# Harvest maturity of almond cultivars in California's Sacramento Valley

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**Abstract.** This report summarizes 10 years of nut maturity data collected at the Regional Almond Variety Trial in Chico, California representing maturation of thirty-four almond cultivars.Cultivars are categorized relative to 'Nonpareil' regarding when they reach 1 percent hull split and 100 percent hull split. The timing of commercial mechanical harvest operations in the trial also ranks cultivars relative to 'Nonpareil'.The rate of nut maturation for each cultivar is represented as the number of days between 1 and 100 percent hull split and cultivars are categorized in four nut maturation groups.

**Keywords.** *Prunus dulcis* – Hull split – Maturation – Harvest – Timing.

***Maturité pour la récolte de cultivars d'amandier dans la vallée de Sacramento en Californie***

***Résumé.*** *Ce rapport résume 10 ans de données recueillies sur la maturité des amandes dans le cadre de l'instance régionale pour les variétés d'amandes à Chico, Californie, représentant la maturation de trente-quatre variétés d'amandes. Les cultivars sont classés par rapport à 'Nonpareil' concernant le moment où ils atteignent 1 pour cent de coque fendue, et 100 pour cent de coque fendue. Le calendrier des opérations de récolte mécanique commerciale dans le cadre de cet essai classifie aussi les cultivars par rapport à 'Nonpareil'. Le taux de maturation des amandes pour chaque cultivar est représenté par le nombre de jours compris entre 1 et 100 pour cent de coque fendue et les cultivars sont classés en quatre groupes selon la maturation des amandes.*

***Mots-clés.*** Prunus dulcis – *Coque fendue – Maturation – Récolte – Calendrier.*

## I – Introduction

The time of harvest and the rate of almond (*Prunus dulcis* (mill.) D.A. Webb) cultivar maturation is important for several reasons. Depending on when a cultivar's hull split begins and when harvest occurs nuts may be exposed to egg laying from one or two generations of the navel orangeworm, *Amyelois transitella* (Walker), the principle pest of almonds in California. Using the navel orangeworm phenology model, generations can be predicted (Zalom *et al*., 1998) and this knowledge can be used to gauge a cultivar's susceptibility to worm damage depending on how nuts mature as harvest approaches. Rapid nut maturity from the initiation of hull split to 100 percent hull split and harvest minimizes the time of exposure to pests and may contribute to keeping worm damage low. An early or timely harvest is a principle method of avoiding worm damage to soft shelled cultivars (Connell *et al*., 1989).

Most cultivars must be harvested separately to optimize hulling, shelling, and marketing. Hence, maturity of individual cultivars in the same orchard must be different enough to prevent undesirable mixing at harvest. Harvest maturity is consequently one of the important considerations in choosing cultivars when planting a new orchard.

Additionally, nuts of late maturing cultivars can be more difficult to dry on the ground due to shorter days and cooler temperatures. If rain begins in early fall, nuts from late maturing

cultivars may be caught in the field. This can reduce nut quality due to harvest delays and can increase harvest costs by extending harvest operations and drying time.

When establishing a new orchard, mistakes in cultivar selection can be costly to almond producers. Recognizing the importance of cultivar selection, the Almond Board of California, the University of California, University of California Cooperative Extension and California State University Chico have been working together on almond cultivar research at the CSU Chico's teaching farm for more than 30 years (Micke *et al*., 1998, Lampinen *et al*., 2002).

## II – Materials and methods

The Chico Regional Almond Variety Trial (RAVT) located in California's Sacramento Valley was established in 1993 on 8.9 hectares to evaluate 34 almond cultivars.New cultivars are planted at a density of 158 trees per hectare in single rows of 20-25 trees planted alternately with rows of standard cultivars such as 'Nonpareil' or 'Mission' that bloom at the same time for cross pollination and comparison. Weekly observations on harvest maturity estimated as the percentage of nuts showing hull split were made on these cultivars annually for a period of 10 years. Hull split as defined here is the time when nuts with green hulls develop the first crack along the suture that penetrates to the shell.The rate of nut maturation for each cultivar in the trial is represented as the number of days between 1 and 100 percent hull split.This report summarizes 10 years of almond harvest maturity observations for cultivars in the Chico trial.

## III – Results and discussion

### 1. The standard for comparison

Since 'Nonpareil' is the leading California cultivar the remaining cultivars in the trial are compared to this standard.The 10-year average hull split initiation date or 1% hull split for 'Nonpareil' nuts is July 17.'Nonpareil' averaged 100% hull split on August 11 and its commercial harvest date defined as the average date nuts were mechanically shaken from the trees is August 25.Cultivars are categorized relative to 'Nonpareil' regarding when nuts reach 1 percent hull split and 100 percent hull split. The timing of commercial mechanical harvest operations in the trial also ranks cultivars relative to 'Nonpareil'.

### 2. Hull split initiation

Hull split initiation is the beginning of nut maturation as harvest approaches and it marks the time when the crop becomes susceptible to worm damage.The initiation of hull split for almond cultivars in the Chico Regional Variety Trial is shown as the time in days relative to 'Nonpareil' when each cultivar reaches 1% hull split.Cultivars in this trial are divided into seven groups (Table 1) representing approximately weekly intervals of initial maturation.

### 3. 100 percent hull split

This maturity stage marks the time when an early commercial mechanical harvest operation can begin to achieve the maximum nut removal.An early harvest when 100% of nuts are split but not fully dry can help preserve crop quality since the navel orangeworm will not lay eggs on nuts once they are shaken to the ground (Flint, 2002).Rapid drying on the ground followed by hulling helps lessen injury by avoiding much of the damage from third generation larvae (Connell *et al*., 1989).

Once a cultivar reaches 100% hull split and nuts can be effectively shaken from the trees, harvest may commence. Cultivars in the Chico RAVT have been divided into six groups relative to 'Nonpareil' that reach 100% hull split at approximately weekly intervals (Table 2). Since most

cultivars must be harvested separately to optimize hulling, shelling, and marketing, two cultivars from the same group should not be planted in adjacent rows in an orchard.Individual cultivars in adjacent orchard rows should mature at different times to prevent undesirable mixing.

**Table 1. Hull split initiation of almond cultivars in the Chico Regional Almond Variety Trial ranked by the number of days before or after 1 percent hull split on 'Nonpareil'**

| 5 days before 'Nonpareil' | 10 to 14 days after 'Nonpareil' | 15 to 20 days after 'Nonpareil' | 22 to 28 days after 'Nonpareil' | 29 to 35 days after 'Nonpareil' | 37 to 39 days after 'Nonpareil' | 45 days after 'Nonpareil' |
|---|---|---|---|---|---|---|
| 'Kapareil' | 'Sonora'<br>'Jiml'<br>'Johlyn'<br>'UC2-19E'<br>'UC1-102W'†<br>'UC2-43W'† | 'UC 25-75'<br>'Donna'<br>'Price'<br>'Rosetta'<br>'Yokut'<br>'UC1-87'<br>'Kochi'† | 'Plateau'<br>'Jenette'<br>'Morley'<br>'Sano'<br>'Livingstone'<br>'Winters (UC13-1)'<br>'Wood Colony' | 'Chips'<br>'Savana'<br>'Aldrich'<br>'Padre'<br>'Butte'<br>'Kahl'<br>'Ruby'<br>'Durango'† | 'Monterey'<br>'Carmel'<br>'Avalon'† | 'Mission' |

†Rankings of these cultivars are based only on 4 years of harvest maturity observations.

**Table 2. 100% hull split of almond cultivars in the Chico Regional Almond Variety Trial ranked by the number of days before or after 100% hull split on Nonpareil**

| Kapareil group 10 days before 'Nonpareil' | Sonora group 7 to 13 days after 'Nonpareil' | Price group 15 to 21 days after 'Nonpareil' | Butte group 23 to 28 days after 'Nonpareil' | Carmel group 29 to 34 days after 'Nonpareil' | Mission group 39 to 40 days after 'Nonpareil' |
|---|---|---|---|---|---|
| 'Kapareil' | 'Kochi'†<br>'Sonora'<br>'UC2-19E'<br>'Rosetta'<br>'Jiml'<br>'UC1-102W'†<br>'UC2-43W'†<br>'Johlyn'<br>'UC25-75' | 'Donna'<br>'UC1-87'<br>'Price'<br>'Jenette'<br>'Morley'<br>'Plateau' | 'Yokut'<br>'Wood colony'<br>'Livingston'<br>'Sano'<br>'Durango'<br>'Aldrich'†<br>'Padre'<br>'Butte'<br>'Chips' | 'Savana'<br>'Winters (UC13-1)'<br>'Carmel'<br>'Avalon'†<br>'Khal'<br>'Ruby' | 'Monterey'<br>'Mission' |

†Rankings of these cultivars are based only on 4 years of harvest maturity observations.

## 4. Nut maturation rate

The rate of nut maturation for each cultivar is represented as the total number of days between 1 percent hull split and 100 percent hull split.Cultivars are categorized into four nut maturation groups; the Carmel group, the Butte group, the Nonpareil group, and the Monterey group (Table 3). How rapidly cultivars mature from hull split initiation to 100 percent hull split influences the time of exposure to pests.A cultivar with a well sealed shell and a short maturation period like 'Carmel' tends to have excellent quality.A paper shelled cultivar such as 'Nonpareil' that has a relatively long maturation period is more susceptible to worm damage.Like wise, the high kernel percentage, very long maturation period, and relatively late harvest of the new 'Winters' cultivar suggests that it has a greater potential for worm damage.Effective pest management for such cultivars will be essential to keep worm damage low.

## 5. Commercial harvest timing

Commercial harvest operations are often guided by how rapidly field operations can progress from one cultivar to the next under orchard conditions.The situation is further complicated if independent custom harvest operators are employed.Custom harvest operators may harvest for several owners by rotating sequentially between different orchards.This is the case for harvest operations at the Chico RAVT.

**Table 3. Nut maturation of almond cultivars in the Chico Regional Almond Variety Trial represented as the number of days between 2 and 100% hull split**

| 'Carmel' group 15 to 19 days short maturation | 'Butte' group 20 to 22 days medium maturation | 'Nonpareil' group 23 to 25 days long maturation | 'Monterey' group 26 to 30 days very long maturation |
|---|---|---|---|
| 'Kochi'† | 'Durango' | 'Donna' | 'Sano' |
| 'Rosetta' | 'UC2-19E' | 'UC25-75' | 'Monterey' |
| 'Carmel' | 'Padre' | 'Avalon'† | 'Winters (UC 13-1)' |
| 'Jenette' | 'UC1-87' | 'Price' | 'Yokut' |
| | 'Mission' | 'Plateau' | |
| | 'Moreley' | 'Jiml' | |
| | 'Kapareil' | 'Savana' | |
| | 'Wood colony' | 'Johlyn' | |
| | 'Butte' | 'Ruby' | |
| | 'UC2-43W'† | 'Chips' | |
| | 'UC1-102W'† | 'Nonpareil' | |
| | 'Aldrich' | 'Kahl' | |
| | 'Kapareil/PA' | 'Livingston' | |
| | 'Sonora' | | |

†Rankings of these cultivars are based only on 4 years of harvest maturity observations.

The Chico RAVT is typically harvested in four or five commercial custom harvest operations. The 34 cultivars in the trial have been divided into five groups according to when they are commonly harvested commercially; the 'Nonpareil' group, the 'Price' group, the 'Butte' group, the 'Carmel' group and the 'Mission' group (Table 4).These groups are harvested at roughly weekly intervals although individual cultivars within the groups are more or less mature at the time of harvest depending on when they reached 100% hull split.The later maturing groups have a higher probability of experiencing rain during harvest that can slow harvest operations and increase costs.

# IV – Conclusions

While not reported here, cultivars in the Chico RAVT are annually evaluated for characteristics such as bloom density and timing, pollen compatibility, yield, and nut quality.Harvest maturity factors presented here such as 1% hull split, 100% hull split, rate of nut maturation, and commercial harvest timing are important characteristics for all almond producers to consider when choosing cultivars for planting new orchards.

Adequate commercial testing is one of the greatest difficulties in new almond cultivar selection in California.The Chico RAVT is used by almond growers and others in the California industry to compare cultivars by visual observations as well as through data summaries generated by researchers. Comparing new cultivars to currently grown standards has helped our industry learn new cultivars characteristics and has successfully identified those with serious faults prior to their widespread commercial planting.

**Table 4. Commercial harvest of almond cultivars in the chico Regional Almond Variety Trial represented as the number of weeks after commercial 'Nonpareil' harvest**

| 'Nonpareil' group with 'Nonpareil' | 'Price' group 1 to 2 weeks after 'Nonpareil' | 'Butte' group 2 to 3 weeks after 'Nonpareil' | 'Carmel' group 3 to 4 weeks after 'Nonpareil' | 'Mission' group 4 1/2 weeks after 'Nonpareil' |
|---|---|---|---|---|
| 'Nonpareil' | 'Kochi'† | 'Plateau' | 'Winters (UC13-1)' | 'Monterey' |
| 'Kapareil' | 'UC2-19E' | 'Wood colony' | 'Chips' | 'Mission' |
| | 'Rosetta' | 'Morley' | 'Kahl' | |
| | 'Jiml' | 'Sano' | 'Ruby' | |
| | 'Sonora' | 'Yokut' | 'Carmel' | |
| | 'UC1-102W'† | 'Livingston' | 'Avalon'† | |
| | 'UC25-75' | 'Butte' | | |
| | 'Price' | 'Aldrich' | | |
| | 'UC1-87' | 'Savana' | | |
| | 'Donna' | 'Durango'† | | |
| | 'Johlyn' | 'Padre' | | |
| | 'Jenette' | | | |
| | 'UC2-43W' | | | |

†Rankings of these cultivars are based only on 4 years of harvest maturity observations.

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