Project No. 80-H4
(Continuation of Project No. 79-H3)

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Project: Navel Orangeworm Research
Almond Quality Research - Harvest & Postharvest

Objectives: To expand testing of the "early harvest" approach to plots located throughout the almond growing regions of California.

Progress: Studies in 1979 suggested that substantial benefits could be had if growers harvested almonds two to three weeks earlier than the time when they are dry on the trees. These studies will be expanded to various locations in order to determine if the "early harvest" concept can be used statewide.

In 1979 an effort to obtain nut drying using ambient forced air was made. Although drying occurred, there were difficulties with mold growth. This year's work is aimed at eliminating this problem.

Plans: (1) To compare "on ground" drying of nuts in "shady" versus "sunny" orchards and correlate with climatic conditions; (2) to develop a useful "harvest index" for growers; (3) to evaluate quality of early harvested almonds; (4) to test, on a commercial scale, "hullability" of early harvested almonds; (5) to set up ambient air drying tests for almonds and evaluate techniques.

Almond Industry Participation $7,350

80-H7

Almond Early Harvest

Data collected in Fresno County during the summer of 1979 indicated that a thorough harvest (almost complete nut removal) could be made 2-3 weeks before nuts are dry on the tree. Tests indicated that early-harvested almonds are as large as those harvested later and could be hulled cleanly. An extensive taste panel study which tested roasted kernels indicated that there were no substantial detectable differences between early-harvested and more mature kernels.

During the summer of 1980 early harvest trials were run in four locations (Wasco, Fresno, Livingston, and Dayton). Effects of tree age on nut maturity and ease of harvest were examined by comparing harvests in young and old blocks at the Wasco and Dayton locations.

As for 1979, in Fresno County, nut removal at 100% hull-split was as good as for harvests two weeks later. However, 100% hull-split did not mark the time of the best nut removal in the other locations. In most cases the best nut removal did not occur until nuts were quite dry on the tree. Nevertheless, because insect damage increased steadily during the last few weeks nuts were on the tree (see the IPM report) an early harvest might be economically advantageous even though complete nut removal is not accomplished. In all locations, once 100% hull split was reached nuts on the ground dried within two weeks.

Younger blocks in Wasco and Dayton matured about one week later than older blocks. As a result on a given day the nut removal was less good in the younger block. If this is taken into account it should still be possible to harvest young trees early.

Tests planned for the 1981 season will seek to define culture practices which promote nut removal for early harvest.

John M. Labavitch

80-H4

Early Harvest Trials - 1980

LABAVITCH

1. Objectives

Data obtained in Fresno County in 1979 suggested that almonds could be harvested 2-3 weeks before they were dry on the tree ("normal harvest") without undue difficulty or cost to the grower. Specifically, mechanical shaking at the time the least mature nuts on the tree had split (100% hull split) resulted in nut removal as complete as that obtained when shaking was delayed 2-3 weeks. Nuts harvested early could be dried on the orchard floor for 10-14 days and then hulled readily. Kernels from these nuts were as large as those from later harvested nuts.

The objective in 1980 was to repeat the 1979 trials at sites located throughout California's almond growing area in order to determine if "early" harvesting of almonds could be a general practice. Because we perceived that efficient hulling of ground-dried, early-harvested nuts could limit the usefulness of the early harvest concept we carried out tests of the commercial scale hulling of these nuts.

2. Interpretive Summary

This years' results provide a less clear picture than did those of 1979. Nuts (hulls and kernels) dry well on the ground in 2 weeks whether the orchard canopy is open or closed. In all locations early-harvested kernels were as large as those harvested later. However, 100% hull split was not always a useful indicator of the best time to shake for maximum nut removal (see Results). Nevertheless, the data provided by portions of the IPM study carried out in parallel with our trials indicate that early nut removal is important in orchards where insect infestation is substantial. This is true in spite of the decreased harvest volume. (Of course, later removal of nuts not shaken from the tree would be an important part of the early harvest approach.)

3. Experimental Procedures

Harvest trials were carried out in Dayton, Fresno, Livingston and Wasco. From 7 to 10 pairs of trees were shaken at weekly intervals, beginning at 95-100% hull split. In each case irrigation was stopped at least 10 days before the first harvest. Harvest efficiency was calculated from counts of nuts on the ground and remaining in the trees. Samples of harvested nuts were taken for analysis of moisture content and insect damage (IPM).

Farm advisors Mario Viveros (Kern County) and Joe Connell (Fresno County) coordinated efforts to test commercial scale hulling of early-harvested almonds. Nuts were harvested weekly, allowed to dry on the ground, and hulled. Hulled samples were then graded in order to determine what effect the early-harvest would have on grower return.

An attempt to determine the usefulness of forced ambient air for almond drying was carried out in Chowchilla with the cooperation of Lou Morton, according to plans worked out by Jim Thompson and Jerry Knutson (UC Davis Agricultural Engineering Extension). Trees were harvested and nuts were allowed to dry on the ground to a hull moisture of 20-25% (so as to reduce the danger of mold growth). A portion of these nuts was then swept up and loaded into a bin (apx. 5 ft. by 10 ft.) to a depth of 8 feet. Unheated air was then blown through (35 cfm) the stack of almonds from the bottom. At intervals, samples were removed from the top of the stack and from depths of 2, 4 and 6 feet. These samples, as well as samples from the harvested nuts that were left in the field, were analyzed for moisture content. Nuts from the bin were subsequently hulled.

4. Results

Harvest trials: Kernel size (as judged by dry weight) was not affected by time of harvest. Kernel dry weight was approximately 1.6 grams at the Livingston and Dayton locations and 10-15% smaller at Wasco. Data from Fresno are not available.

As for 1979, nut removal in Fresno at 100% hull split was excellent (96%) and essentially complete (>99%) one week later. However, there was considerable variation from this pattern at the other locations (Table 1). Nut removal increased steadily throughout the test period. The increase was most clear at Livingston where nut removal increased from 55 to 95% over the 3 week test period. The relationship of tree age to nut maturation was clearly in evidence. Nut removal at the younger plots in Dayton and Wasco lagged behind that of the older plots at the same locations.

In all locations the drying of nuts on the ground proceeded rapidly. Nuts were generally at a moisture suitable for hulling within two weeks (Table 2). The earliest harvested nuts dried a bit more slowly than those harvested later. This was undoubtedly because they were not as fully open.

Hulling tests: Tests of the hulling of early-harvested nuts indicated only slight differences between nuts harvested one week apart (Tejon) and two weeks apart (Fresno). Foreign matter (stick tights and hulls that curled up and could not be removed by an air leg) was higher in the early samples. These amples also tended to contain more chipped and broken kernels. In Fresno this would have led to a 1¢/lb. lower return on the earlier sample. However, as shown in the results from Tejon, the increased incidence of rejects in the nuts harvested later would probably have meant a better return with the early harvest.

Air drying: Nuts in the bin through which air was forced dried to a hull moisture of 10-12% and kernel moisture of less than 5% within 3 days. If the fan was allowed to run through the night the nuts picked up moisture from the more humid night air. Hulling of these nuts at the Chowchilla site was excellent. However, ground drying of nuts harvested at the same time was as rapid as for nuts dried in the bin.

5. Discussion

The results of this years' work indicate that the main impediment to an efficient, cost-effective early harvest is the timing of tree shaking. The time of 100% hull split was not necessarily the best time to shake. Unfortunately, a number of variables from site to site could have affected our ability judge the value of using hull split as an early harvest index. Among these variables are soil type, scheduling of water and nitrogen applications, the length of the main trunk and other tree-training characteristics, shaker type and operation, and climate. We recommend that a single-site study, which would eliminate a number of variables, be carried out to determine the effect of timing of water and nitrogen applications on nut maturation. These results could then be put to use in tests state-wide.

It is clear that kernel sizing, drying of grounded nuts, and hulling should not be serious problems for early harvest operations. Nevertheless, the possibility of problems does exist. Nuts wetted by rain are subject to mold growth--nuts in the tree dry more rapidly than those on the ground. Ants and ground squirrels must be controlled. It is clear that these animals can take a heavy toll when nuts are on the ground for a few weeks. Finally, because more nuts will be left in the tree, care must be taken to remove mummies during the post harvest period.

While forced air drying of almonds may have a value under certain circumstances it probably would not be generally useful. Nuts on the ground dried as rapidly as those in bins and the additional handling required to move quantities of nuts into bins and the energy cost to operate the fan would add expense to the drying operation.

6. Publications

Joe Connell and I are currently putting together an article to describe this work. No publications, other than annual reports, describe the results of our studies.

Table 1. Nut removal. Data given are average figures for 7-10 adjacent pairs of Non-pareil trees. The figures are the percent of nuts on the ground based on counts of nuts on the ground and remaining in the tree.

Location	Week 1	Week 2	Week 3	Week 4	Week 5
Dayton-old	92.4	96.4	98.1	97.5	-
Dayton-young	79.5	86.8	94.0	94.3	-
Wasco-old	89.1	92.5	93.8	95.8	94.4
Wasco-young	85.8	91.4	92.0	94.2	96.0
Fresno	95.9	99.1	99.4	-	-
Livingston	55.4	74.7	86.5	95.5	-

a. The first harvest in Dayton was on August 14, in Wasco on August 12, in Livingston on August 11 and in Fresno on August 5. Harvests were at weekly intervals.

b. The old orchard at Dayton was an 11-year-old planting; the young was 6 years old.

c. The old orchard at Wasco was a 14-year-old planting; the young was 7 years old.

Table 2. Hull and kernel moisture contents at harvest and after various periods of drying on the orchard floor.

Location	Harvest	Moisture Content (% fresh wt.)					
		At Harvest		One Week Post-harvest		Two Weeks Post-harvest	
		Hull	Kernel	Hull	Kernel	Hull	Kernel
Dayton-old	8/14	75	30	20	8	11	4
	8/21	65	20	9	3	8	2
	8/28	30	9	7	2	-	-
	9/4	9	3	-	-	-	-
Dayton-young	8/14	79	33	35	15	9	4
	8/21	80	30	14	6	9	3
	8/28	71	22	11	3	10	3
	9/4	40	12	11	3	-	-
Wasco-old	8/12	52	22	11	3	8	3
	8/19	40	12	8	2	-	-
	8/26	21	4	7	2	-	-
	9/2	9	3	-	-	-	-
Wasco-young	8/12	75	28	17	7	10	4
	8/19	66	23	19	6	8	2
	8/26	54	16	6	5	7	2
	9/2	30	8	10	3	7	4
Fresno	8/5	73	36	10	5	8	3
	8/12	68	29	10	4	6	2
	8/19	47	19	7	3	-	-
Livingston	8/11	74	32	67	24	10	5
	8/18	69	26	20	7	10	3
	8/25	52	16	14	4	5	4
	9/2	15	5	15	5	-	-

Acknowledgement

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and, most important, growers - C. V. Hansoh, W. McFarlane, L. Morton, K. Wedel and L. Ybanez

John M. Labavitch

Appendix

At the time of the 1979 Annual Report the results of the taste panel evaluating consumer acceptability of early-harvested almonds was not available. The report of the panel, which was directed by Christi Heintz, is attached. In brief, there are few taste differences between roasted samples of early- and late-harvested Non-pareil almonds. In fact, if there is any difference, it is that early-harvested nuts are slightly more palatable.

July 28, 1980

TO: Dr. John Labavitch

FROM: Christi Heintz

SUBJECT: A Report on the Sensory Evaluation of Almonds Harvested During the 1979 Season

I. INTRODUCTION

The major objective of this project was to determine the effect of harvest time on the texture and flavor of almonds. The study actually included three tests:

Test I. Effect of week of normal harvest - differences between nuts harvested August 21 and August 28

Test II. Effect of time before gathering nuts of each harvest

Test III. Effect of time of harvest - a study of immature to overmature nuts (nuts harvested weekly from July 17 to September 11).

II. MATERIALS AND METHODS

A. ALMOND PROCESSING AND STORAGE

Almonds were harvested during the summer of 1979, packaged in airtight heat-sealable pouches and stored at 34° F. in controlled atmosphere rooms at the Department of Pomology, UCD. In an effort to provide the taste panel with almonds more closely related to marketable nuts, the almonds were roasted January 18 and 19, at the California Almond Growers Exchange under the supervision of Mr. Gary Gray. A pilot-scale technique for "medium-roast" nuts was used which employed a Sears Cooker-Fryer heated to 310° F. to roast nuts for 4-5 minutes. Nuts were roasted in enough almond oil to cover the nuts and were dried at room temperature overnight on paper towels. Nuts went into cold storage again until two hours prior to panel tasting.

B. SENSORY PANEL

The almond taste panel commenced January 23, 1980 with ten days of training including triangle tests, paired comparison, and descriptive analysis training. The taste panel members consisted of volunteer graduate students and staff of the Pomology and Plant Growth Departments of UCD. After several days of training, a meeting of all panel members was held to discuss appropriate texture and flavor terms. For the almonds of this study, processed by the methods given above, the panel felt the most important sensory characteristics and their definitions were:

For texture-

firmness: force required to penetrate nuts with the molar teeth
brittleness: characterized by nuts shattering easily and 'exploding' when breaking apart
hollowness: the presence of airy pockets in the center of the nut such that the nut is not solid

For flavor-

roasted: a cooked flavor often associated with exposing substances to a heat source. A 'burnt' flavor would be an extreme roasted condition
sweet: the sensation typified by the taste of sucrose
oily: a slick, greasy taste
bitter: the taste characterized by caffeine or quinine solutions, perceived primarily at the back of the tongue
rancid: a rank taste characterized by old or oxidized oil.

Some comments brought up by panel members at the discussion of texture and flavor descriptors were: 1) flavor attributes were not as distinguishable as texture characteristics, possibly due to the roasting procedure being too severe, 2) thorough mastication is necessary as flavor attributes are not initially apparent, and 3) members felt aftertaste and/or duration of flavor were important but could not agree on terms for evaluation of aftertaste which did not involve hedonic connotations.

Three nuts per sample were given to each judge with a maximum per day of four triangle test sets or nine different samples for descriptive analysis. Nuts were given in random order and coded with a three digit random number and presented under red lights, the red lighting masking any color differences between nuts. Judges were asked to expectorate samples after evaluation and to rinse between samples.

For simple difference testing, a triangle test was used where each judge was given three to four sets of three samples and told that two of the samples in each set were the same while one was different and to choose the odd sample in each set (Appendix 1). In descriptive testing, the judges were asked to rate each sample for firmness, brittleness, hollowness, roasted flavor, sweetness, oiliness, bitterness, and rancidity using an unstructured 10 cm. horizontal line anchored at either end by "none" or "extreme" intensity of a characteristic (Appendix 2).

III. RESULTS AND DISCUSSION

TEST I. Effect of Week of Normal Harvest

To test whether almonds harvested on August 21 differed from nuts harvested on August 28, a triangle test was used. Fourteen judges were presented with four triangle test sets each for a total of 56 judgements. Twenty-two sets were correctly judged, not enough to make the two harvest dates significantly different.

Further, nuts harvested by picking directly off the tree were compared in a triangle test to nuts shaken from the tree and picked up off the ground that same day. Sixteen judges were given four triangle test sets each for a total of 60 judgements. The nuts did not differ as only sixteen sets were correctly judged.

TEST II. Effect of Time Before Gathering Nuts of Each Harvest

Differences in texture and flavor characteristics were studied for almonds shaken from the tree on a particular date and then left to dry on the ground until gathered one, two, and sometimes three weeks later. This test actually consisted of eight smaller experiments, one for each day a tree was shaken (harvested). A tree was shaken each week, so comparisons were made between the nuts left on the ground and gathered later at different intervals with the nuts gathered the day the tree was shaken. The almonds gathered the day of the harvest were given as a "reference" to each judge. For each texture and flavor characteristic, then, the horizontal lines on the score sheet were labeled at the center with an 'R' such that other nuts could be scored relative to this reference (Appendix 3).

Data were compared using Analysis of Variance and results of the eight weeks of the test are given in Table 1. When the immediately gathered almonds were scored, it would be expected they would receive a score of 5.0 corresponding to the middle of the scale or the same intensity as the reference, as they were almonds of the same lot. In most cases, it was found the immediately harvested nuts did receive scores near 5.0.

For the first week of harvest, July 17, there was insufficient quantity to include immediately gathered nuts in the analysis. Almonds laying on the ground one, two, and three weeks did not differ in oiliness, bitterness, or rancidity. Almonds on the ground one and two weeks did not differ in firmness, brittleness, hollowness, or roasted flavor. Almonds left on the ground three weeks were significantly more firm.

Almonds harvested on July 24 did not differ in sweetness, oiliness, bitterness, or rancidity. No difference was seen in firmness or brittleness of nuts left on the ground one or two weeks. Nuts gathered immediately were less firm and more brittle than nuts harvested but left lying on the ground.

For the third week of harvest, July 31, nuts gathered immediately and nuts left on the ground one or two weeks did not differ in oiliness or rancidity. Further, nuts left on the ground one and two weeks differed in none of the sensory characteristics. Nuts gathered immediately were

TABLE 1. EFFECT ON TEXTURE AND FLAVOR OF NUTS LEFT ON THE GROUND AS COMPARED TO IMMEDIATELY GATHERED NUTS FOR EACH OF EIGHT HARVEST WEEKS IN 1979.

WEEK OF HARVEST	DATE NUTS GATHERED	FIRM	BRITTLE	HOLLOW	ROASTED	SWEET	OILY	BITTER	RANCID
7/17	7/24[1]	5.9 ^{a}	4.5 ^{a,b}	3.8 ^{b}	5.3 ^{a}	5.0 ^{b}	4.8	4.8	4.6
(n=48)	7/31	5.9 ^{a}	4.8 ^{b}	3.1 ^{a,b}	5.9 ^{a,b}	4.0 ^{a}	5.3	5.2	4.8
	8/7	6.5	3.7 ^{a}	2.6 ^{a}	6.6 ^{b}	4.3 ^{a,b}	5.1	5.3	5.0
	SIGN LEVEL[2]	5%	1%	1%	.1%	.1%	NS	NS	NS
	LSD=[3]	0.3	0.9	0.8	1.0	0.9	-	-	-
7/24	7/24	5.0	5.0	4.9 ^{a}	4.9 ^{a}	5.2	5.3	4.9	5.1
(n=48)	7/31	7.0 ^{a}	3.6 ^{a}	2.8 ^{a}	4.8 ^{a}	4.8	5.2	4.7	5.0
	8/7	6.8 ^{a}	3.5 ^{a}	2.4	6.0	4.6	5.5	4.7	4.8
	SIGN LEVEL	.1%	.1%	.1%	.1%	NS	NS	NS	NS
	LSD=	0.6	0.7	0.7	0.9	-	-	-	-
7/31	7/31	4.9 ^{a}	5.2	5.2	4.8	5.0	5.1	5.0 ^{a}	5.2
(n=48)	8/7	5.7 ^{a,b}	4.2 ^{a}	3.4 ^{a}	5.7 ^{a}	4.1 ^{a}	5.1	5.5 ^{b}	5.6
	8/14	6.2 ^{b}	3.9 ^{a}	3.0 ^{a}	6.3 ^{a}	4.2 ^{a}	5.2	5.3 ^{a,b}	5.4
	SIGN LEVEL	.1%	.1%	.1%	.1%	.1%	NS	1%	NS
	LSD=	1.0	0.7	0.9	0.7	0.6	-	0.3	-
8/7	8/7	4.9 ^{a}	5.0 ^{b}	4.8	4.8	4.9	5.2	5.1	5.1
(n=48)	8/14	5.5 ^{a,b}	4.4 ^{a,b}	3.8 ^{a}	5.8 ^{a}	4.4	5.0 ^{a}	5.2	5.1
	8/21	6.0 ^{b}	4.1 ^{a}	3.4 ^{a}	6.1 ^{a}	4.4	5.0 ^{a}	5.4	5.4
	SIGN LEVEL	.1%	.1%	.1%	.1%	NS	5%	NS	NS
	LSD=	0.7	0.8	0.8	0.9	-	0.1	-	-
8/14	8/14	5.4	5.0 ^{b}	4.6	4.8	5.1 ^{b}	5.3	4.9	5.0
(n=48)	8/21	6.2 ^{a}	4.4 ^{a,b}	3.6 ^{a}	5.8 ^{a}	4.4 ^{a,b}	5.1	5.4 ^{a}	5.5 ^{a}
	8/28	6.3 ^{a}	4.3 ^{a}	3.5 ^{a}	6.4 ^{a}	4.1 ^{a}	5.2	5.7 ^{a}	5.5 ^{a}
	SIGN LEVEL	1%	1%	.1%	.1%	.1%	NS	.1%	5%
	LSD=	0.7	0.6	0.9	0.8	0.7	-	0.4	0.4
8/21	8/21	5.1	5.2	4.8	4.9	5.0	5.2	5.1	5.2
(n=45)	8/28	5.4	4.9	4.6	5.6 ^{a}	4.7	5.4	5.2	4.9
	9/4	5.4	4.8	4.4	5.4 ^{a}	4.9	5.3	5.0	4.6
	SIGN LEVEL	NS	NS	NS	5%	NS	NS	NS	1%
	LSD=	-	-	-	0.4	-	-	-	0.5
8/28	8/28	5.2	5.2	4.9 ^{a}	5.2 ^{a}	5.1	5.1	4.9	5.0
(n=45)	9/4	4.7	5.5	5.5	5.5 ^{a,b}	4.7	5.2	5.2	5.5 ^{a}
	9/11	5.1	5.1	4.9 ^{a}	5.9 ^{b}	4.4	5.0	5.5	5.6 ^{a}
	SIGN LEVEL	NS	NS	5%	5%	NS	NS	NS	5%
	LSD=	-	-	0.3	0.4	-	-	-	0.4
9/4	9/4	5.0	5.3	5.3	5.0	4.9	5.5	4.9	5.1
(n=48)	9/11	5.0	5.3	5.3	5.1	5.3	5.5	4.7	4.9
	SIGN LEVEL	NS	NS	NS	NS	NS	NS	NS	NS
	LSD=	-	-	-	-	-	-	-	-

[1] insufficient quantity to include immediately harvested nuts for 7/17.

[2] level of statistical significance.

[3] least significant difference.

a,b Common superscripts within attributes for a particular week of harvest indicate no significant difference.

more brittle, more hollow, and more sweet than nuts left on the ground.

Nuts harvested August 7 did not differ in sweetness, bitterness, or rancidity. Almonds immediately gathered were more hollow than other nuts but did not differ from almonds left on the ground one week in firmness or bitterness. Almonds lying on the ground one and two weeks were also no different in firmness, brittleness, hollowness, or oiliness.

Almonds harvested August 14 and gathered immediately were less firm, bitter, and rancid and more hollow than nuts left on the ground. Almonds left on the ground one and two weeks were not different in any of the sensory characteristics.

Considering the weeks of normal harvest, August 21 and 28, almonds did not differ in firmness, brittleness, hollowness (August 21 only), sweetness, oiliness, or bitterness. Further, nuts gathered one and two weeks after harvest on August 28 did not differ in rancidity. Almonds gathered immediately upon harvest were significantly more rancid August 21 and significantly less rancid August 28 than nuts left on the ground.

For the week of the last harvest, September 4, only those nuts left on the ground one week were compared with those gathered immediately and no significant differences were found.

Little discussion has been given so far to the differences in roasted flavor. As can be seen from Table 1, differences were almost always found in degree of roasted flavor, especially when comparing immediately gathered nuts to those left on the ground one and two weeks. Rating the intensity of roasted flavor was more of a check on the similarity of the roasting treatments given to each lot of nuts. Differences found might be due to the effect of the roasting procedure on the physiology of the nut which is likely to change with time left on the ground, but is due probably to lack of control in pilot-scale roasting conditions.

The effect of time before gathering nuts of each harvest seemed more to influence textural rather than flavor characteristics, as evidenced by the relatively fewer occasions texture terms were nonsignificant when compared to flavor terms.

Nuts harvested and gathered immediately were generally less firm, bitter, and rancid and more brittle, hollow, and sweet than nuts left on the ground. Almonds left on the ground one or two weeks differed in few of the sensory characteristics. It would seem nuts should be gathered immediately and not left on the ground as they have more desireable sensory characteristics (more sweet, less bitter and rancid). Yet, immediately harvested nuts have a higher moisture content (are less firm) and consequently become hollow in the center upon roasting due to the moisture vaporizing with increased temperatures. Due to a build-up of steam in the center of the nuts, many of these high moisture nuts "popped" similar to popcorn during the roasting process. Therefore, the mechanics of drying the immediately harvested almonds without development of these air pockets should be studied.

Differences between almonds when comparing time gathered for each harvest decreased toward the end of the harvest season. Up until August 14, nuts of the same harvest but gathered at different times were different in relatively more sensory characteristics than nuts harvested August 14 or later.

TEST III. Effect of Time of Harvest

For the purpose of this study, it was established that normal harvest of almonds occurs around August 21 or August 28 and triangle tests showed nuts harvested and gathered on those dates did not differ. We then specifically tested by triangle tests nuts harvested July 31 and August 7 and left on the ground one and two weeks with those nuts of the normal harvest. It was found that under all four conditions (harvest July 31 - nuts gathered August 8 and August 14; harvest August 7 - nuts gathered August 14 and August 21), when compared to nuts harvested at the normal time, the almonds did not differ (n = 36, 36, 36, and 48, respectively).

Descriptive analysis with no center-point reference was used to compare nuts harvested weekly from July 17 through September 11 (and gathered immediately). Data were compared using Analysis of Variance and are summarized in Table 2. Note that the week of July 17 was not included due to a shortage of sample. Also, August 28 is not mentioned as it was found no difference existed between the August 21 and August 28 harvest dates.

Almonds differed in roasted flavor but this is, again, probably due to roasting procedure rather than the nuts themselves.

Almonds harvested at different weeks did not differ in oiliness. Further, nuts harvested July 31, August 7, and August 14 did not differ in brittleness, hollowness, sweetness, bitterness, and rancidity. Almonds harvested August 21, September 4, and September 11 were more firm, bitter, and rancid, and less brittle, hollow, and sweet. July 24 harvested nuts were significantly the least firm and most rancid nuts.

Early harvest nuts after July 24 had more desireable sensory characteristics, they were more sweet and less bitter and rancid, but they were more hollow and brittle than later harvest nuts due to the moisture content at the time of roasting. Again, the feasibility of harvesting an earlier nut without acquiring the air pockets upon roasting should be studied.

IV. CONCLUSIONS

The following points conclude the results of this study.

TEST I. Effect of Week of Normal Harvest

1) almonds harvested August 21 and August 28 and gathered immediately did not differ in sensory characteristics.
2) nuts harvested directly off the tree and nuts shaken and gathered from the ground the same day were not different.

TABLE 2. EFFECT OF TIME OF HARVEST OF ALMONDS ON TEXTURE AND FLAVOR CHARACTERISTICS (n=48).

WEEK OF HARVEST	FIRM	BRITTLE	HOLLOW	ROASTED	SWEET	OILY	BITER	RANCID
7/24	3.7	6.4^{a}	6.3^{a}	2.8^{a}	$4.0^{a,b}$	3.3	2.1^{b}	3.5
7/31	4.2	6.0^{a}	$5.8^{a,b}$	3.0^{a}	4.9^{b}	3.7	0.9^{a}	1.4^{a}
8/7	4.9	5.7^{a}	$5.1^{a,b}$	$3.5^{a,b}$	4.8^{b}	3.5	$1.2^{a,b}$	1.3^{a}
8/14	5.1	5.6^{a}	4.6^{b}	3.4^{a}	4.9^{b}	3.4	1.0^{a}	1.1^{a}
8/21	6.0^{a}	3.9^{b}	2.2^{c}	4.5^{b}	3.8^{a}	3.8	2.2^{b}	1.6^{a}
9/4	6.0^{a}	3.9^{b}	1.8^{c}	5.3^{b}	3.3^{a}	3.8	2.1^{b}	2.0^{a}
9/11	6.8	4.3^{b}	1.5^{c}	5.6^{b}	3.2^{a}	3.5	2.2^{b}	1.9^{a}
SIGN LEVEL	.1%	.1%	.1%	.1%	.1%	NS	.1%	.1%
LSD=	0.1	1.2	1.4	1.2	1.0	-	1.0	1.2

^{a,b,c} COMMON SUPERSCRIPTS WITHIN ATTRIBUTES INDICATE NO SIGNIFICANT DIFFERENCE

TEST II. Effect of Time Before Gathering Nuts of Each Harvest

1) nuts differed more in textural rather than flavor characteristics.
2) those nuts gathered immediately had more desireable sensory characteristics (they were sweeter nuts with less bitterness and rancidity) but were more hollow in the center of the nut due to a higher moisture content and will present a problem upon roasting.
3) almonds left on the ground one and two weeks differed relatively little from one another.
4) the sensory differences between almonds gathered at different times for the same harvest decreased toward the end of the season.

TEST III. Effect of Time of Harvest

1) almonds harvested July 31 and August 7 and left on the ground until gathered one and two weeks later were no different from nuts of the normal harvest.
2) almonds harvested July 31, August 7, and August 14 were less firm, bitter, and rancid, while being more brittle, hollow, and sweet and have therefore more desireable sensory characteristics than those nuts harvested July 24 or after August 14.
3) the feasibility of harvesting an earlier nut without acquiring the air pockets upon roasting should be studied.

Because almonds differed in degree of roasted flavor, it is felt that the roasting procedures were not similar for each lot of nuts and could therefore be an important source of variability in the study. Further, it may be possible that this type of roasting procedure may have caused the increased bitterness and rancidity in the normal harvest and later season almonds.

APPENDIX 1. SCORESHEET FOR SENSORY TRIANGLE TESTS

ALMONDS 1979 Season

NAME_____

DATE_____

Two of the following three samples in each set are identical. Taste a nut from each sample then circle the odd sample in the set.

SET

1) _____ _____ _____

2) _____ _____ _____

3) _____ _____ _____

4) _____ _____ _____

ALMONDS 1979 Season

Name_____

Date_____

Two of the following samples in each set are identical. Taste a nut from each sample then circle the odd sample in the set.

SET

1) _____ _____ _____

2) _____ _____ _____

3) _____ _____ _____

4) _____ _____ _____

APPENDIX 2. SCORESHEET FOR DESCRIPTIVE SENSORY ANALYSIS

NAME _____

ALMONDS 1979 Season

DATE March 7 10 11 1980

Please score the samples for the following characteristics by proportionally marking the line with a vertical line.

NONE — EXTREME

Firm
Brittle
Hollow
Roasted
Sweet
Oily
Bitter
Rancid

Firm
Brittle
Hollow
Roasted
Sweet
Oily
Bitter
Rancid

APPENDIX 3. SCORESHEET FOR DESCRIPTIVE SENSORY ANALYSIS USING CENTER-POINT REFERENCE

Name _____

ALMONDS - 1979 Season

Date _____

In relation to the reference sample, please score the following samples for the different characteristics by proportionally marking the line with a vertical line.

SAMPLE

_____

LESS — R — MORE

Firm

Brittle

Hollow

Roasted

Sweet

Oily

Bitter

Rancid

_____

Firm

Brittle

Hollow

Roasted

Sweet

Oily

Bitter

Rancid