiri (Calif. Agric., Vol. 29 #7, 1975) have also used this pollen tube technique to show that the time required for pollen to reach the base of pistils was slightly less for 'Mission' than for 'Nonpareil'.

These studies have significance in that it is assumed that the ability of the egg cell to be fertilized and produce the almond seed in a pollinated flower is directly related to: a) the length of time the egg cell is viable and b) the time required for the pollen to grow down to fertilize the egg. Thus rate of pollen tube growth can be directly correlated to final set.

This years work was intended to establish the relative difference in pollen tube growth of 11 new self-fertile selections (see Project 1) after self- and cross-pollination. Sixty pistil samples were collected, 20 of which were time-sequence studies. Because of lack of time and insufficient personnel only a small part of study is completed. On the basis of all of the preliminary data gotten so far we can list the following as regards self-compatibility.

Group I. Completely self-incompatible. 'Mission', 'Nonpareil', 'Ne Plus Ultra', Sel 2-55, Sel 2-17, 'Jeffrey Nonpareil', 'Tardy Nonpareil'. However, some show more pollen tube growth after selfing than others.

Group II. Partially self-compatible. Pollen tubes grow slower after selfing than after crossing. In an orchard these varieties would probably benefit from cross-pollination even though some selfing occurred. Sel 36-51, Sel 36-52, Sel 44-63, Sel 45-8.

Group III. Seemingly highly self-fertile with rapid tube growth upon selfing. Sel 56-98, Sel 37-9, Sel 44-7.

Methodology. We are particularly interested in developing the fluorescent technique as a rapid screening method for pollen tube examination. The very limited work done to date shows potential advantages in that tubes stand out brilliantly yellow on a black background. We are interested not only for its use in variety studies under controlled conditions as described above, but as a tool for monitoring pollination under orchard conditions. This should be useful in studying pollination affectiveness.

Table 2. Inventory of UC-USDA almond selections being tested in final stages.

NAME	CHARACTERISTICS	STATUS
Group 1.	UC-USDA material originated before 1951	
CP 5-58	'Mission x Swanson'. Mission type in tree, bloom, harvesting and nut character. Very easy to harvest. Highest yielding. Use as pollinizer of 'Mission'.	Indexing tests to be completed Summer 1977. Scheduled for early release.
5A-3	(Complex pedigree of 'Nonpareil' and 'Eureka') 'Nonpareil' type. Pollinizer of 'Nonpareil'.	Indexing and variety verification completed in FSPMS. Will await results of RVT tests.
5A-20	(Complex pedigree of 'Nonpareil' and 'Eureka') 'Jordanolo' market type. Has poor shell and some production problems.	Since growing in RVT plots, it will remain under observation. But considered to have many disadvantages.
Group 2.	UC selections since 1951	
3-24E	(Complicated crosses involving 'Nonpareil', 'Eureka', 'Harriott', 'Sans Faute' and 'Arbuckle') Late bloom, very high producing; plump kernel.	PRSV pos. and is undergoing thermotherapy. Further tests must wait.
3-63E	(Same as 3-24E) 'Nonpareil' bloom, heavy production. California type.	Indexing started in 1976. Will be tested in RVT plots.
1-46	('Nonpareil' x 'Mission') High yielding; relatively good shell, easy harvest. California type.	Indexing started in 1976. Will be planted in RVT plots.
1-69	('Mission' x 'Milow' [12-38]) High yielding, easy harvest, relatively good shell. California type.	Indexing started in 1976. Will be planted in RVT plots.
2-62	('Thompson' x 'Tardy Nonpareil') Yield tends to be good, kernel and shell.	Indexing started in 1975. To go into RVT plots.
2-13	('Tardy Nonpareil' x 'Thompson') Good yield kernel, and tree. Shell tends to be poor.	Indexing started in 1976. To go to RVT plots.
13-1	('Peerless' x 'Harriott') x ('Nonpareil x 'Jordanolo') Long, narrow kernel, shell fair, high yielding.	Was PRSV positive. Is being heat-treated.
3-5W	('Nonpareil' x Prunus fenzliana) OP. Small, (30-40/0Z), high yielding, possible harvest and pruning problems, good shell.	Virus test started 1975. Will go into RVT plots.

Table 2. (continued)

37-9	(Complicated 'Nonpareil', 'Eureka' 'Harriott', 'Sans Faute' and peach progeny) Apparently highly self-fertile. High yield, small, flat round kernel. Fair shell.	Need to get more performance and yield data in selection blocks.

Several other unnamed selections are being examined but we do not have enough performance data in selection blocks to present detailed discussion.

Group 3. USDA selections since 1971

K13N	'Nonpareil' type.	Has been planted in RVT. Submitted for indexing 1975.
K16-14	Good yielding, good shell.	Submitted for indexing 1976, to go into RVT plots.
24-5Z	Good yield, 'Mission' type, hard shell; compatible with 'Marianna' 2624.	Submitted for indexing 1975. Will go into RVT plots.

Several other selections were made but insufficient performance data is present. Submitted for indexing in 1976. Will go into RVT.

Table 3. Inventory of almond material planted in Regional Variety Trial (RVT) orchards: kind and number of plants.

Almond Material	Source	Location of plots: Kern County	Colusa County	Butte County
Group A. "Clones" and selections of standard varieties				
Nonpareil	FSPMS 3-8-2-70	26	60	250
	" 3-8-4-72		45	100
	" 3-8-5-72		55	99
	" 3-8-6-72		-	-
	" 3-8-7-72		45	96
	" 3-8-8-72		-	22
	" 3-8-9-72		-	22
	" 3-8-10-72		-	22
	" 3-8-11-72		-	22
	Commercial	390 D.W.N. (1)	many (F.N.)	-
Mission	FSPMS 3-6-1-65	52	30	88
	" 3-6-2-71	26	25	86
	" 3-6-5-67	26	30	69
	Commercial	78 D.W.N.	many (F.N.)	
Ne Plus Ultra	FSPMS 3-7-1-63	26	15	40
	" 3-7-2-72	-	15	-
	Commercial	26 B.N.	many (F.N.)	-
Peerless	FSPMS 3-10-1-63	-	20	-
	" 3-10-2-70	-	20	-
Jordanolo	" 3-3-1-70	26	20	20
	Commercial	26 D.W.N.	-	-
Thompson	FSPMS 3-11-1-72	-	15	32
	Commercial	many D.W.N.	-	-
Group B. Name varieties				
Butte	F.N. (Pat)	26	15	25
Carmel	B.N. (Pat)			22
Carrion	B.N. (Pat)			33
Fritz	B.N. (Pat)			30
Granada	S.G.N. (Pat)			23
Harvey	F.N. (Pat)			25
Merced			-	21
Money tree	F.W. (Pat)		15	-
Norman	F.N. (Pat)			26
Price	F.N. (Pat)			25
Robson	S.J.T. (Pat)			26
Vesta	FSPMS 3-26-1-72			23
Ripon	B.N. (Pat)		-	31
Ruby			-	-
Jeffries	(Pat)		-	-

Table 3. (continued)

Group C. Numbered selections from UC and/or USDA programs

5A-3	UC-USDA	26	15	22
5A-20	" "	26	15	21
CP 5-58	" "	26	15	63
12-38 (Milow)	UC	13	15	24
" /PA	"	13	-	-
3-63E	"	26	15	22
3-24E	"	26	-	-
2-17	"	26	-	-
3-5W	"	-	15	22
1-46	"	26	↓	↓
1-69	"	26		
2-62	"	26		
2-13	"	-		
K16-14	USDA	26		
K7-10	"	26	-	-
23-5.16-40B	"	-	15	22
24-5Z	"	-	↓	↓
79-49	"	-		
88-55	"	-		
88-66	"	-		
23-122	"	26		26
K13N	"	26		27
69-60	"	↓	↓	24
2-55	UC		-	-

(1) B.N. - Burchell Nursery
F.N. - Fowler Nursery
S.G.N. - Sierra Gold Nursery
S.J.T. - S.J. Toy, Chico
F.W. - Fred Wells, Chico

Table 5. Crosses made in 1976 to determine cross-compatibility and self-fertility in almond varieties. Orchard tests.

Purpose	Seed Parent		Pollen Parent	No. of flowers	% Set
To test cross-compatibility	Nonpareil	x	Sel 2-55	283	1
		x	Sel 2-62	280	25
		x	Self	300 (?)	1
	Mission (Texas)	x	Sel 2-55	136	24
		x	Sel 2-62	184	42
	Tardy	x	Nonpareil	221	0
	Nonpareil	x	SF (?) Jeffries Nonpareil	155	0
		x	Mission	156	15
To test self-fertility	Sel 56-98 (1)	x	Self a)	269	19
	Sel 56-98	x	b)	70	26
	Sel 56-98	x	Ne Plus Ultra a)	268	15
		x	Ne Plus Ultra b)	107	26
	Ne Plus Ultra	x	Self	310	2
	Ne Plus Ultra	x	56-98	277	15

Table 6. Growth of pollen tubes in styles of almond varieties after self- and cross pollination in the greenhouse.

Seed parent		Pollen parent	Rep.	No. of pollen grains on tip	Number of tubes observed in: Upper 1/3	Middle 1/3	Lower 1/3
A. Pollen tube tests with known self-incompatible varieties							
Mission	x	Self	a	5	12	0	0
			b	2	0	0	0
"	x	Nonpareil	a	20	0	8	2
			b	25	6	3	3
Sel 2-55	x	Self	a	5	9	3	0
			b	2	8	3	0
"	x	Nonpareil	a	16	5	2	0
			b	9	2	2	2
Sel 2-17	x	Self	a	10	9	1	0
			b	16	12	3	0
"	x	Nonpareil	a	0	0	0	0
			b	36	10	2	6
			c	4	5	2	0
B. Pollen tube tests with previously identified self-fertile varieties							
56-98	x	Self	a	yes	many	7	3
			b	yes	4	4	5
"	x	NPU	a	yes	20	12	0
			b	1	1	2	1
Ne Plus Ultra (greenhouse)	x	Self	a	yes	3	0	0
"	x	56-98	a	many	many	7	3
			b	?	1	8	0
Ne Plus Ultra (orchard)	x	Self	a	0	0	0	0
			b	0	0	0	0
"	x	56-98	a	0	0	0	0
			b	1	0	0	0
Sel 36-51	x	Self	a	12	5	2	0
			b	8	2	2	1
"	x	Nonpareil	a	4	6	7	4
			b	8	12	7	5
Sel 36-52	x	Self	a	0	0	0	0
			b	2	2	0	0
"	x	Nonpareil	a	0	0	3	4
			b	6	8	6	4
Sel 37-9	x	Self	a	4	6	3	11
			b	0	0	0	0
			c	4	3	1	3
"	x	Nonpareil	a	1	2	1	5
			b	0	0	0	0
Sel 44-63	x	Self	a	15	7	6	0
			b	10	7	6	0
"	x	Nonpareil	a	6	4	4	2
			b	5	9	4	1
			c	15	14	5	1
Sel 44-7	x	Self	a	0	8	6	3
			b	0	7	6	3
Sel 45-8	x	Self		2	3	5	0

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