Project No. 80-K7
(Continuation of Project No. 79-M6)

Cooperator:
University of California
Department of Pomology
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Davis, California 95616

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Project: Tree and Crop Research
Part 1 - Non-infectious Bud Failure
Part 2 - Variety Evaluation

Part 1 - Non-infectious Bud Failure (BF)

Objectives: (1) To modify BF-expression in orchards; (2) to identify BF-resistant plants in BF-susceptible varieties; (3) to develop BF-immune varieties.

Progress: Two concepts are involved relative to BF. One is the concept of a "clone", initiated either from a single plant of a seedling population (as in breeding programs) or from a single plant within a vegetative propagated variety (as in propagation programs). The other concept involves classes of clones relative to uniformity and stability. In terms of the BF phenomenon, the following classes are used:

I. No BF symptoms in source tree or its vegetative progeny.

II. No BF symptoms in source tree, but may appear with time in vegetative progeny.

III. BF symptoms in source tree and in vegetative progeny.

This scheme could apply to any kind of variability within a variety. Nonpareil clones representing all three classes have been identified and are being used in research to investigate physiological differences among plants of the three classes and the processes that are involved in the development of Class II and Class III clones. It is now hypothesized that there is a loss of a hormonal function that involves increased susceptibility to heat damage as well as producing other physiological effects.

Vegetative progeny tests of specific clones in the field have not only shown differences in their BF potentiality but comparative yielding potential for possible commercial use.

Seedling progeny tests with both almond X almond and almond X peach have shown inheritance patterns of BF. Progeny have been produced pointing towards "screening out" of BF and incorporation "resistance" with specific other characteristics particularly involving n.o.w. resistance due to thin stone shell character, self-fertility, and tree stature (genetic dwarfs and semi-dwarfs).

Plans: (1) To conduct vegetative progeny tests utilizing shoot-tip cultures in test tubes to compare time-temperature requirements for clones of different BF classes established through orchard tests. This procedure can also be applied to testing a wide range of susceptibilities, to various environmental and pathologic agents under precise controls. Two applications of immediate possibility would be sensitivity to herbicides and sensitivity to the toxin for the leaf scorch organism; (2) to compare clones biochemically utilizing specific marker tests (with Dr. A. Kuniyuki) and physiologically utilizing a variety of techniques involving heat stress (graduate student); (3) to compare clones at the cellular level utilizing tissue and cell cultures to establish a mechanism for difference (graduate student); (4) to continue inheritance studies in progress but include tests of measuring BF sensitivity of seedling offspring in test tubes immediately on germination.

Part 2 - Variety Evaluation

Objectives: (1) To complete development of a selection index by which the almond industry can systematically evaluate the current array of available almond varieties; (2) to obtain and evaluate quantitative data from Regional Variety Test Plots to be used to evaluate yield, performance and nut characteristics of the varieties therein; (3) to establish the feasibility of translating yield differences among varieties and seasons into yield components of tree growth, nut number and size and to relate these to environmental effects on them, directed toward the eventual development of a computer model for almond tree growth and yield forecasting.

Progress: In 1978, acreages of 36 varieties of almond were reported with nonbearing acreages of 26 of these. Most of these are relatively new and pose not only potential good for almond improvement but also potential problems either in the orchard or the marketplace. Considering the past history of almond variety development, the risk of the latter is great.

A Variety Evaluation Schedule developed in 1979 provides for establishing selection indices for:

A. Tree characteristics

B. Tree resistances

C. Nut characteristics - raw product

D. Nut characteristics - processed product

This scheme has been used to evaluate six of the newer leading commercial varieties along with five "standard" varieties.

Regional Variety Test Plots have been established beginning 1974 and data on yield, performance and nut characteristics of a range of almond varieties is beginning to accumulate. Nut samples are available which can allow the comparison of different varieties in terms of nut size, and quality, both raw and processed grown under the same environmental and production system. Likewise it is possible to compare the same variety produced in different locations.

Analysis of yield differences among varieties, locations and seasons so far shows that these can be translated into nut size and number and related to tree size, bearing habit, cross-pollination relationships and environmental conditions at critical times of the season, particularly during bloom.

Plans: (1) To distribute Almond Variety Evaluation Schedule, followed by Analysis of Eleven Varieties. During 1980, review usage and revise as needed but finalize at end of 1980 season for permanent publication; (2) to instigate systematic data collection precedures for Regional Variety Plots for yield collection, bloom opening maturity, etc. Compare to weather data. Relate maturity curves to n.o.w. computer model; (3) developmental and yield studies will be programmed eight years from planting per plot or given variety. This breaks down into: First, second, third year developmental stages for growth and training; fourth, fifth years for early yield development, and sixth, seventh, eighth years for "full bearing". Consideration of a given variety could be suspended at any time, if appropriate; (4) to investigate alternate methods for yield estimation based on branch counts, growth habits, etc.; (5) to collect nut samples of varieties at different plots, bring to UCD for size and quality evaluation and use to provide kernel samples for comparative blanching and roasting tests; (6) to collect samples and orchard information data on varieties not currently in bearing in plots, analyze in same manner as in item 5. Utilize data to develop selection indices. Anticipate a concerted effort of two years with growers, handlers, nurserymen, farm advisors, and other industry members, to provide a comparative comprehensive evaluation picture for current and projected varieties in California; (7) to develop a computer system of data storage, retrieval and analysis which can lead to the development of a computer model for almond growth, production and yield forecasting.

Almond Industry Participation

Part 1		$16,500
Part 2 - Variety Evaluation	10,000	
Trees - CSU Fresno	4,500	14,500
		$31,000

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COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION
DEPARTMENT OF POMOLOGY

DAVIS, CALIFORNIA 95616

January 15, 1981

Mr. Dale Morrison
Almond Board of California
P. O. Box 15920
Sacramento, California 95813

Dear Mr. Morrison:

Enclosed you will find my annual report for 1980-81.

Sincerely,

Dale

Dale E. Kester
Professor of Pomology

DEK/kc

Enclosure

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Enclosure

Annual Report

Almond Board of California

Project 80-K-7
Tree Research. A. Noninfectious Bud failure
B. Variety Evaluation

Reported by: D. E. Kester
Department of Pomology
University of California
Davis, California 95616

Collaborators include:
Cooperative Extension: W. Micke, M. Viveros, T. Aldrich, D. Rough, J. Connell
Pomology: R. Asay, L. Liu, L. Fenton, M. Aduib
Other: R. Baldie (CSUC), G. Blomgren (Delta), A. Hewitt (CSUF)

A. Noninfectious Bud-Failure

Objectives:

Overall: a) to modify our control BF-expression in orchards, b) to identify BF resistant clones in BF-susceptible varieties and, c) to develop BF-immune varieties. Specifically, this year our objectives are:

1. To establish "genetic indexing" procedures to identify clones and varieties resistant to BF utilizing vegetative progeny tests and seedling progeny tests supplemented by physiological studies.

2. To continue breeding studies pointed toward combining BF resistance with other characteristics as NOW resistance, self-fertility and productivity.

Interpretive Summary:

I. Non-infectious bud-failure.

A. Physiology.

Seasonal cycle studies of excised vegetative shoots are continuing to show that the critical factor in the development of symptoms is the plants response to high temperature in mid-summer. A plant normally stops growing and goes dormant apparently due to production of growth inhibiting substances. In the BF plant we are getting preliminary evidence that a toxic substance is being produced instead that injures the vegetative growing point and delays the initiation of the rest period in the fall. We are investigating now the identity of the hypothesized toxic substance. Differences in varieties and differences in locations can be associated with the total amount of heat accumulation which would correlate to the production of such substances.

B. Selection within varieties.

Tests in progress since early 1970's have shown that differences among propagation source materials in respect to BF can be shown within a relatively few years if the progeny trees are grown in an appropriate environment where high summer temperatures occur. A longer term test in western Kern County using randomly selected bud-sticks from normal trees and orchards in Manteca area and Wasco is showing a gradual increase year by year in trees with identifiable BF. The rates are low (about 1% per year so far) but indicate that production of BF trees may occur continuously. The number produced from Wasco source trees is significantly greater than from Manteca source trees.

Nine clones of 'Nonpareil' being tested in the RVT plots have remained free of BF but trees of 'Merced' (Kern County) and 'Harvey' have not (Kern, Fresno and Colusa County). BF is continuing to occur sporadically in various 'Carmel' orchards primarily in middle to southern San Joaquin Valley in orchards five or more years old. The pattern is similar to what had been seen in early days with Merced and appears to be part of the general pattern that the industry must expect to occur with many if not all varieties that come into the picture.

C. Inheritance.

Test crosses of different almond varieties in F_1 almond x peach crosses are confirming earlier results that show a BF factor segregates from various almond varieties. Further, the expression of these BF offspring is only occurring in those progenies involving early blooming varieties. These findings point towards methods of breeding to eliminate BF sensitive varieties which we are now ready to test.

B. Variety Evaluation

Objectives:

1. To complete development of a selection index by which the almond industry can systematically evaluate the current array of available almond varieties.

2. To obtain and evaluate quantitative data from Regional Variety Test Plots to be used to evaluate yield, performance and nut characteristics of the varieties therein.

3. To establish the feasibility of translating yield differences among varieties and seasons into yield components of tree growth, nut number and size and to relate these to environmental effects on them, directed toward the eventual development of a computer model for almond tree growth and yield forecasting.

Interpretive Summary:

A. RVT test plots.

Data on yield and various other parameters were obtained this year on three plots (see attached) at McFarland (Kern County), Arbuckle (Colusa County), Durham (Butte County) and to a limited amount of Manteca (San Joaquin County). A fifth plot is being established this winter at Fresno with CSUF (Dr. Allan Hewitt).

Differences are appearing in yield and performance, among varieties, among plots and among years. For any one year the analysis of the climatic pattern, particularly that occurring during bloom, is critical in interpreting results. This year the rainy, poor pollinating conditions during Nonpareil and early bloom time had a strong inhibiting effect on yield. Later blooming varieties yielded better.

Differences among varieties is also a function of nut size (weight). For this reason we have presented data as number of nuts/tree which is then translated into number of lbs./tree. Yield data is presented only as a preliminary report of the total data that we are obtaining.

Using a selection index involving 40 characters weighted to reflect relative significance we have analyzed 11 varieties of almond which are currently being grown. Five of these - Nonpareil, Mission, NePlus Ultra, Peerless and Merced are used as standards. Six others, which are varieties where considerable industry experience is available, include Butte, Carmel, Fritz, Price, Ruby and Thompson. These are not presented as recommendations for use but as a first phase of a process whereby others with be evaluated as data is obtained. This information was published in California Agriculture, October 1980.

The evaluation schedule has been prepared and exists in mimeograph form. Further work was done to determine pollination groups and results are being tabulated.

Tree Research A. Noninfectious bud-failure

Subproject 1. Physiology of bud-failure.

Expt. 1 and 2. Seasonal bud development in BF and normal buds and effect of location and irrigation on bud-failure symptoms.

Procedure:

Same general procedures were used as described previously and involves shoot collections, forcing in growth chambers and analysis of buds for shoot tip necrosis. During 1980 summer and fall samples have been collected of buds and leaves for hormone analysis. Soil moisture levels have been analyzed with Neutron probes.

Results:

Three years date have been obtained on seasonal patterns of bud-failure symptom development. A general description of these results is as follows:

In both normal and BF plants, the growing points change to buds with scales about late May, June and early July. In July and August flowers begin to differentiate although one can't actually see the flower parts develop until September and later. Flower buds are not affected in BF plants and on per-shoot basis show about the same density in normal and BF plants. Shoot buds in normal plants gradually become more and more dormant in a continuous change from August, September into November but the pattern differed between Davis (cooler) and Winters (hotter), and somewhat among years and treatments. This change was shown in rate of sprouting not in % sprouting. Approximately 50% of buds were able to sprout all through the season, the remainder being mostly flower buds. Buds on BF plants began to show internal necrosis at various times during the summer and fall and seemed to increase gradually with time. The number affected differed between Davis and Winters and between irrigated and nonirrigated. In 1979, with a very long hot summer, the development of BF buds did not begin until September and October in well irrigated trees at Winters but developed in July and later in nonirrigated trees. However, the final % of BF buds was actually less in the latter group. A notable feature of all these studies was that in late July and August when plants are exposed to the highest temperature, the buds on the BF plant show more active growth response in the Petri dish tests than do the buds from the normal plant which begins to show the development of dormancy. In 1979, this lack of dormancy resulted in a delay in the induction of an apparent "rest" condition by November and December such that the BF plant could well have shown effects of lack of chilling the next spring. Main conclusion we have made are that (1) the normal almond plant has a mechanism for resisting heat that involves a dormancy response which the BF plant lacks. (2) This response does not involve a direct injury but results from the gradual accumulation of a toxic substance which is associated with total exposure to heat. We are now examining extracts of these buds to attempt to identify such substances. Preliminary evidence suggests this may be a cyanide containing compound and that resistance is associated with high inhibition (abscisic acid) levels. We will be looking to the leaves as being the controlling factor of these enzymatic reactions.

Expt. 3. Effect of sprinkling on BF trees.

Procedure:

Mature trees were subjected to overhead sprinkling during June, July and August at West Side Field Station (WSFS) in 1979. In 1980, a small block of trees in an orchard in Kern County were sprinkled and others were sprayed with a foam material. Shoot samples were collected in August, September and December and Petri dish tests carried out. December samples were analyzed for BF symptoms.

Results:

Examination of WSFS trees in spring 1980 could show no particular benefit to the trees in alleviating BF. The severe leaf burn in 1979 did not seem to affect bloom or set particularly the next spring.

Data from the Kern tests are not clear cut but show some trends. Buds on BF branches collected in early August showed greater growth activity and a lower dormancy level than those from normal trees similar to that shown by our other tests at Davis and Winters. There was lesser numbers of BF buds on the branch samples taken from sprinkled and sprayed trees than the BF check but the difference was not quite significant at 5% level. Slightly greater flower buds/shoot occurred with sprayed and sprinkled branches but the differences were not significant.

Expt. 4. Tissue and bud culture.

Procedure:

Details of this procedure has been described before. Briefly it consists of removing pieces of stem or the growing point of a bud and establishing it in aseptic culture in a test tube where it is supplied with nutrients.

Results:

As reported previously studies of almond callus in culture have shown differences between the normal and BF condition. Primarily the BF callus tends to grow more rapidly time over than from the normal plant. Lou Fenton, graduate student, has succeeded in growing suspensions of almond cells from BF callus in continuous culture and is now trying to grow cells of the "normal" plant. When this is accomplished he plans to study how temperature affects the growth of these materials and what differences in biochemistry occur.

Shoot tip from seedling plants of almond have been established on a continuous growth basis but we have had difficulty to establish growing shoots of Nonpareil continuously in culture. However, methods have been relatively successful with a peach x almond hybrid clone and we hope to establish procedures with this more favorable material.

Subproject B. Selection within varieties.

Expt. 5. Relative rate of BF development within clones

Procedure:

Trees originating from separate clones and nursery sources were planted at WSFS (Fresno County) in 1971 and 1972. These have been examined each spring for BF symptoms.

Results:

Differences among source material began to appear after the first year but the % has leveled off at 3-5 years from the date of planting. No further difference has occurred in the 8 and 9 years of growth.

Expt. 6. Long-term development of BF in Nonpareil.

Procedure:

Collections were made of bud sticks from orchards in Manteca and Wasco areas. All trees were normal and were about 10 years old. Nursery trees propagated from them were planted in a commercial orchard in western Kern County in 1972. Trees have been examined for BF symptoms each spring.

Results:

BF trees are appearing at a slow but continuous rate from all the separate nursery source materials represented. The rate is about 1% per year and the overall amount is about 6%. There are significantly more trees appearing from the Wasco collection than from the Manteca collection.

Expt. 7. Selection within varieties.

Procedure:

Clones of Nonpareil have been selected in the past from single tree sources, tested for virus and maintained in Foundation Orchard at UC Davis. Tree from these have been propagated and grown at WSFS (Fresno County) since 1972 (see Expt. 2) and in the various RVT plots.

Results:

No BF trees have appeared in any of the nine clones of Nonpareil now being tested.

BF is now appearing significantly in Carmel orchards in the San Joaquin Valley. These are mostly in trees 5 years old or more. Some younger trees have also be reported.

Harvey trees in the Colusa and Kern County plots have now begun to show BF as have trees in WSFS variety/rootstock plot. In the latter there is a close association with the north and east exposed rows.

Subproject C. Inheritance.

Expt. 8. Inheritance of BF in almond x peach hybrid population.

Procedure:

These have been described previously and preliminary reports given. Basically the procedure involves making a cross of various almond varieties with 2 specific peach varieties we have used as parents an early blooming, low chilling peach 40A-17 and a late blooming, high chilling variety - J. H. Hale.

Results:

Two basic results alluded to previously have been confirmed by the 2nd year results obtained last spring.

1. One is that the BF character is transmitted from Nonpareil in approxmiately a 1:1 ratio with half of the offspring apparently free of BF. The half with BF appears whether the Nonpareil has BF or not. However, the severity of the BF condition is greater if the parent Nonpareil tree does have BF. Associating this result with our results of the physiology studies, we believe this means that the almond has a unique mechanism that involves its response to heat which is different than in peach (or peach does not possess). We further believe this provides a procedure for "breeding out" the BF system. Plans are being made to follow up this idea by producing F_2 populations among these normal peach x almond hybrids.

2. The second result is that no BF offspring has appeared when the late blooming J. H. Hale was used as a parent and the offspring were all late blooming. Further we can now associate the sensitivity of some varieties to BF with their relative bloom time and with the physiological results in subproject A. Consequently this provides another mechanism by which late bloom and high chilling will be examined as a guide to selection for freedom from BF.

Further crosses have been made to test this idea and results may begin to appear by next spring.

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Tree Research B. Variety Evaluation

Subproject 1. RVT plots.

Procedure:

Has been described previously in some detail. Briefly involves . planting of alternate rows of test varieties with a pollinizing variety, growing trees in groups representing early bloom (with NePlus Ultra), mid bloom (Nonpareil) or late bloom (Mission). Yield data is obtained by (a) harvesting entire row of trees of 1 variety, getting a gross weight of total, (b) collecting nut samples of 4 lbs., (c) counting nuts per sample (d) obtaining average weights of hulls, nuts and kernels. By this system one can calculate yield on a basis of number of nuts, per tree weight and per acre weight. In addition nut shape and quality ratings are obtained. Weather data has been obtained during bloom. Estimates of bloom openings and hull split and nut maturity have been obtained. In the Arbuckle plot, a team headed by Dr. Beth Teviotdale and Dr. William Moller measured comparative brown rot susceptibility.

Results:

Yield data for the 3 plots, Kern County, Colusa County and Butte County are shown in accompanying tables. Interpreting yield for any one year and location is not as easy as it might appear. First, one must consider the total tree size and number (density) of flowers. Secondly, one must consider the % set, as determined by such factors as weather during bloom, the relative bloom opening patterns and inherent capacity to set. Thirdly, one must consider losses of nuts (after blossoming) due to natural drop, disease, NOW, etc. Fourth, one must consider the relative nut size and number.

Size vs number. Varieties are compared in the three tables in order of nut number as being the most meaningful basis for comparing productivity. Comparing the 3 plots, the Kern plot yielded about 2X that of the Butte plot and about 4X that of Colusa. In part this reflects age of plot, in part the relative production potential of the location and in part the weather conditions during bloom.

In general rainy and cool weather existed in the early blooming period and extended through Nonpareil bloom time. Warm dry weather developed after Nonpareil.

Average kernel weight was also important. Overall kernel size in the Kern plot tended to be small. This reflects in part the high nut yields and this factor can be seen in the inverse correlation shown in comparing kernel size and number among the various Nonpareil clones. Also it may reflect some effects of tree stress but it also may be an area effect that needs to be explored.

Larger sizes were shown in both Colusa and Butte. This in part reflects reduced yields. Also size in the Butte plot appears to be a direct effect of young tree age (5th growing season) and higher vigor relative to production.

Early blooming varieties.

(1.) NePlus Ultra, along with other early blooming varieties, showed low kernel numbers but the large size increased tonnage significantly. Two separate clones of the NePlus Ultra yielded essentially the same. (2.) Jordanolo only yielded moderately but, the very large kernel size compensated. Nut quality was very poor with severe creases, callus growth, pubesence, high worm count, etc. No BF trees have developed on this clone.

(3.) Moneytree has a kind of abnormality that shows variable nonproductivity, although overall yield in Kern was as good as others of the early blooming group. Leaf symptom of calico virus are found in the Colusa trees and are believed to be the cause of abnormality. (4.) 5A-20 is an early blooming, large kernel, high quality, more or less Nonpareil type, poor shelled variety that yielded very well last year but was disappointing this year. Bloom time during rain may have obscured true picture. (5.) Peerless yielded as well as any of this early bloom group but was only in the Colusa plot.

Mid blooming group.

(6.) Nonpareil is the basic variety of this group in yield and quality. In Kern, it paralleled Fritz and Carmel as being highest yield, (1 ton per acre) of group because of combination of nut number and kernel size. In Colusa and Butte plots, Nonpareil showed less production but was essentially in the range with Price and Carmel as being some of best of bloom group. Five clones of Nonpareil (2-70, 4-72, 5-72, 6-72 and 12-72) showed equally good yields at Kern, 3 others (8-72, 9-72 and 10-72) showed no significant difference among them. No BF trees have occurred in any of these Nonpareils.

(7.) Norman, blooming slightly later, showed highest nut number in all plots but small size reduced yield somewhat. (8.) Carmel produced equally well with Nonpareil but in Colusa plot produced significant brown rot. (9.) Price produced less in Kern plot but may have been subject to inadequate pollination. At Colusa and Butte plots, it paralleled Nonpareil. (10.) Harvey produced equally well to Nonpareil in all plots this year. Kernel size tended to be less and reduced yield slightly. BF is appearing on Harvey trees at Colusa and Kern but the effect is slight so far. This variety was most severely affected with brown rot. Trees in Colusa plot showed minor leaf symptoms of calico virus. It had one of the most significant NoW counts, an apparent reflection of the thin, poorly sealed shell. (11.) Fritz tended to bloom earlier than expected in all plots since it was planted with Mission. Despite this, it had fairly good yield. Its kernel quality rating was down but it showed low worm count. Late maturity (after Mission) has present. (12.) Merced yield was on medium to low side in both Kern and Butte plots, BF is appearing in Merced trees at Kern but not in Butte. (13.) Granada had a good yield in Kern but less in Colusa and Butte plots. Its poor quality rating and questional market outlet is against this variety. (14.) Robson did not produce well in any of the 3 plots and it shows relatively low quality ratings. Likewise, (15.) Vesta, (16.) 5A-3 and, (17.) Milow did not produce well this year but the bloom time and accompanying poor weather has obscured differences. Milow's earlier than expected bloom has apparently been an adverse factor when planted with Nonpareil. (18.) A numbered selection 23-122 did well in Colusa and Butte plots but has done poorly in Kern.

Late blooming varieties.

(19.) Mission is the basic variety of this group and among the highest producing varieties of all 3 plots. Three separate clones of Mission are represented and all show consistent high yield and typical small, hardshelled kernel types among all the trees grown.

(20.) Butte was consistantly the highest yielding in nut number but it has a somewhat small size. Shells are relatively hard. (21.) Thompson was the highest yielding of all varieties at Kern and equalled Mission at Colusa. It is not present in Butte plot. (22.) Ruby performed equally well as Mission in the Kern plot but is missing from the others. (23.) Carrion is a late blooming variety planted in the plots with Mission but bloomed this year slightly after Nonpareil. It yielded very well in the Kern plot but considerably less at Colusa and Butte plots. Leaf symptoms of calico virus are present in the trees of these two plots. Unfavorable weather at bloom may obscure yield potential. Kernel quality factors were favorable. (24.) Ripon has consistently been yielding poorly as compared to others.

1980 CROP

Kern RVT Plot
McFarland, California
1974 Planting

Variety	# Nuts /Tree	Average Size #/oz.	Yield tree lbs.	Yield acre (1) lbs.	Shelling %	% Sealed	% NOW	Bloom (2)
A. Early Blooming Varieties								
Money tree (5)	7344	20	23.4	1756	64	20	0	2/18
Ne Plus Ultra .	6518	20	20.6	1545	55	68	0	2/15
Jordanolo	6492	17	23.7	1779	60	52	0	2/12
Ne Plus Ultra	5841	20	18.6	1396	58	74	0	2/15
Jordanolo	5520	16	22.2	1665	65	42	0	2/12
B. Nonpareil Bloom								
Norman	12,375	31	24.8	1860	65	62	0	2/25
Fritz	11,974	27	28.1	2108	53	96	0	2/20
Granada	11,940	33	22.6	1695	60	74	0	2/25
Carmel	11,041	26	26.5	1988	60	94	0	2/25
Nonpareil (3)	10,032	24	27.3	2069	63	25	0	2/24
Harvey	9590	30	20.4	1531	66	78	0	2/26
Milo/PA	9356	31	18.9	1418	67	80	4	2/23
69-60	8009	29	17.7	1328	55	98	0	2/24
2-17	7970	27	18.5	1388	53	96	0	2/26
Merced	7900	25	20.1	1508	66	90	0	2/25
Price	7691	28	17.4	1305	62	50	0	2/23
Robson	7676	24	20.5	1538	59	74	2	2/24
Milow/Nem	7508	31	15.0	1125	69	56	0	2/23
5A-3	7492	26	18.6	1395	65	12	2	2/23
Vesta	5919	27	14.3	1073	51	50	0	2/24
23-122	5253	29	11.4	840	49	100	0	2/23
5A-20(4)	4984	18	17.2	1291	73	18	0	2/23
C. Mission Bloom								
Thompson	15,494	25	39.2	2926	67	60	0	2/25
Carrion	14,629	27	34.7	2603	61	100	0	2/26
Butte	13,342	31	26.8	2011	55	100	0	3/1
3-24E	13,166	38	21.9	1643	58	64	0	3/2
Ruby	12,809	29	28.5	2138	57	100	0	3/4
5-58	12,153	33	23.6	1770	53	100	0	2/27
Mission 1-65	11,246	28	25.0	1875	47	100	0	3/4
Ripon	6534	27	17.5	1313	45	96	0	3/3

D. Nonpareil Clones

3-8-5-72	12,426	27	29.0	2176	64	28	0	
3-8-12-72	12,188	27	28.0	2101	64	20	0	
3-8-4-72	10,916	26	27.3	2048	65	26	0	
3-8-2-70	10,470	24	28.2	2115	65	24	0	
3-8-6-72	10,470	24	28.2	2115	65	24	0	
3-8-8-72	9588	26	23.2	1741	63	32	0	
3-8-9-72	9345	25	23.9	1793	66	38	0	
3-8-10-72	8889	25	22.8	1710	65	38	0	
3-8-11-72	5246	23	14.4	1081	61	28	0	

E. Mission Clones

3-6-1-65	11,924	29	26.7	2003	45	100	0	
3-6-1-65	10,569	28	23.3	1747	48	100	0	
3-6-2-71	10,524	26	25.1	1898	46	100	0	
3-6-3-67	10,522	27	24.3	1823	47	100	0	
Commercial	10,247	28	23.3	1748	49	100	0	3 rows
Commercial	9319	28	21.0	1590	48	100	0	

(1) At 75 trees/acre.
(2) Estimate of Mario Viveros.
(3) Commercial source, average 5 rows.
(4) Jordanolo as pollinizer.
(5) Nonpareil as pollinizer.

Personnel: Mario Viveros (Kern County), Warren Micke, Ron Snyder Cooperative Extension, D. Kester, R. Asay, Department of Pomology, UCD

Appreciation extended to Warren Carter, owner, and Tom Almberg, manager of Kern Farm Company.

Nickels Estate Research Farm
Arbuckle, California
1975 Planting

Variety	# Nuts /Tree	Average Size #/oz.	lbs./ Tree	Per Acre Yield (4)	Full Bloom (3)	Shelling %	% Sealed	% NOW
A. Early Blooming								
Peerless 1-65 (3)	2114	23	5.8	435	2/17	33	100	0
Ne Plus Ultra 2-70 (1)	1910	18	6.5	488	2/14	53	97	1
Ne Plus Ultra 1-63	1770	20	5.7	428	2/14	56	99	0
Peerless 2-70	1468	19	4.7	352	2/17	32	99	0
Jordanolo	1342	16	5.3	398	2/11	58	33	5
5A-20	1239	16	5.0	375	2/15	70	14	1
Money tree	871	16	3.4	255	2/19	66	0	3
Milow (1)	636	27	1.5	112	2/18	62	96	1
K-13N (1)	375	20	1.2	90	2/17	57	16	0
B. Nonpareil Bloom								
Norman	3232	28	8.6	645	2/24	64	29	1
23-122	2726	21	7.9	592	2/24	49	96	0
Carmel	2609	20	8.2	615	2/24	57	89	1
Price	2523	22	7.1	532	2/24	62	55	1
Nonpareil-2-70	2439	22	6.8	510	2/23	58	62	3
Harvey	2089	21	6.1	458	2/25	64	15	4
Granada	1890	25	4.7	352	2/23	55	85	1
Fritz (2)	1794	20	5.5	412	2/20	53	4	3
5A-3	1606	23	4.4	330	2/22	59	81	0
69-60	1324	21	4.0	300	2/21	50	93	1
Vesta	1315	18	4.3	322	2/23	51	41	1
Robson	982	18	3.4	255	2/23	59	45	0
C. Mission Bloom Time								
Butte	3683	25	9.2	690	2/26	50	71	1
Mission 1-65	2576	21	7.5	562	2/27	46	99	1
Mission 2-71	2518	21	7.4	556	2/27	46	100	0
Mission 5-67	2466	21	7.4	556	2/27	46	100	0
Thompson	2329	22	6.5	488	2/26	60	41	3
Carrion	1872	19	6.0	450	2/25	60	63	3

D. Nonpareil Clones

3-8-4-72	2602	21	7.7	577	2/23	59	61	2
3-8-7-72	2467	22	6.4	480	2/23	58	58	2
3-8-2-70	2439	22	6.8	510	2/23	58	62	3
3-8-5-72	2282	21	6.8	410	2/23	58	52	4

(1) Planted with Nonpareil as pollinizer.
(2) Planted with Mission as pollinizer.
(3) Record of T. Aldrich.
(4) At 75 trees/acre.
(5) All clone numbers shown are preceded by 3 and number for variety.

Personnel: T. Aldrich, Colusa County, Cooperative Extension
D. Kester, UCD

1980 CROP

CSUC RVT Plot
Durham, California
1976 Planting

Variety	# Nuts /Tree	Average Size #/oz.	lbs./ Tree	Per Acre Yield	Shelling %	% Sealed	% NOW
A. Ne Plus Ultra Bloom							
Jordanolo	3521	16	14.2	1065	61	40	80
Ne Plus Ultra	3404	18	11.8	885	58	84	12
5A-20	868	15	3.7	278	70	48	24
B. Nonpareil Bloom							
Norman	4850	25	11.9	892	63	68	12
23-122	4279	21	12.8	960	54	88	0
Harvey	3626	21	10.6	765	66	36	12
Nonpareil 2-70(1)	3170	17.5	11.2	826	64	24	2
Price	3139	18	11.0	825	61	68	0
Fritz (2)	3088	21	9.2	690	51	72	4
Carmel	2978	18	10.1	750	61	88	0
Nonpareil 4-72(1)	2972	18	9.8	735	65	44	4
Merced	2429	18	8.3	622	67	20	12
Nonpareil 5-72(1)	2370	18	8.3	621	63	26	4
Nonpareil 7-72(1)	2330	18	8.3	621	62	15	1
Granada	2140	22	6.1	458	64	24	8
Vesta	1526	17	5.5	412	72	40	24
Milow (3)	1396	22	3.9	292	57	80	12
5A-3	1380	21	4.2	315	54	88	4
Robson	1265	17	4.6	345	67	56	12
K13N (3)	583	18	2.0	150	64	20	24
C. Mission Bloom							
Mission 5-67 (4)	7179	24	18.8	1410	41	100	0
Butte	6162	25	15.2	1140	50	96	4
Mission 1-65 (4)	5822	23	15.7	1178	42	100	0
Mission 2-71 (4)	5275	23	14.1	1058	45	100	0
CP 5-58	4556	25	11.3	848	50	100	0
Mission 1-65 (4)	4437	24	11.6	870	44	100	0
Mission 2-71 (4)	4408	24	11.6	870	48	100	0
Carrion	3721	20	11.7	878	62	84	0
Mission 5-67 (4)	3640	25	9.1	682	41	100	0
Ripon	3158	20	9.8	512	46	100	0

(1) Complete clone no. = 3-8- ; average of four rows.
(2) Mission as pollinizer.
(3) Actually bloomed nearer Ne Plus Ultra.
(4) Complete clone no. = 3-6- ; single rows.

Personnel: Dr. R. Baldie, CSUS
Dr. D. Kester, UCD, R. Asay, UCD

Publications

1. Kester, D. E., W. Micke, D. Rough, D. Morrison, R. Curtis. 1980. Almond Variety Evaluation. Calif. Agriculture 34(10):4-7. 1980.

2. Kester, D. E., L. Liu, and R. Hellali. 1980. Changes in the dormancy status of vegetative buds of Nonpareil almond in relation to BF symptom expression. HortScience 15(3):410 (Abstract of paper presented at annual meeting, Fort Collins, Colorado, August 1980).

3. Kester, D. E. and R. N. Asay. 1980. Interactions of Noninfectious bud-failure (BF) and chilling requirements in F_1 Seedling population of Almond-peach hybrids. HortScience 15(3):408 (Abstract of paper presented at Fort Collins, Colorado, August, 1980).

4. Weinbaum, S., Z. Even-Chen and D. E. Kester. 1980. Increased stomatal resistance in two cultivars of Almond sensitive to bud-failure. HortScience 15(5):583-85.

Almond Research Conference
December 8, 1980

Progress Report
Project 80-K7

I. Noninfectious bud-failure.

A. Physiology.

Seasonal cycle studies of excised vegetative shoots are continuing to show that the critical factor in the development of symptoms is the plants response to high temperature in mid-summer. A plant normally stops growing and goes dormant apparently due to production of growth inhibiting substances. In the BF plant we are getting preliminary evidence that a toxic substance is being produced instead that injures the vegetative growing point and delays the initiation of the rest period in the Fall. We are investigating now the identity of the hypothesized toxic substance. Differences in varieties and differences in locations can be associated with the total amount of heat accumulation which would correlate to the production of such substances.

B. Selection within varieties.

Tests in progress since early 1970's have shown that differences among propagation source materials in respect to BF can be shown within a relatively few years if the progeny trees are grown in an appropriate environment where high summer temperatures occur. A longer term test in western Kern County using randomly selected bud-sticks from normal trees and orchards in Manteca area and Wasco is showing a gradual increase year by year in trees with identifiable BF. The rates are low (about 1% per year so far) but indicate that production of BF trees may occur continuously. The number produced from Wasco source trees is significantly greater than from Manteca source trees.

Nine clones of 'Nonpareil' being tested in the RVT plots have remained free of BF but trees of 'Merced' (Kern County) and 'Harvey' have not (Kern, Fresno and Colusa County). BF is continuing to occur sporadically in various 'Carmel' orchards primarily in middle to Southern San Joaquin Valley in orchards five or more years old. The pattern is similar to what had been seen in early days with Merced and appears to be part of the general pattern that the industry must expect to occur with many if not all varieties that come into the picture.

C. Inheritance.

Test crosses of different almond varieties in F_1 almond x peach crosses are confirming earlier results that show a BF factor segregates from various almond varieties. Further, the expression of these BF offspring is only occurring in those progenies involving early blooming varieties. These findings point towards methods of breeding to eliminate BF sensitive varieties which we are now ready to test.

II. Variety evaluation.

A. RVT test plots.

Data on yield and various other parameters were obtained this year on three plots (see attached) at McFarland (Kern County), Arbuckle (Colusa County), Durham (Butte County) and to a limited amount of Manteca (San Joaquin County). A fifth plot is being established this winter at Fresno with CSUF (Dr. Allan Hewitt).

Differences are appearing in yield and performance, among varieties, among plots and among years. For any one year the analysis of the climatic pattern, particularly that occuring during bloom, is critical in interpreting results. This year the rainy, poor pollinating conditions during Nonpareil and early bloom time had a strong inhibiting effect on yield. Later blooming varieties yielded better.

Differences among varieties is also a function in nut size (weight). For this reason we have presented data as number of nuts/tree which is then translated into number of lbs./tree. Yield data is presented only as a preliminary report of the total data that we are obtaining.

Using a selection index involving 40 characters weighted to reflect relative significance we have analyzed 11 varieties of almond which are currently being grown. Five of these - Nonpareil, Mission, Ne Plus Ultra, Peerless and Merced are used as standards. Six others, which are varieties where considerable industry experience is available, include Butte, Carmel, Fritz, Price, Ruby and Thompson. These are not presented as recommendations for use but as a first phase of a process whereby others with be evaluated as data is obtained. This information was published in California Agriculture, October, 1980.

The evaluation schedule has been prepared and exists in mimeograph form. Further work was done to determine pollination groups and results are being tabulated.

Report prepared by: D. Kester

Collaborators include:

Cooperative Extension: W. Micke, M. Viveros, T. Aldrich, D. Rough, J. Connell

Pomology: R. Asay, L. Liu, L. Fenton, M. Aduib

Other: R. Baldie (CSUC), G. Blomgren (Delta), A. Hewitt (CSUF)

Kern RVT Plot
McFarland, California
1974 Planting

Variety	# Nuts /Tree	Average Size #/oz.	Yield tree lbs.	Yield acre (1) lbs.	Shelling %	% Sealed	% NOW	Bloom (2)
A. Early Blooming Varieties								
Money tree (5)	7344	20	23.4	1756	64	20	0	2/18
Ne Plus Ultra	6518	20	20.6	1545	55	68	0	2/15
Jordanolo	6492	17	23.7	1779	60	52	0	2/12
Ne Plus Ultra	5841	20	18.6	1396	58	74	0	2/15
Jordanolo	5520	16	22.2	1665	65	42	0	2/12
B. Nonpareil Bloom								
Norman	12,375	31	24.8	1860	65	62	0	2/25
Fritz	11,974	27	28.1	2108	53	96	0	2/20
Granada	11,940	33	22.6	1695	60	74	0	2/25
Carmel	11,041	26	26.5	1988	60	94	0	2/25
Nonpareil (3)	10,032	24	27.3	2069	63	25	0	2/24
Harvey	9590	30	20.4	1531	66	78	0	2/26
Milo/PA	9356	31	18.9	1418	67	80	4	2/23
69-60	8009	29	17.7	1323	55	98	0	2/24
2-17	7970	27	18.5	1388	53	96	0	2/26
Merced	7900	25	20.1	1508	66	90	0	2/25
Price	7691	28	17.4	1305	62	50	0	2/23
Robson	7676	24	20.5	1538	59	74	2	2/24
Milow/Nem	7508	31	15.0	1125	69	56	0	2/23
5A-3	7492	26	18.6	1395	65	12	2	2/23
Vesta	5919	27	14.3	1073	51	50	0	2/24
23-122	5253	29	11.4	840	49	100	0	2/23
5A-20(4)	4984	18	17.2	1291	73	18	0	2/23
C. Mission Bloom								
Thompson	15,494	25	39.2	2926	67	60	0	2/25
Carrion	14,629	27	34.7	2603	61	100	0	2/26
Butte	13,342	31	26.8	2011	55	100	0	3/1
3-24E	13,166	38	21.9	1643	58	64	0	3/2
Ruby	12,809	29	28.5	2138	57	100	0	3/4
5-58	12,153	33	23.6	1770	53	100	0	2/27
Mission 1-65	11,246	28	25.0	1875	47	100	0	3/4
Ripon	6534	27	17.5	1313	45	96	0	3/3

D. Nonpareil Clones

3-8-5-72	12,426	27	29.0	2176	64	28	0	
3-8-12-72	12,168	27	28.0	2101	64	20	0	
3-8-4-72	10,916	26	27.3	2048	65	26	0	
3-8-2-70	10,470	24	28.2	2115	65	24	0	
3-8-6-72	10,470	24	28.2	2115	65	24	0	
3-8-8-72	9588	26	23.2	1741	63	32	0	
3-8-9-72	9345	25	23.9	1793	66	38	0	
3-8-10-72	8889	25	22.8	1710	65	38	0	
3-8-11-72	5246	23	14.4	1081	61	28	0	

E. Mission Clones

3-6-1-65	11,924	29	26.7	2003	45	100	0	
3-6-1-65	10,569	28	23.3	1747	48	100	0	
3-6-2-71	10,524	26	25.1	1898	46	100	0	
3-6-3-67	10,522	27	24.3	1823	47	100	0	
Commercial	10,247	28	23.3	1748	49	100	0	3 rows
Commercial	9319	28	21.0	1590	48	100	0	

(1) At 75 trees/acre.
(2) Estimate of Mario Viveros.
(3) Commercial source, average 5 rows.
(4) Jordanolo as pollinizer.
(5) Nonpareil as pollinizer.

Personnel: Mario Viveros (Kern County), Warren Micke, Ron Snyder Cooperative Extension, D. Kester, R. Asay, Department of Pomology, UCD

Appreciation extended to Warren Carter, owner, and Tom Alaberg, manager of Kern Farm Company.

Nickels Estate Research Farm
Arbuckle, California

Variety	# Nuts /Tree	Average Size #/oz.	lbs./ Tree	Per Acre Yield (4)	Full Bloom (3)	Shelling %	% Sealed	% NOW
A. Early Blooming								
Peerless 1-65 (3)	2114	23	5.8	435	2/17	33	100	0
Ne Plus Ultra 2-70 (1)	1910	18	6.5	488	2/14	53	97	1
Ne Plus Ultra 1-63	1770	20	5.7	428	2/14	56	99	0
Peerless 2-70	1468	19	4.7	352	2/17	32	99	0
Jordanolo	1342	16	5.3	398	2/11	58	33	5
5A-20	1239	16	5.0	375	2/15	70	14	1
Money tree	871	16	3.4	255	2/19	66	0	3
Milow (1)	636	27	1.5	112	2/18	62	96	1
K-13N (1)	375	20	1.2	90	2/17	57	16	0
B. Nonpareil Bloom								
Norman	3232	28	8.6	645	2/24	64	29	1
23-122	2726	21	7.9	592	2/24	49	96	0
Carmel	2609	20	8.2	615	2/24	57	89	1
Price	2523	22	7.1	532	2/24	62	55	1
Nonpareil-2-70	2439	22	6.8	510	2/23	58	62	3
Harvey	2089	21	6.1	458	2/25	64	15	4
Granada	1890	25	4.7	352	2/23	55	85	1
Fritz (2)	1794	20	5.5	412	2/20	53	4	3
5A-3	1606	23	4.4	330	2/22	59	81	0
69-60	1324	21	4.0	300	2/21	50	93	1
Vesta	1315	18	4.3	322.	23	51	41	1
Robson	982	18	3.4	255	2/23	59	45	0
C. Mission Bloom Time								
Butte	3683	25	9.2	690	2/26	50	71	1
Mission 1-65	2576	21	7.5	562	2/27	46	99	1
Mission 2-71	2518	21	7.4	555	2/27	46	100	0
Mission 5-67	2466	21	7.4	556	2/27	46	100	0
Thompson	2329	22	6.5	488	2/26	60	41	3
Carrion	1872	19	6.0	450	2/25	60	63	3

D. Nonpareil Clones

3-8-4-72	2602	21	7.7	577	2/23	59	61	2
3-8-7-72	2467	22	6.4	480	2/23	58	58	2
3-8-2-70	2439	22	6.8	510	2/23	58	62	3
3-8-5-72	2282	21	6.8	410	2/23	58	52	4

(1) Planted with Nonpareil as pollinizer.
(2) Planted with Mission as pollinizer.
(3) Record of T. Aldrich.
(4) At 75 trees/acre.
(5) All clone numbers shown are preceded by 3 and number for variety.

Personnel: T. Aldrich, Colusa County, Cooperative Extension
D. Kester, UCD

CSUC RVT Plot
Durham, California
1976 Planting

Variety	# Nuts /Tree	Average Size #/oz.	lbs./ Tree	Per Acre Yield (4)	Shelling %	% Sealed	% NOW
A. Ne Plus Ultra Bloom							
Jordanolo	3521	16	14.2	1065	61	40	80
Ne Plus Ultra	3404	18	11.8	885	58	84	12
5A-20	868	15	3.7	278	70	48	24
B. Nonpareil Bloom							
Norman	4850	25	11.9	892	63	68	12
23-122	4279	21	12.8	960	54	88	0
Harvey	3626	21	10.6	765	66	36	12
Nonpareil 2-70(1)	3170	17.5	11.2	826	64	24	2
Price	3139	18	11.0	825	61	68	0
Fritz (2)	3088	21	9.2	690	51	72	4
Carmel	2978	18	10.1	750	61	88	0
Nonpareil 4-72(1)	2972	18	9.8	735	65	44	4
Merced	2429	18	8.3	622	67	20	12
Nonpareil 5-72(1)	2370	18	8.3	621	63	26	4
Nonpareil 7-72(1)	2330	18	8.3	621	62	15	1
Granada	2140	22	6.1	458	64	24	8
Vesta	1526	17	5.5	412	72	40	24
Milow (3)	1396	22	3.9	292	57	80	12
5A-3	1380	21	4.2	315	54	88	4
Robson	1265	17	4.6	345	67	56	12
K13N (3)	583	18	2.0	150	64	20	24
C. Mission Bloom							
Mission 5-67 (4)	7179	24	18.8	1410	41	100	0
Butte	6162	25	15.2	1140	50	96	4
Mission 1-65 (4)	5822	23	15.7	1178	42	100	0
Mission 2-71 (4)	5275	23	14.1	1058	45	100	0
CP 5-58	4556	25	11.3	848	50	100	0
Mission 1-65 (4)	4437	24	11.6	870	44	100	0
Mission 2-71 (4)	4408	24	11.6	870	48	100	0
Carrion	3721	20	11.7	878	62	84	0
Mission 5-67 (4)	3640	25	9.1	682	41	100	0

(1) Complete clone no. = 3-8- ; average of four rows.
(2) Mission as pollinizer.
(3) Actually bloomed nearer Ne Plus Ultra.
(4) Complete clone no. = 3-6- ; single rows.

Personnel: Dr. R. Baldie, CSUS
Dr. D. Kester, UCD, R. Asay, UCD