with the placement of these 2 cultivars in 1972–1973 as having 26–50% injury (1). Cultivars differing from earlier classification include 'Baco Noir' (13.1%), 'Ravat Blanc' (8.7%), 'Aurore' (7.5%), and 'Joannes Seyve 26-627' (7.8%), all estimated as having 26–50% injury in the earlier rating (1).

American grape cultivars exhibited a wider range in sensitivity to ambient ozone than *V. vinifera* or French hybrid cultivars, with many American cultivars highly sensitive. The data indicate tolerance to exist within all 3 cultivar groups. Many of the French hybrids and American cultivars are of complex parentage involving several American grape species and *V. vinifera,* and their classification as American or French is not related to their genetic background. However, the French hybrid and *V. vinifera* cultivar groups have considerably less variability in sensitivity to ozone than the American cultivar group. The French hybrids tend to be more like the *V. vinifera* group. Sensitivity to ozone in *Vitis* may originate in one or more of the American *Vitis* species. The high sensitivity of some of the American cultivars was not transmitted to progeny in crosses made by developers of the French hybrids.

No grape cultivar was free of oxidant stipple injury. Even though 'Isabella', 'Delaware', 'Villard Blanc', 'Joannes Seyve 12-428', and others had little injury and can be considered tolerant, small amounts of injury occurred on those cultivars in most years. 'Ives' and 'Couderc 3309' were the most sensitive grape cultivars as reported earlier (1). 'Ives' has been used in New York as a bioindicator of ambient ozone since the early 1970s. In some years, oxidant stipple injury has been observed on 'Ives' foliage as early as several weeks before bloom of that cultivar.

Injury ratings of most of the cultivars we examined generally are consistent with earlier initial estimates (1). Major exceptions to the earlier estimates have been described. Differences may be related to vineyard location or management during the 2 study periods. Results reported here are specific for the site where these grapevines were growing in Geneva, N.Y. It is expected that the relative ranking of each cultivar may vary with microclimatic and soil changes due to vineyard location and with vineyard cultural practices (2, 4). In addition, we have found that injury rankings of grapevine cultivars vary from year to year. The tables can be used to indicate relative ranking in terms of general tolerance or sensitivity. Cultivar position ranking in the tables may vary somewhat from year to year and with specific vineyard conditions.

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Self-compatibility in 'Truoito' Almond and the Effect of Temperature on Selfed and Crossed Pollen Tube Growth

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Additional index words. *Prunus amygdalus*, self-fertility, self-pollination

Abstract **The level of fruit set of 'Truoito' almond from hand self-pollination was high (47.7% and 56.8% in 1982 and 1983, respectively) and similar to the fruit set from hand cross-pollination. Fruit set in bagged branches excluding pollinators (honey bees and wind) was high and similar to that from open pollination (38.0% and 40.0%, respectively). Effective self-pollination occurred without pollinators because the stigmatic surface was adjacent to the anthers, in contrast to other cultivars examined in which the stigma was above the anthers. Pollen tube growth in self-pollinated styles was faster than in those cross-pollinated at 10° and 15°C, but similar at 20° and 25° and slower at 30°. Inhibition of pollen tube growth occurred at 30° in 45% of the self-pollinated styles. Optimum temperatures for 'Truoito' pollen tube growth in either selfed or crossed styles were between 20° to 25°, and 54 hr elapsed before tubes reached the base of the style after pollination. Pollen tube growth under field conditions was similar in both selfed and crossed styles.**

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Commercial almond cultivars are self-incompatible (2, 3), and for an economical fruit set of 30% or higher, pollinizers are required (3). Almonds bloom early, and when the weather is not favorable for good bee activity, yields may be poor. Therefore, self-compatible cultivars are desirable. Self-compatible cultivars usually do not set fruit as linated. This difference is related to genotype (6, 7).

Temperature affects not only bee activity but also pollen tube growth and fruit set of almonds (1, 6). Pollen tube growth of various genotypes responds to different optimum temperatures (6).

Muhturi-Stylianidu (5) in Greece reported that the 'Truoito' almond is self-compatible, and fruit set with self-pollination is as high as that obtained from cross-pollination. In addition, she found that it can set fruit with out the aid of insects.

The objectives of this study were to confirm the self-compatibility of 'Truoito' by using fluorescent microscopy, to determine the extension and growth rate of selfed and crossed pollen tubes at various temperature regimes, and to determine relative levels of fruit set from self and cross-pollination without the aid of pollen transfer by insects.

Self- and cross-pollination with pollen of 'Texas' was performed by hand to emasculated flowers on 10 bagged branches for each treatment on 10 mature trees in 1982.

Fruit set of self-pollinated 'Truoito' flowers without the aid of insects was studied under lab and field conditions in 1983. First, bouquets from mature trees with only a few open flowers were brought to the lab, and flowers of all stages were removed except those at the balloon stage, which were left to open. Stigmas were examined for pollen after dehiscence. Secondly, 40 branches on mature trees in the field were chosen for examining self-pollinated stigmas and for fruit set determination. Ten of these were unbagged for open pollination. Twenty were bagged with cheesecloth to exclude bees, half to be hand self-pollinated, and the other half

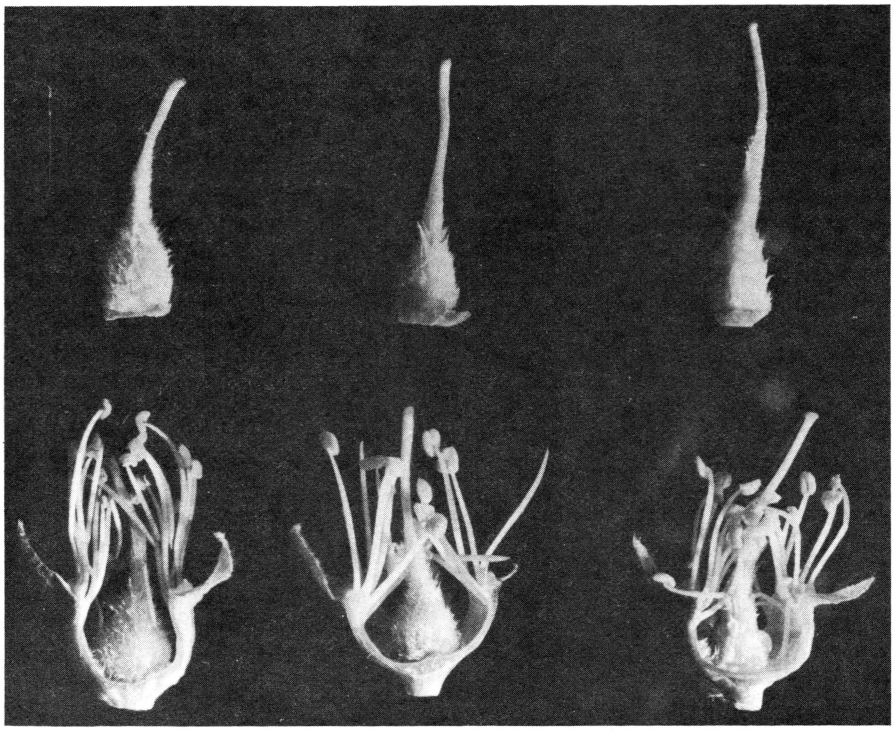

Fig. 1. Flowers (below) and pistils (above) of 3 almond cultivars. Left to right, Truoito, Retsu, and Texas.

bagged with cellophane to prevent open-pollination by wind. Samples of 10 flowers from each were examined by fluorescent microscopy for the percentage of flowers with pollen tubes in the styles. Fruit set was determined after the June drop.

Flower morphology was studied and the position of the stigma was measured in 50 flowers in relation to the anthers of 5 known self-incompatible cultivars ('Ferragnes', 'Ardechoice', 'D. Larguetta', 'Retsu', 'Texas') and of 'Truoito'. The length of the highest anther were measured.

Pollen tube extension and growth rate in relation to temperature were evaluated on hand self-pollinated and hand cross-pollinated 'Truoito' flowers on trees grown in 20 liter pots or from branches cut from mature trees. All flowers were emasculated during a 24-hr period, and then pollinated. The trees or the bouquets then were transferred to rooms with temperatures of 10°, 15°, 20°, 25°, 30°C or ambient temperature in the field (2 or 3 replications of each one). Samples of 15 flowers were collected every 12 or 24 hr and placed in FAA. The pistils were washed and macerated in 4N NaOH for 14 hr. Samples were washed and prepared for staining with 0.1% amiline blue (4), and the styles were placed on a microscope slide with a drop of glycerine and squashed under a cover slip for observation of the pollen tubes with the aid of HBO 200 W high pressure Hg lamp.

Pollen tube lengths were measured in 10 styles for each collection, and are reported as the percentage of the style length penetrated by the longest pollen tube.

Fruit set in 1982 after hand self- or cross-pollination was high, 47.7 (± 10.4)% and 48.8 (± 7.4)%, respectively. Hand self-pollination in 1983 resulted in 56.8% fruit set (Table 1). Flowers examined for unaided self-pollination under lab conditions showed that 55.0 (± 4.5)% of the flowers had pollen tubes. Under field conditions on bagged branches, the percentage of flowers with pollen tubes was even higher, 65.0 (± 6.7)%. Fruit set on bagged branches without insect pollination was the same as that of open-

Table 1. The percentage of fruit set of the 'Truoito' almond after open-pollination, hand self-pollination, and natural self-pollination (10 reps.).

Branch covering	Type of pollination	Fruit set (%)
No cover	Open	40.8 a[z]
Cheesecloth	Hand self	56.8 b
Cheesecloth	Natural self [y]	34.4 a
Cellophane	Natural self[y]	38.0 a

[z]Means separated by Duncan's multiple range test (5%).
[y]Pollination without the aid of insects or wind.

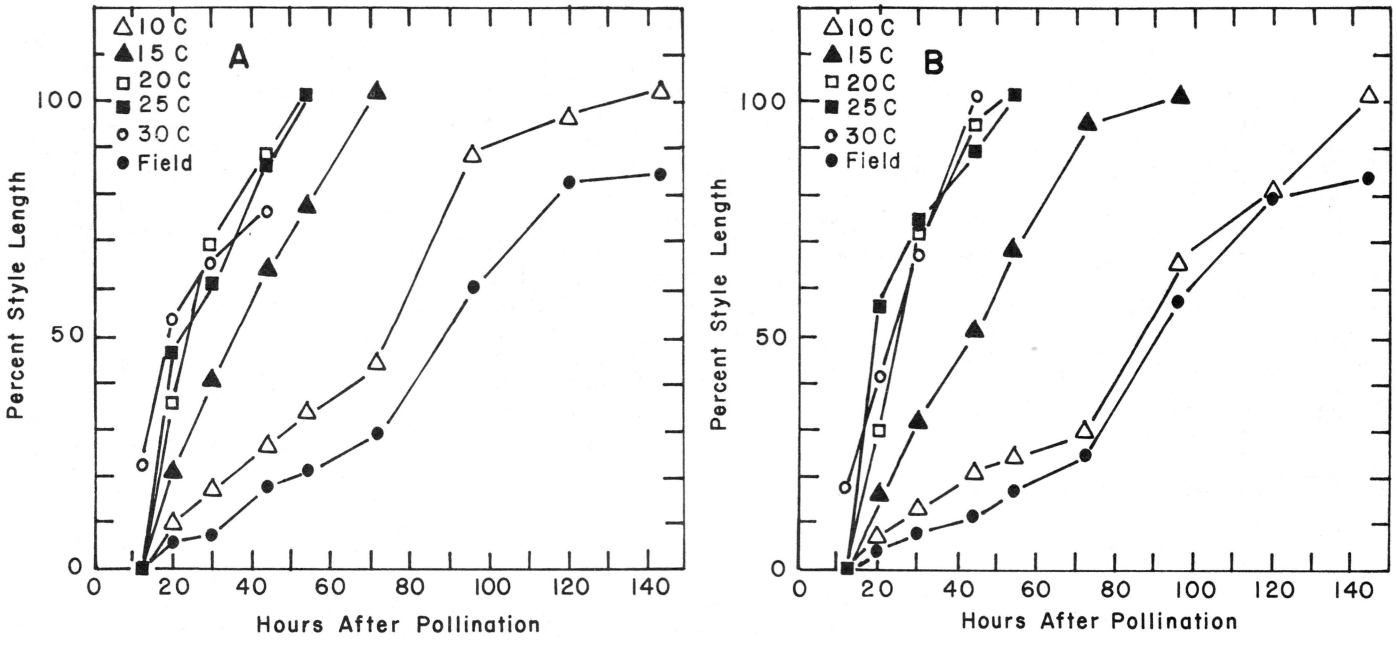

Fig. 2. The mean percentage of style length traversed by the longest pollen tube in 5 controlled temps and the field at time intervals after self- **(A)** and cross- **(B)** pollination (10 'Truoito' styles per rep and 2 or 3 reps, 1983).

Table 2. Mean style length and distance of stigma from the highest anther in flowers of 6 almond cultivars.

Cultivar	Style length (mm)	Distance of stigma from the highest anther (mm)[z]
Ardechoice	11.3 ± 0.5[y]	+2.0 ± 0.2
Desmayo Larguetta	12.7 ± 1.0	+2.6 ± 0.5
Ferragnes	13.3 ± 0.7	+ 3.1 ± 0.2
Retsu	10.9 ± 0.9	+ 0.2 ± 0.8
Texas	11.3 ± 0.8	+ 3.3 ± 0.2
Truoito	8.6 ± 0.9	− 2.3 ± 0.3

[z] + Stigma above highest anther; − Stigma below highest anther.
[y]Mean and SD (n = 50).

pollinated flowers (Table 1), but significantly lower than the hand self-pollinated.

The stigmas of 'Ferragnes', 'Ardechoice', 'D. Larguetta', and 'Texas' were positioned above the highest anther (Table 2), while the stigmas of 'Retsu' were at the same level as the highest anther. Stigmas of the 'Truoito', however, were between the lowest and highest anthers (Fig. 1). Most of the 'Truoito' flowers examined had stigmas in contact with anthers. The morphology of the 'Truoito' flower is ideal for cool climate pollination (too cool for bee flight) because the short style length maintains a stigmatic surface below and in contact with the anthers (30 per

Pollen tube growth was temperature related as has been reported for other almond cultivars (1, 6). Pollen tube growth in selfed styles of 'Truoito' was continuous without any sign of incompatibility at all temperatures tested, except 30°C, in 1982 and 1983 (Fig 2). It took 144 hr for pollen tubes to penetrate the base of all styles in both treatments at 10°C, while 72 hr were required in the selfed and 96 hr in crossed styles at 15°. At 20° and 25°, pollen tube extension to the stylar base took 54 hr for both self- and cross-pollination. Pollen tube growth in selfed styles at 30°C was inhibited, however, and only 55% had pollen tubes at their base after 54 hr.

Pollen tube growth in the field was slow in both treatments, taking 120 hr to penetrate the base of most styles. No differences in pollen tube growth rate were noticed between selfed or crossed styles, which explains the high fruit set from selfing.

The self-compatibility of 'Truoito' has been confirmed by examining the pollen tube growth and the fruit set level from self- or cross-pollination. The ratio of stamen number to pistil length in 'Truoito' flowers was 2.5 and it was higher than the range of 2.0 to 1.7 found in self-incompatible cultivars examined or reported elsewhere (7). Screening of other almond cultivars and seedlings for flowers having similar morphological characteristics would be desirable in a breeding program.

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Pecan Kernel Proteins and Their Changes with Kernel Development

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Additional index words. amino acids, albumins, globulins, prolamines, glutelins, irregular bearing, nutrition

Abstract. **Pecan [*Carya illinoensis* (Wangenh.) Koch] kernel development is characterized by rapid accumulation of dilute acid and dilute alkali soluble proteins and decline of buffer and alcohol soluble proteins during embryo and cotyledon expansion. Mature kernels contained 7.8% protein, consisting of 51% acidic glutelins, 27% alkali glutelins, 9% concentration alkali, 7% prolamine, 4% albumin, and 1% globulin. Each fraction was composed of at least 2 proteins throughout kernel development. Proteins in each fraction were comprised primarily of neutral amino acids, but individual amino acid levels were highest for basic amino acids, with relatively high levels of lysine and sulfur containing amino acids. Electrophoresis of acid soluble glutelins revealed at least 7 subunits with molecular weights of 102, 58, 37, 30, 26, 19, and 16 (× 10^3). The data are considered in relation to alternate bearing and manipulations of fruit maturity.**

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Annual pecan production in the United States approximates 154 million kg of which essentially all comes from trees exhibiting some degree of irregular bearing. Irregular bearing creates uncertainly in income, marketing, and kernel quality. It seems largely dependent upon energy reserves, such that low reserves correlates with reduced nut yield (12, 13, 15, 16). Factors, such as late-season kernel filling, that prevent accumulation of a high level of energy reserves in storage tissues by the conclusion of the growing season contribute to irregular bearing (12). Early kernel development and maturation in relation to autumn leaf abscission would likely contribute to consistent nut production and quality. The developmental processes of kernel growth (filling of cotyledons) are intimately associated with both quantitative and qualitative changes in endogenous kernel proteins (8). These proteins accumulate rapidly after shell hardening (7) to about 10% of kernel weight at nut maturity (5, 7). The relationship of protein types and composition to kernel development is unknown, especially the relationship with initiation of rapid kernel filling. This report presents baseline information concerning protein classes and their association with kernel development.

Source of plant material. Pecan fruit were collected from ten 65-yr-old 'Moneymaker' pecan trees maintained free of disease and insect pests. Samples were from trees with moderate crops; thus, kernel development was normal and had well-filled cotyledons. Fruit were collected 10 Aug. to 27 Oct. at intervals of 1–3 weeks, packed in dry ice, bulked, transported to the laboratory, and lyophilized. The kernel (embryo, endosperm, and testa) was separated from other fruit tissues and analyzed for lipid and protein characteristics.