'Liberty' and CBR4T29 (firm apples) and that of 'MacSpur McIntosh' or 75-03-06 (soft apples). 'Liberty' was deemed coarse by Lamb *et al.* (11) but this was not evident in the present study (Figure 2).

In summary 'Liberty' and CBR4T29, two scab-resistant apples, were rated higher for overall quality than the two scab-susceptible varieties, 'MacSpur McIntosh' and 'Spartan.' 'Trent' and FAR54A48 also rated well with the 2 commercial cultivars (Table 1).

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Evaluation of Selected Almond [*Prunus dulcis* (Miller) D. A. Webb] Germplasm for Several Shell and Kernel Characteristics

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Abstract

Nine almond selections from a previous breeding program were compared with 'Nonpareil' for their potential usefulness. In-shell kernel weights, kernel percentage, percent doubles, amount of worm damage and kernel color were measured. All nine selections had significantly less worm damaged kernels than 'Nonpareil.' Variability was also present for in-shell and kernel weights, kernel percentage and kernel color. Other production characteristics including cross compatibility with 'Nonpareil' are also discussed.

Introduction

California almond growers have produced a majority of the world almond supply each year since 1979 (1). Over 170,000 H are currently planted in California with 1990 gross sales receipts totaling over $650 million. More than 40 cultivars are planted, but only a few predominate the total acreage. 'Nonpareil' is the cultivar of choice for growers, processors and

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marketers. It comprises over half the California almond acreage. Since 'Nonpareil' and other U.S. cultivars are not self-fruitful, two or more cross compatible cultivars having the same relative bloom period are planted in an orchard to maximize pollinization. Pollinizers of 'Nonpareil' are typically harvested separately to avoid mixing kernels of different cultivars. Mixing is discouraged by almond processors due to potential problems during processing and marketing (7).

Although 'Nonpareil' is the preferred almond of processors, the cultivar has its problems. An open suture in the shell makes it susceptible to worm damage and a mid bloom date predisposes it to frost sensitivity. 'Nonpareil' and many cultivars derived from it are susceptible to genetic bud-failure (5).

Kernel quality, consistent yield, processing qualifications and market demand have kept 'Nonpareil' the most widely utilized cultivar in spite of its weaknesses.

In this study, nine almond selections from a previous almond cultivar development program were evaluated for current potential usefulness to the almond industry. The nine selections and 'Nonpareil' were evaluated for: inshell and kernel weight, kernel percentage, double kernels, worm damage to kernels and kernel color. Bloom periods and cross compatibility of selections with 'Nonpareil' as well as other production factors are also discussed.

Materials and Methods

The nine selections were top worked onto 'Nonpareil' trees in 1972 in a commercial planting owned by S & J Ranch, Doma Division and managed by C. Downing, Chowchilla, California. Trees were harvested by commercial shaker on 26 August 1990. Almond samples of 'Nonpareil' and the nine selections were collected from the orchard floor. In-hull nuts were air dried, hulled and oven dried at 43°C for three days. All kernels were shelled by hand. Experimental unit size ranged from 100 nuts to 50 nuts depending on selection, with six replications. Data collected were: oven dried in-shell weight, kernel weight, number of double kernel in-shell nuts and number of worm damaged kernels. No discrimination was made between kernels damaged by Navel Orangeworm and/or Peach Twig Borer. Colorimetric analysis of chroma, hue and value for the tests were measured with a Minolta Chroma Meter CR-200. Averages of 10 nut subsamples from each experimental unit were used for these measurements. All data were analyzed, without transformation, using standard ANOVA procedures.

Results

Experimental selections exhibited variability with regard to both in-shell and kernel weights as well as kernel percentage and extent of worm damage (Table 1). In-shell weights of 23-122 and 72-26 were both significantly higher than 'Nonpareil.' Compared

Table 1. Comparison of four important nut characteristics for 'Nonpareil' and nine USDA almond selections. Samples were collected from S & J Ranch, Chowchilla, California during the 1990 harvest.

Selection	Weights of (g)		Kernel %	Worm damage (%)
	In-shell	Kernel		
Nonpareil	1.65	1.08	65.4	15.5
23-122	1.85**	1.06	57.3	0.8**
23.5-16-40B	1.58	0.86	54.4	9.4**
25.5-40	1.56	0.76	48.7	0.0**
72-26	1.90**	1.01	53.1	5.0**
75-16	1.56	1.09*	69.9**	9.3**
78-62	1.27	0.72	56.6	3.6**
79-9	1.66	0.69	41.5	0.2**
82-78	1.16	0.58	50.0	5.1**
88-66	1.64	0.76	46.3	1.5**

*, ** denotes significantly larger than 'Nonpareil' for in-shell weight, kernel weight and kernel %, or significantly less worm damage than 'Nonpareil' at the 0.05 or 0.01 level, respectively according to a Student-Newman-Keul test.

with 'Nonpareil,' selection 75-16 had both a significantly larger kernel percentage and a larger kernel. Worm damage to nutmeats varied from a high of 15.5% for 'Nonpareil' to 0% in selection 25.5-40. All nine selections had significantly fewer worm damaged kernels than 'Nonpareil.'

Both percentage of double kernels and kernel color were also evaluated (data not presented). Kester and Asay (4) indicated that the number of doubles within a cultivar varies with the particular season. There were no statistical differences between the evaluated selections with regard to the percent double kernel nuts. Doubles ranged from a high of 1.01% for 82-78 to a low of 0.98% for 75-16. All values were well within acceptable industry limits for even the prestigious 'U. S. Fancy' grade designation. All almonds sampled in this test were classified as a dull rusty yellow with the exception of 25.5-40 which was light yellow. Visually, selection 25.5-40 appeared more blonde than other samples. Selections 23-122 and 75-16 appeared indistinguishable from 'Nonpareil' with regard to perceived color, shape and surface texture of the kernel although they had significantly higher 'chroma' values than 'Nonpareil.'

Discussion

'Nonpareil' is an accepted almond cultivar which comprises over half the almond acreage in California. Thus, an almond breeder's aim of replacing 'Nonpareil' with new cultivars having higher yields, pest resistance and later bloom cannot be realistically accomplished in a short time period. As long as 'Nonpareil' remains the dominant cultivar, new cultivars should be both cross compatible and harvestable with it. Successful replacement of the 'Nonpareil' cultivar, with no loss of market recognition, is dependent upon matching nutmeat size, shape, color, flavor, yield and processing capability.

A major concern with 'Nonpareil' is its susceptibility to kernel damage by Naval Orangeworm. Crop damage from this pest ranged from two to over eight percent industry-wide from 1974 through 1988 (6). Susceptibility of 'Nonpareil' and many other cultivars is due to an open suture which provides access to the pest. Harvesting at 100% hullsplit is one cultural practice that can reduce Naval Orangeworm damage (2). With pests left unchecked by accepted cultural practices, crop damage can increase over one percent per day after the emergence of second generation Naval Orangeworm moths (3).

An earlier almond breeding program placed high priority on developing new cultivars with completely closed sutures. The papery shell material of 'Nonpareil' would be adequate to provide protection against worm damage if the suture were sealed as is illustrated by the performance of selection 75-16. A harder, thicker shell is not necessary for Naval Orangeworm control and might also be detrimental to a new cultivar by lowering kernel percentage. This contrast in shell types is exemplified by selections 25.5-40 and 79-9. Both have closed sutures and sustained the least amount of worm damage. The kernel percentage of 25.5-40 was 48.7% while that of the semi-hard shelled 79-9 was significantly less at 41.5%. A significantly larger kernel percentage translates to a higher economic return per hauled volume of inshell nuts. In orchards producing 3,369 kg/H (3,000 lb/A) inshell al-monds, kernel percentage of 48.7% yields 1,640 kg/H (1,460 lb/A) meats. When kernel percentage is 41.5%, the 3,369 kg/H orchard yields 1,398 kg/H (1,244 lb/A) meats. The 242 kg difference per hectare would translate to $559/H ($226/A) for growers assuming the 1990 market price of $2.24/kg ($1.05/lb).

Other important production criteria are limited for these almond selections. Interested producers should be forewarned that data presented here are from the 1990 harvest only, and bear-

ing cycles or cropping consistency are unknown at this time. Each selection blooms within two days of 'Nonpareil'; however, cross compatibility with 'Nonpareil' is only certain for selections 23-122, 75-16 and 23.5-16-40B. Shell characteristics of these remnant selections range from papery (75-16) through semi-hard (79-9). Records indicate that harvest dates of most selections were typically 7 to 10 days after 'Nonpareil,' although in 1990, trees of each selection were commercially shaken with the 'Nonpariel' harvest. Visual observations indicated a certain degree of field tolerance to mite infestations in selections 25.5-40, 82-78 and 88-66. Specific yield data are not available since all selections were top worked to single scaffolds in a 'Nonpareil' planting. New plantings of these and other selections are planned for 1992 to continue evaluation of this potentially important germplasm.

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Wilder Medal Nominations

The Wilder Medal Committee of the American Pomological Society (APS) invites nominations for the 1992 Wilder Silver Medal Award. All active members of APS are eligible to submit nominations. The award was established in 1873 in honor of Marshall P. Wilder, the founder and first President of APS, and is presented at the APS meeting, held during the ASHA Annual Meeting.

The Wilder Medal is presented to individuals or organizations that have rendered outstanding service to horticulture in the area of pomology. Special consideration is given to work relating to the origination and introduction of meritorious fruit cultivars. Individuals associated with either commercial concerns or professional organizations may be considered if their introductions are truly superior and have been widely planted.

Significant contributions to the science and practice of pomology other than through fruit breeding will also be considered. Such contributions may relate to any important area of fruit production, such as rootstock development and evaluation, anatomical and morphological studies, or noteworthy publications in any of the above subjects.

To obtain nomination guidelines, contact Dennis J. Werner, Department of Horticultural Science, Box 7609, North Carolina State Univ., Raleigh, NC 27695-7609; phone 919/515-3166. Nominations must be submitted by **1 May 1992.**