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# Prune Maturity and Storage

*By*

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## Summary

1. Maturity changes of the Italian prune are characterized by softening of the flesh, development of color pigments in the skin, increase in sugar content, and decrease in acid content.

2. Orchards vary in their production of sugar and acid in fruit when measured at a definite firmness. A similar seasonal variation within a given orchard also exists.

3. The length of time that prunes may be kept in storage is usually limited by shriveling, the more mature the prune when stored the sooner it will shrivel. Other storage troubles are mold, which especially occurs where the skin of the fruit is broken, and internal breakdown of the tissues which turn brown.

4. Under the storage conditions described, prunes kept about the same length of time as they did on the tree in favorable weather.

5. Firmness seems to be an accurate measure of the keeping qualities of a prune in storage.

6. Firm prunes with a high sugar content when picked keep as well as prunes of the same firmness with a low sugar content, and also have a better flavor.

7. Prunes kept at room temperature and humidity softened and shriveled rapidly, indicating that early storage after harvest lengthens their keeping period.

## Acknowledgements

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# Prune Maturity and Storage

By

LOWELL R. TUCKER\* AND LEIF VERNER†

THIS BULLETIN is a report of maturity studies and of storage tests on the Italian prune. The work was started in the Boise valley of Idaho in 1927. A preliminary report (7) of the first two years' work was published in 1929. These studies (6, 7) showed that seasonal maturity changes consist of a gradual softening of flesh and at the same time an increase in sugar content and decrease in acid content of the fruit. As a measure of maturity changes in an orchard during one season, sugar content was found to be more variable than firmness. Similar results also have been obtained with the Italian prune by Hartman (2) in Oregon and by Allen, Magness and Haller (1) with plums in California.

The preliminary study indicated that skin color and acid content likewise were less dependable than firmness as a measure of maturity. Prunes picked at a firmness of 12 pounds as measured by the U. S. pressure tester held up well in storage but did not develop prime quality. Shriveling was found to be the most extensive type of deterioration and the first to occur. This was followed closely by mold and internal browning. The progress report (7) and the study by Ramsey (3) showed that cold storage lengthens the time prunes will keep and that upon removal from storage they deteriorate rapidly.

## Plan of Report

In this study the differences in maturity changes from season to season were noted. The keeping qualities of the fruits in storage each season also were compared. In 1930 and 1931 maturity changes were noted in different orchards of various localities of southern Idaho (4).

Seasonal data taken were: date picked, firmness, Balling hydrometer readings of the expressed juice as a measure of sugar content, acid content of the juice, size of fruit, flavor, the number of days and the date to which the stored fruit kept (Tables I, II, III and IV).

Data taken on fruit from various orchards in 1930 were: date picked, firmness of the fruit, and hydrometer readings of the expressed juice. In 1931 the firmness of the fruit was

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TABLE I  
Prune Harvest and Storage Data for 1927

| Date picked | Resistance to pressure lbs. | Sugar content of juice per cent. | Acid per cent. | Aver. vol. per prune c. c. | Flavor      | Date kept | Days kept |
|-------------|-----------------------------|----------------------------------|----------------|----------------------------|-------------|-----------|-----------|
| 8-31        | 12.6                        | 14.0                             | 1.31           | 25.65                      | Very sour   | 9-27      | 27        |
| 9-3         | 12.0                        | 14.8                             | 1.30           | 26.05                      | Very sour   | 10-8      | 35        |
| 9-6         | 11.1                        | 15.9                             | 1.25           | 26.70                      | Sour        | 10-11     | 35        |
| 9-9         | 10.2                        | 16.1                             | 1.25           | 26.85                      | Sour        | 10-2      | 23        |
| 9-12        | 10.0                        | 16.1                             | 1.19           | 27.45                      | Sour        | 10-5      | 23        |
| 9-15        | 9.9                         | 16.1                             | 1.18           | 28.00                      | Mildly sour | 10-3      | 18        |
| 9-18        | 9.5                         | 18.0                             | 1.14           | 28.65                      | Mildly sour | 10-7      | 21        |
| 9-21        | 8.6                         | 18.5                             | 0.94           | 26.00                      | Fair        | 10-6      | 15        |
| 9-24        | 8.6                         | 21.5                             | 0.95           | 25.00                      | Fair        | 10-5      | 11        |
| 9-27        | 8.7                         | 19.8                             | 0.74           | 25.25                      | Fair        | 9-30      | 3         |
| 9-30        | 8.7                         | 22.3                             | 0.80           | 25.00                      | Fair        | 10-3      | 3         |
| 10-3        | 6.8                         | 20.7                             | 0.64           | (25.00)                    | Fair        | 10-7      | 4         |
| 10-6        | 7.4                         | 23.7                             | 0.60           | (25.00)                    | Good        |           |           |
| 10-9        | 6.4                         | 23.5                             | 0.62           | (25.00)                    |             |           |           |

again noted, and also the flavor. The refractive index readings of the juice as measured by the Zeiss refractometer were taken as a measure of sugar content, replacing the Balling hydrometer readings of 1930.

Preliminary tests of the adaptability of the refractometer showed that this machine gave readings slightly lower but

TABLE II  
Prune Harvest and Storage Data for 1928.

| Date picked | Resistance to pressure lbs. | Sugar content of juice per cent. | Acid per cent. | Flavor      | Date kept | Days kept |
|-------------|-----------------------------|----------------------------------|----------------|-------------|-----------|-----------|
| 8-27        | 9.6                         | 15.5                             | 0.58           | Sour        | 9-29      | 33        |
| 8-30        | 9.7                         | 17.0                             | 0.60           | Sour        | 10-6      | 37        |
| 9-2         | 8.4                         | 17.0                             | 0.41           | Mildly sour | 9-23      | 21        |
| 9-5         | 7.5                         | 17.0                             | 0.71           | Fair        | 9-23      | 18        |
| 9-8         | 8.5                         | 18.5                             | 0.59           | Fair        | 9-23      | 15        |
| 9-11        | 8.4                         | 18.5                             | 0.68           | Fair        | 9-23      | 12        |
| 9-14        | 8.1                         | 19.5                             | 0.62           | Fair        | 9-25      | 11        |
| 9-17        | 7.4                         | 18.5                             | 0.62           | Fair        | 9-26      | 9         |
| 9-20        | 7.8                         | 19.0                             | 0.60           | Good        | 9-26      | 6         |
| 9-23        | 7.6                         | 20.5                             | 0.60           | Very good   | 9-29      | 6         |
| 9-26        | 7.6                         | 21.5                             | 0.58           | Very good   |           |           |
| 9-29        | 7.1                         | 23.0                             | 0.58           | Prime       |           |           |
| 10-2        | 7.1                         | 23.5                             | 0.48           | Prime       |           |           |
| 10-5        | 6.4                         | 22.0                             | 0.57           | Prime       |           |           |
| 10-8        | 5.8                         | 23.5                             | 0.55           | Prime       |           |           |
| 10-11       | 5.3                         | 25.0                             | 0.52           | Prime       |           |           |
| 10-14       | 5.7                         | 26.0                             | 0.52           | Flat sweet  |           |           |

TABLE III  
Prune Harvest and Storage Data for 1929.

| Date picked | Resistance to pressure lbs. | Sugar content of juice per cent. | Acid per cent. | Aver. vol. per prune o. c. | Flavor      | Date kept | Days kept |
|-------------|-----------------------------|----------------------------------|----------------|----------------------------|-------------|-----------|-----------|
| 9-3         | 15.8                        | 11.5                             | 1.06           |                            | Very sour   |           |           |
| 9-6         | 13.9                        | 13.1                             | 1.21           | 21.56                      | Very sour   | 10-16     | 40        |
| 9-9         | 13.6                        | 13.9                             | 1.18           | 21.62                      | Very sour   | 10-23     | 44        |
| 9-12        | 12.9                        | 14.0                             | 1.18           | 22.20                      | Sour        | 10-15     | 33        |
| 9-15        | 12.6                        | 16.1                             | 1.16           | 23.22                      | Sour        | 10-17     | 32        |
| 9-18        | 12.3                        | 18.1                             | 1.12           | 22.90                      | Mildly sour | 10-10     | 22        |
| 9-21        | 12.4                        | 16.5                             | 0.99           | 23.70                      | Mildly sour | 10-4      | 13        |
| 9-24        | 11.7                        | 16.8                             | 0.88           | 23.90                      | Mildly sour | 10-15     | 21        |
| 9-27        | 11.4                        | 16.4                             | 0.95           | 24.38                      | Fair        | 10-10     | 13        |
| 9-30        | 11.5                        | 19.5                             | 0.84           |                            | Good        | 10-13     | 13        |
| 10-3        | 10.3                        | 20.2                             | 0.91           |                            | Good        | 10-11     | 8         |
| 10-6        | 10.7                        | 21.2                             | 0.80           |                            | Good        | 10-12     | 6         |

otherwise paralleling the Balling hydrometer. This machine was used in place of the hydrometer for three reasons: (1) It requires a smaller volume of equipment, making the laboratory more easily moved; (2) It increases speed so that a larger number of tests can be made; (3) It makes possible the comparison of small units. For example: the juice from individual prunes can be readily tested, which is not the case with the Balling hydrometer; the sugar contents of definite areas of an individual fruit can be compared, as a russeted area with a normal or otherwise affected area. One thing that

TABLE IV  
Prune Harvest and Storage Data for 1930.

| Date picked | Resistance to pressure lbs. | Sugar content of juice per cent. | Acid per cent. | Aver. vol. per prune o. c. | Flavor      | Date kept | Days kept |
|-------------|-----------------------------|----------------------------------|----------------|----------------------------|-------------|-----------|-----------|
| 8-19        | 16.7                        | 15.0                             | 1.37           | 28.6                       | Very sour   |           |           |
| 8-21        | 15.9                        |                                  |                |                            | Very sour   |           |           |
| 8-23        | 15.0                        | 15.7                             | 1.14           | 28.0                       | Very sour   |           |           |
| 8-26        | 13.7                        | 16.3                             | 1.14           | 29.6                       | Sour        |           |           |
| 8-29        | 12.5                        | 17.1                             | 0.95           | 29.3                       | Sour        |           |           |
| 9-1         | 12.5                        | 17.3                             | 1.07           | 29.2                       | Sour        | 9-11      | 10        |
| 9-4         | 11.2                        | 18.5                             | 0.98           | 29.3                       | Mildly sour | 9-27      | 23        |
| 9-7         | 10.4                        | 18.2                             | 0.84           | 31.8                       | Mildly sour | 9-29      | 22        |
| 9-10        | 9.9                         | 19.5                             | 0.86           | 33.8                       | Fair        | 10-10     | 30        |
| 9-13        | 9.7                         | 21.4                             | 0.71           | 32.4                       | Good        | 10-6      | 23        |
| 9-16        | 9.1                         | 21.7                             | 0.78           | 31.8                       | Very good   | 9-28      | 12        |
| 9-19        | 8.8                         | 21.4                             | 0.67           | 34.2                       | Very good   | 9-26      | 7         |
| 9-22        | 9.9                         | 22.7                             | 0.66           | 30.2                       | Very good   | 9-27      | 5         |
| 9-25        | 9.6                         | 21.9                             | 0.56           | 33.5                       | Very good   | 10-5      | 10        |

must be constantly watched is that the refractive indices of various portions of what appears to be a normal fruit vary consistently. For instance: the juice from the stem end of a prune shows a consistently lower index than the juice from the apical end of the same fruit.

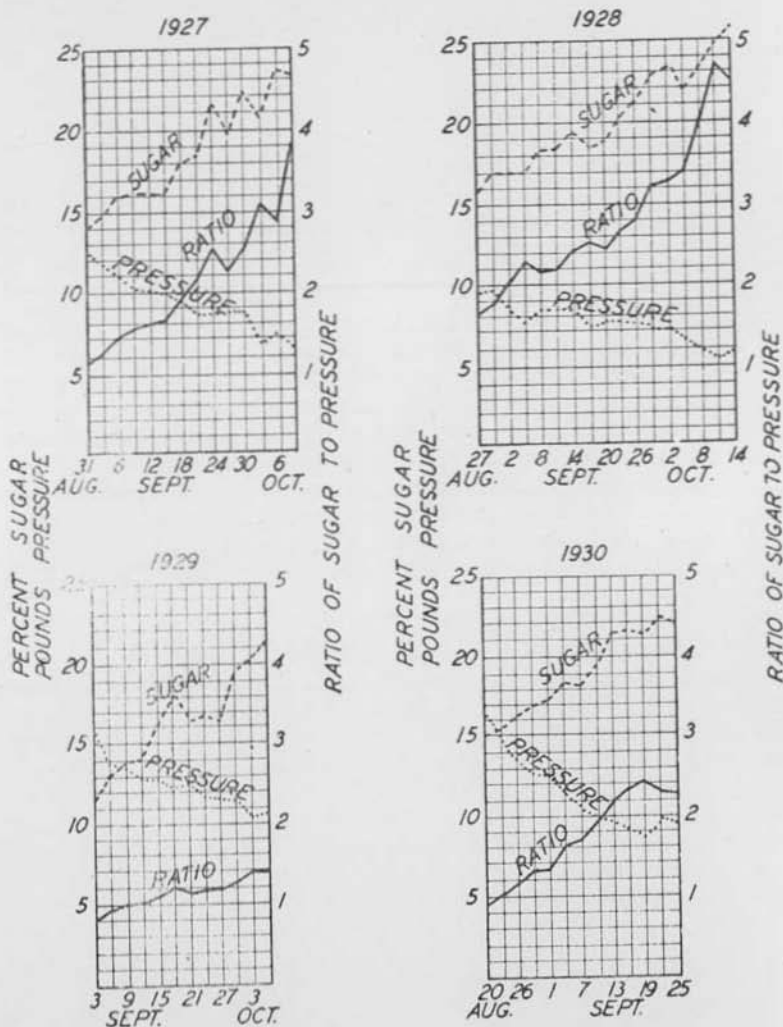


Fig. 1.—Maturity changes in the Italian prune preceding, during and following harvest season for fresh fruit shipments in the Boise Valley, Idaho, 1927-30.

Prunes picked on various dates were stored and their keeping qualities noted at regular intervals. They were stored in the Boise Cold Storage plant at 45° F. for the first 11 days, then at 32° to 35° F. At intervals of 10 days for each lot, one sample was tested and a comparable sample was placed in the window at about 65° to 75° F. for three days to represent store temperature, and then tested. Storage data taken were firmness and flavor of the fruit, and the amount of shriveling, mold, and internal browning present.

#### Seasonal and Orchard Survey of Maturity

The seasonal survey of maturity has been studied from two angles; first, the changes taking place as the fruit matures; and second, a comparison of the fruit produced in different seasons and variations in seasonal maturity changes.

#### *Changes During Maturity Process*

The progress report has shown that prunes as they reach maturity become softer, with an increase in sugar content and a decrease in acidity. Figure 2 shows that temperature affects the rate at which the fruit softens during and just preceding the harvest season. As the temperature becomes cooler in the fall the fruit softens at a slower rate. It may be that fruit softens at a constantly diminishing rate as it approaches maturity (Fig. 1). However, it was noted that the rate diminished during cool periods and increased during warm periods of the season (Fig. 2). The fluctuations in hydrometer readings were large but did not seem to conform to temperature changes.

#### *Seasonal Variation in Maturity Changes*

Since the most nearly consistent measure of maturity change found for one orchard during one season was firmness, recommendations were made (2, 7) for harvesting according to the firmness of the fruit. A four-year survey, however, showed objections to this method that were not formerly apparent (Fig. 1). Maturity tests of fair-flavored prunes in different seasons showed that although firmness is an accurate measure of maturity changes occurring during a season in one orchard it is not as accurate a measure of flavor from one season to the next (Table V). Sugar content and acidity likewise vary accordingly. Because of these variations a firmness standard that is satisfactory one season may not be satisfactory the following season. Table VI, a summary of Tables I, II, III and IV, shows the sugar and acid content variations in the different seasons at a definite firmness. For instance: at 11.0 to 11.9 pounds in firmness, sugar content

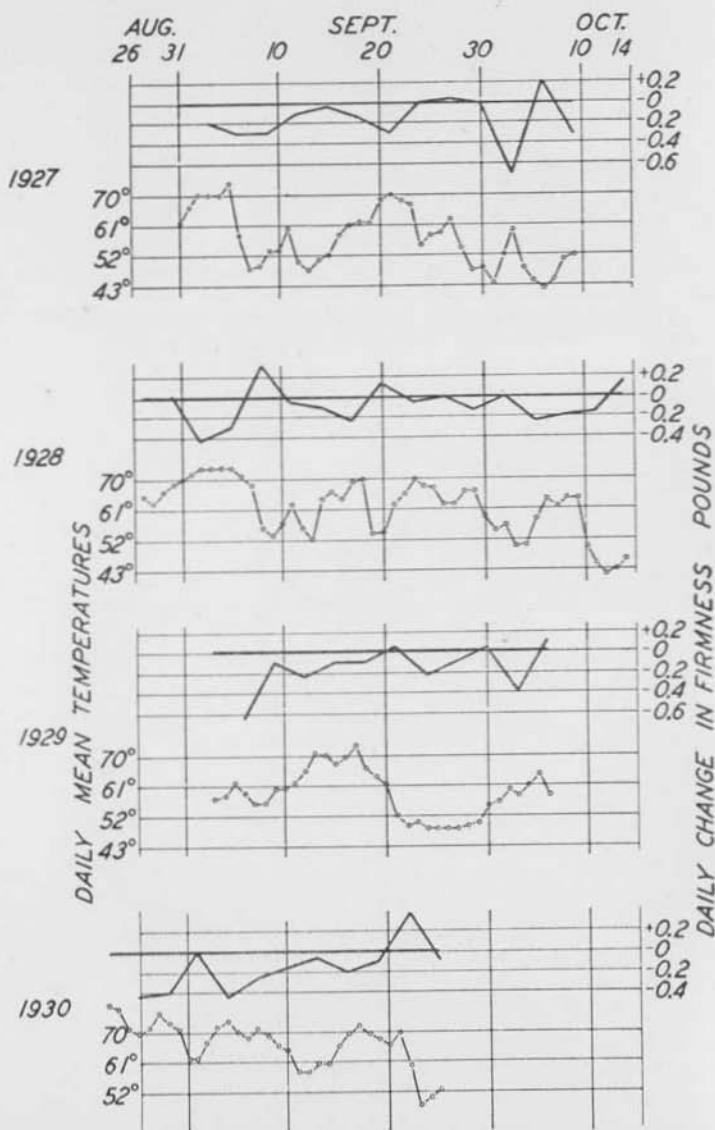


Fig. 2.—Solid line shows daily average change in firmness during harvest season with tests made at three-day intervals. Broken line shows temperatures during the same season. These graphs show that usually with a drop in temperature during this season the rate of softening diminishes.



TABLE V  
Maturity Tests of Fruit from McBirney Orchard at Fair Flavor

|                           | 1927 | 1928 | 1929 | 1930 | 1931  |
|---------------------------|------|------|------|------|-------|
| Firmness in lbs.          | 8.3  | 8.0  | 11.4 | 9.9  | 12.2  |
| Sugar content in per cent | 20.6 | 18.4 | 16.4 | 19.5 | 19.2  |
| Acid content in per cent  | 0.81 | 0.60 | 0.95 | 0.86 | ..... |

varied from 15.9 to 18.5 per cent. This variation would probably have been more had the 1928 fruit been tested at that firmness. Seasonal variations in firmness and acid content at a constant sugar content (Table VII) show fully as great variations as those in Table VI.

At a constant firmness the flavor was improved with increased sugar content (Table VIII), and with a constant sugar content the flavor was improved as the fruit softened (4). Seasons producing a soft fruit seemed also to produce a low acid fruit.

Since flavor in itself is an indefinite measure, and a definite mechanical measure is desired, the other tests of maturity for each flavor class were averaged for the years 1927 to 1930 inclusive, and in 1931 separately. These are summarized in Tables IX and X. They indicate the range of sugar content for each flavor shown in Table XI.

In seasons when sugar content is high a firm prune will have as good flavor as a softer prune in seasons when the sugar content is low. An example of this is a comparison of prunes in 1928 and 1929 (Tables II, III). In 1929 they were about four pounds firmer than in 1928 at the same flavor. The firm fruit of the 1929 season had exceptional carrying quality and offered an opportunity to increase prices through storage and late picking. It also had high dessert qualities.

#### *Orchard Variation in Maturity Changes*

A survey of several orchards in 1930 and 1931 (4) showed that less striking but similar variations to those found between seasons also exist among orchards. This is shown by the data presented in Table VIII. From these tests it would seem that by orchard selection a similar opportunity exists through storage and late picking to increase the market season and prices.

#### *Rates at Which Maturity Changes Occur*

A summary of the 1927-1930 data indicates that maturity changes occur at the average rate shown in Fig. 3. This figure also answers an inquiry of some of the growers as to when their fruit will be mature enough to start harvest. By first determining the firmness of the fruit and locating this point

TABLE VI  
Sugar and Acid Content of Prunes at Various Stages of Firmness.  
McBirney Orchard.

| Firmness<br>in pounds<br>pressure | Sugar Content  |          |                |          |                |          |                |          | Acid Content   |          |                |          |                |          |                |          |
|-----------------------------------|----------------|----------|----------------|----------|----------------|----------|----------------|----------|----------------|----------|----------------|----------|----------------|----------|----------------|----------|
|                                   | 1927           |          | 1928           |          | 1929           |          | 1930           |          | 1927           |          | 1928           |          | 1929           |          | 1930           |          |
|                                   | No.<br>Samples | Per cent | No.<br>Samples | Per cent | No.<br>Samples | Per cent | No.<br>Samples | Per cent | No.<br>Samples | Per cent | No.<br>Samples | Per cent | No.<br>Samples | Per cent | No.<br>Samples | Per cent |
| 15.0-15.9                         |                |          |                |          | 1              | 11.5     | 1              | 15.7     |                |          |                |          | 1              | 1.06     | 1              | 1.14     |
| 14.0-14.9                         |                |          |                |          | 0              |          | 0              |          |                |          |                |          | 0              |          | 0              |          |
| 13.0-13.9                         |                |          |                |          | 2              | 13.5     | 1              | 16.3     |                |          |                |          | 2              | 1.20     | 1              | 1.14     |
| 12.0-12.9                         | 2              | 14.4     |                |          | 4              | 16.2     | 2              | 17.2     | 2              | 1.30     |                |          | 4              | 1.11     | 2              | 1.01     |
| 11.0-11.9                         | 1              | 15.9     |                |          | 3              | 17.6     | 1              | 18.5     | 1              | 1.25     |                |          | 3              | .89      | 1              | .98      |
| 10.0-10.9                         | 2              | 16.1     |                |          | 2              | 20.7     | 1              | 18.2     | 2              | 1.22     |                |          | 2              | .86      | 1              | .84      |
| 9.0- 9.9                          | 2              | 17.0     | 2              | 16.2     |                |          | 5              | 21.4     | 2              | 1.16     | 2              | .59      |                |          | 5              | .91      |
| 8.0- 8.9                          | 4              | 20.5     | 4              | 18.4     |                |          | 1              | 21.4     | 4              | .86      | 4              | .58      |                |          | 1              | .67      |
| 7.0- 7.9                          | 1              | 23.7     | 7              | 20.4     |                |          |                |          | 1              | .60      | 7              | .60      |                |          |                |          |
| 6.0- 6.9                          | 2              | 22.1     | 1              | 22.0     |                |          |                |          | 2              | .63      | 1              | .57      |                |          |                |          |
| 5.0- 5.9                          |                |          | 3              | 24.8     |                |          |                |          |                |          | 3              | .53      |                |          |                |          |



TABLE VIII

Variations in Fruit Maturity Between Orchards; (1) In Firmness at a Constant Sugar Content, and (2) in Sugar Content at a Constant Firmness.

| Orchard No. | 1930                    |                        |                              |               | 1931                    |                        |                              |               |             |
|-------------|-------------------------|------------------------|------------------------------|---------------|-------------------------|------------------------|------------------------------|---------------|-------------|
|             | At 10.2 pounds firmness |                        | At 16 per cent sugar content |               | At 12.2 pounds firmness |                        | At 17 per cent sugar content |               |             |
|             | Date                    | Sugar content per cent | Date                         | Firmness lbs. | Date                    | Sugar content per cent | Flavor*                      | Firmness lbs. | Flavor*     |
| 1           |                         |                        |                              |               | 8-28                    | 19.3                   | Good                         |               |             |
| 2           |                         |                        |                              |               | 8-27                    | 19.0                   | Fair                         | 14.6          | Sour        |
| 3           |                         |                        |                              |               | 8-23                    | 17.3                   | Mildly sour                  | 13.1          | Mildly sour |
| 4           |                         |                        |                              |               | 8-27                    | 18.4                   | Fair                         | 14.4          | Mildly sour |
| 5           |                         |                        |                              |               | 8-30                    | 18.1                   | Fair                         | 13.1          | Mildly sour |
| 6           | 8-29                    | 16.0                   | 8-29                         | 10.2          | 8-30                    | 16.8                   | Mildly sour                  | 11.9          | Fair        |
| 7           |                         |                        |                              |               | 9- 1                    | 19.6                   | Fair                         | 14.8          | Sour        |
| 8           | 9- 2                    | 15.8                   | 9- 4                         | 10.0          | 8-29                    | 17.2                   | Fair                         | 12.2          | Fair        |
| 9           |                         |                        |                              |               | 8-28                    | 18.0                   | Fair                         | 14.3          | Mildly sour |
| 10          | 8-25                    | 15.5                   | 8-29                         | 9.7           | 9- 1                    | 17.4                   | Fair                         | 12.7          | Fair        |
| 11          | 9-15                    | 18.5                   | 9- 1                         | 12.6          | 9- 4                    | 18.8                   | Fair                         | 13.8          | Mildly sour |
| 12          |                         |                        |                              |               | 9- 4                    | 19.5                   | Good                         | 14.5          | Mildly sour |
| 13          |                         |                        |                              |               | 9- 1                    | 17.7                   | Mildly sour                  | 13.8          | Mildly sour |
| 14          | 9- 8                    | 18.6                   | 8-25                         | 14.3          | 9- 1                    | 20.0                   | Good                         | 16.2          | Sour        |
| 15          | 9- 3                    | 17.4                   | 8-27                         | 11.6          | 9- 5                    | 17.8                   | Fair                         | 14.4          | Fair        |
| —           | 9- 6                    | 14.7                   | 9- 9                         | 8.8           |                         |                        |                              |               |             |
| —           | 9-24                    | 18.1                   |                              |               |                         |                        |                              |               |             |
| —           | 8-25                    | 15.4                   | 8-28                         | 8.5           | 8-26                    | 17.7                   | Fair                         |               |             |
| —           |                         |                        |                              |               | 9- 1                    | 18.1                   | Mildly sour                  | 14.6          | Mildly sour |
| —           |                         |                        |                              |               | 8-31                    | 17.7                   | Mildly sour                  |               |             |

\* Good flavor—ripe enough to eat out of hand.  
Sour flavor—too green to eat out of hand.

on the firmness curve, then locating the harvest firmness on the curve, the time required for the fruit to change this much may be determined by tracing these points to the bottom of the graph. If sugar content is the basis of measure, the same procedure would then be followed, using the line showing rate of sugar change.

#### Storage Studies

Fresh prunes, to reach market, must stand up under a few days' transportation conditions by railroad and usually three

TABLE IX  
Average Maturity Tests of Prunes at Various Flavor Stages—McBirney Orchard, 1927-1930.

| Flavor      | Sugar content in per cent |             | Firmness pounds |             | Acid content in per cent |             |
|-------------|---------------------------|-------------|-----------------|-------------|--------------------------|-------------|
|             | Average                   | Stand. Dev. | Average         | Stand. Dev. | Average                  | Stand. Dev. |
| Very sour   | 14.0 ± .28                | 1.09        | 14.3 ± .35      | 1.45        | 1.21                     | 0.10        |
| Sour        | 16.4 ± .20                | 0.94        | 11.5 ± .29      | 1.34        | 1.03                     | 0.23        |
| Mildly sour | 17.6 ± .22                | 0.93        | 10.7 ± .33      | 1.39        | 0.93                     | 0.23        |
| Fair        | 19.2 ± .32                | 1.59        | 8.5 ± .23       | 1.15        | 0.76                     | 0.14        |
| Good        | 21.0 ± .38                | 1.39        | 9.5 ± .42       | 1.53        | 0.74                     | 0.11        |
| Very good   | 21.5 ± .16                | 0.57        | 8.6 ± .25       | 0.90        | 0.64                     | 0.08        |
| Prime       | 23.6 ± .24                | 0.73        | 6.5 ± .27       | 0.90        | 0.54                     | 0.05        |
| Flat sweet  | 26.0                      |             | 5.7             |             | 0.52                     |             |

days or more from the storage through the grocery until they reach the consumer. They may or may not be stored after reaching the city or market before going to the grocery.

In order to test the keeping quality of the prunes under treatment similar to the above they were picked, sorted, and immediately placed in storage at 45° F. for 11 days, the average period required to reach far eastern markets. Then some were tested for keeping quality, while others were placed in the window for three days and then tested. The remainder were stored at 32° to 35° F. for different periods of time and then tested both before and after the three-day window treatment. When 10 per cent of the fruit became unmarketable the

TABLE X  
Average Maturity Tests of Prunes at Various Flavor Stages in 1931. Summary of Tests From 18 Orchards.

| Flavor      | Number of Samples tested | Sugar content in per-cent |             | Firmness in pounds |             |
|-------------|--------------------------|---------------------------|-------------|--------------------|-------------|
|             |                          | Average                   | Stand. Dev. | Average            | Stand. Dev. |
| Sour        | 18                       | 15.8 ± .20                | 1.25        | 15.1 ± .12         | 0.75        |
| Mildly sour | 22                       | 17.3 ± .10                | 0.70        | 13.4 ± .16         | 1.09        |
| Fair        | 26                       | 18.3 ± .13                | 1.00        | 12.3 ± .13         | 0.96        |
| Good        | 10                       | 20.0 ± .17                | 0.80        | 11.2 ± .13         | 0.60        |
| Very good   | 1                        | 20.2                      | .....       | 10.7               | .....       |
| Prime       | 2                        | 23.1                      | .....       | 8.3                | .....       |

TABLE XI  
Sugar Content of Fruit at Various Flavors, 1927-1931.

| Flavor | Sugar content in per cent |         |
|--------|---------------------------|---------|
|        | Range                     | Average |
| Sour   | ..... - 16.9              | 15.8    |
| Fair   | 17.0 - 19.2               | 18.3    |
| Good   | 19.3 - 21.6               | 20.1    |
| Prime  | 21.7 - 24.6               | 23.1    |
| Flat   | 24.7 - .....              | 25.7    |

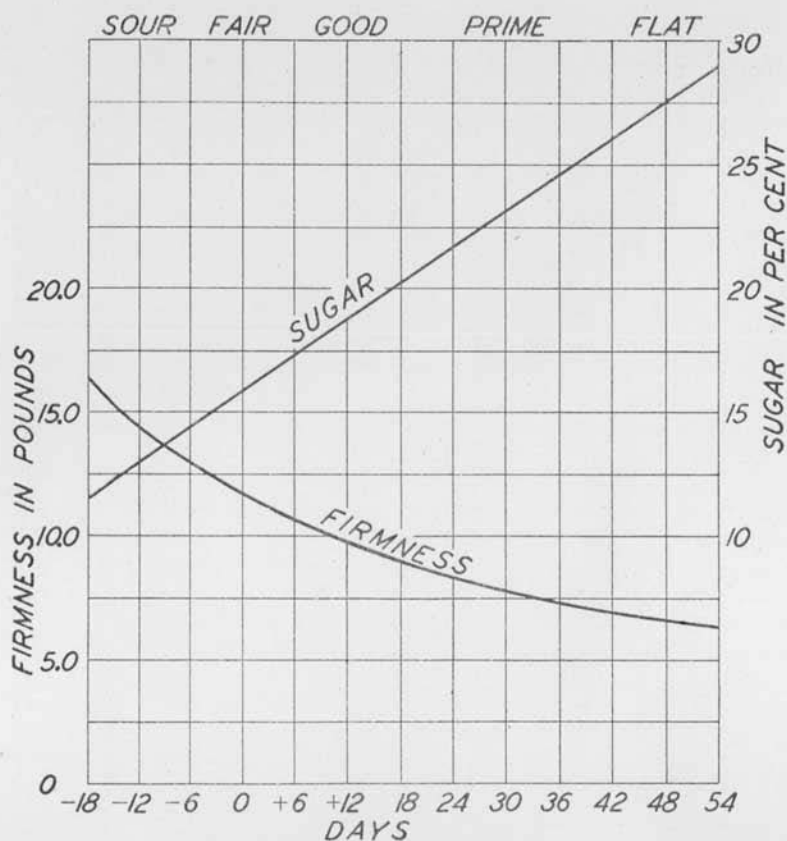


Fig. 3.—Average of maturity changes during the seasons 1927-1930, McBirney Orchard. Average recommended test for start of harvest is 12 lbs. firmness, 16 per cent sugar and 0 days.

end of the keeping period was considered to have been reached.

Prunes soften more rapidly at room temperature than in cold storage, as shown by comparison of the two portions of Table XII. For instance: prunes picked September 4 and stored 21 days tested 10.0 pounds in firmness. After being left in a window three days a test of 7.9 pounds was obtained, a decrease of 2.1 pounds. These differences are summarized in Table XIII. It is also of interest to note that the rate of softening decreases as the fruit becomes softer.

The length of time that a prune will keep is limited by shriveling, decay, internal browning or breakdown, and deterioration in flavor. Shriveling is usually the limiting storage

TABLE XII

Firmness of Prunes Picked at Different Dates, After Remaining in Storage for Various Lengths of Time. McBirney—1930.

| No. days in storage               | Dates in September that prunes were picked |      |      |      |     |     |     |      |     |
|-----------------------------------|--|------|------|------|-----|-----|-----|------|-----|
|                                   | 1  | 4    | 7    | 10   | 13  | 16  | 19  | 22   | 25  |
| 0                                 | 12.5                                       | 11.2 | 10.4 | 9.9  | 9.7 | 9.1 | 8.8 | 9.9  | 9.6 |
| 11                                | 12.9                                       | 11.8 | 11.5 | 10.6 | 9.7 | 9.2 | 9.1 | 10.6 | 9.6 |
| 21                                | 11.3                                       | 10.0 | 11.2 | 9.5  | 9.0 | 7.7 | 9.4 | 8.5  | 7.2 |
| 31                                | 10.2                                       | 9.2  | 9.8  | 8.6  | 7.5 | 7.1 | 7.7 | 8.5  | 8.1 |
| 41                                | 8.1  | 8.4  | 8.3  | 6.9  | 7.2 | 5.8 | 6.8 | 7.2  |     |
| 51                                |  |      |      | 5.9  | 6.4 |     |     |      |     |
| Ave. 11 to 41                     | 10.8                                       | 9.8  | 10.2 | 8.9  | 8.8 | 7.4 | 8.2 | 8.7  |     |
| Days in storage, + days in window | Dates in September that prunes were picked |      |      |      |     |     |     |      |     |
|                                   | 1  | 4    | 7    | 10   | 13  | 16  | 19  | 22   | 25  |
| 0+0                               | 12.5                                       | 11.2 | 10.4 | 9.9  | 9.7 | 9.1 | 8.8 | 9.9  | 9.6 |
| 11+3                              | 7.0  | 7.6  | 7.0  | 8.0  | 7.7 | 8.4 | 8.3 | 8.2  | 8.8 |
| 21+3                              | 8.7  | 7.9  | 9.8  | 7.5  | 6.7 | 8.4 | 7.9 | 7.9  | 8.2 |
| 31+3                              | 8.4  | 8.3  | 9.1  | 8.4  | 6.7 | 6.1 | 6.3 | 7.7  | 7.1 |
| 41+3                              | 8.1  | 7.4  | 8.1  | 6.0  | 5.7 | 6.9 | 6.1 | 6.5  |     |
| 51+3                              |  |      |      | 6.1  | 4.7 |     |     |      |     |
| Ave. 11-3 to 41-3                 | 8.0  | 7.8  | 8.5  | 7.5  | 6.7 | 7.4 | 7.2 | 7.6  |     |

factor. The riper and softer a prune is when picked the sooner it will shrivel. Mold and decay vary with the conditions under which the prune is kept. After some time the flesh becomes brownish and unattractive. The high-flavored prune retains a good flavor longer than does one stored when greener and with poorer quality. The rate of flavor loss then does not run parallel with shriveling for prunes picked at different stages of maturity. The storage life of prunes, mature enough when picked to have good quality, is usually limited by shriveling.

Although a small amount of shriveling is not necessarily an indication of spoilage and may not greatly impair the quality, any considerable amount of it severely curtails the market value of the fruit. A shriveled prune is looked upon by the dealer as an aged prune and will be disposed of at once

TABLE XIII

Prunes Picked at Different Dates Showing Decrease in Firmness Caused by Three Days in Window, After Remaining in Storage for Various Lengths of Time. McBirney—1930.

| Days in storage | Dates in September that prunes were picked |      |      |      |      |      |      |      |      | Total | Ave. |
|-----------------|--|------|------|------|------|------|------|------|------|-------|------|
|                 | 1  | 4    | 7    | 10   | 13   | 16   | 19   | 22   | 25   |       |      |
| 11              | 5.9  | 4.2  | 4.5  | 2.6  | 2.0  | 0.8  | 0.8  | 2.4  | 0.8  | 24.0  | 2.67 |
| 21              | 2.6  | 2.1  | 1.4  | 2.0  | 2.3  | +0.7 | 1.5  | 0.6  | +1.0 | 10.8  | 1.20 |
| 31              | 1.8  | 0.9  | 0.7  | 0.2  | 0.8  | 1.0  | 1.4  | 0.8  | 1.0  | 8.6   | 0.96 |
| 41              | 0.0  | 1.0  | 0.2  | 0.9  | 1.5  | +1.1 | 0.7  | 0.7  |      | 3.9   | 0.49 |
| Total           | 10.3                                       | 8.2  | 6.8  | 5.7  | 6.6  | 0.0  | 4.4  | 4.5  | 0.8  |       |      |
| Ave.            | 2.58                                       | 2.05 | 1.70 | 1.42 | 1.65 | 0.0  | 1.10 | 1.12 | 0.27 |       |      |
|                 | 2.11                                       |      |      | 1.92 |      |      | 0.83 |      |      |       |      |

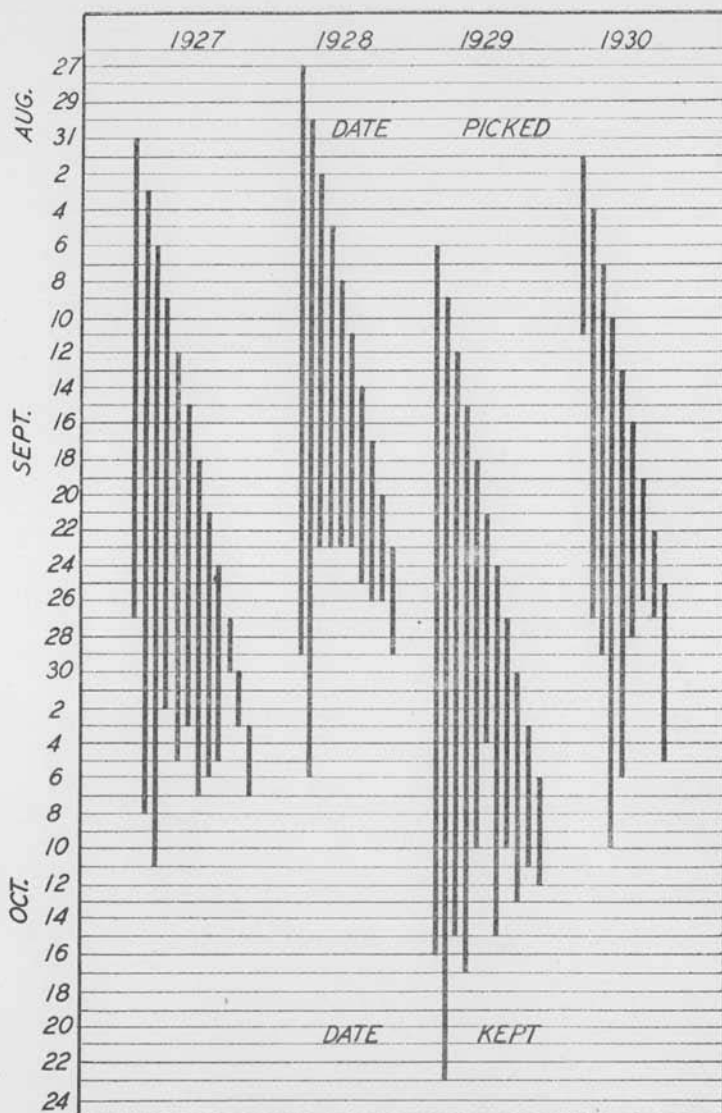


Fig. 4.—Keeping qualities of prunes harvested at various dates. Keeping quality varied from one season to another.



to a second class trade at a low price; while a sound lot of prunes, showing no shriveling, may be held several days for a fancy trade and better prices.

The lengths of time that prunes remained marketable under the above described transportation and storage conditions for the four years 1927-30 are shown in Figure 3. This figure shows the date the samples were picked and the date to which, as well as the number of days, each kept. The more mature prunes which were picked later in the season kept a shorter length of time than did those less mature when picked; but all kept to approximately the same date.

The fruit growers' problem is two-fold: to be sure that the prune is mature enough to be edible, and that it is not so ripe that it will break down in transit. It will be noted that the prunes from this one orchard kept longer some years than others in the following order: 1929, 1927, 1928, 1930. Except for the season of 1930, when the fruit was badly damaged, as shown by russet and sunburn injury (5), the firm fruit seemed to keep better in storage than did the soft fruit with the same sugar content. It would seem then that while sugar content aids in determining flavor, firmness determines the end of the picking season when a distant market is to be supplied. Prunes that are firm enough when picked to show at least eight pounds pressure will probably hold up long enough to reach the consumer on the eastern coast. They may, however, be marketed nearer home.

In case of an over-supply on the market, firm prunes may be kept in cold storage for a time. While the less mature prunes keep longer they must also be picked earlier in the season. The four years' study (Fig. 4, Table XI) indicates that prunes hold up on the tree about as long as under transit conditions. Since the whole crop can not be picked at once it might be well to remember that first grade prunes can be expected to hold up under transit conditions about the same length of time as they can be expected to remain on the tree in good weather.

Variations in maturity changes in different years and in various orchards have been previously discussed. Since flavor determines when a prune is edible and since firm prunes keep better than soft prunes having the same sugar content, storage of firm fruit with high sugar content is recommended.

In 1931, prunes from two different orchards were stored and their keeping qualities compared. Table XIV shows the test of each lot when picked and its keeping qualities in storage. Here again firmness seemed to determine the length of time that each lot would keep. The fruit with the highest

sugar content had the best flavor. For storage a firm prune must be selected for long keeping and also one with high sugar content, in order to obtain better quality.

**TABLE XIV**  
1931 Prune Storage Data.

Prunes From William Giffels Orchard, Picked and Stored  
September 2, 1931.\*

| Date tested | Number tested | Average firmness in pounds | Average sugar content in per cent | Percentage shriveling |        |       |            |       | Flavor       |
|-------------|---------------|----------------------------|-----------------------------------|-----------------------|--------|-------|------------|-------|--------------|
|             |               |                            |                                   | Light                 | Medium | Heavy | Very Heavy | Total |              |
| 9-2         | 20            | 11.4                       | 17.1                              | 0                     | 0      | 0     | 0          | 0     | Fair         |
| 9-22        | 20            | 8.9                        | 18.2                              | 15                    | 0      | 0     | 0          | 15    | Good         |
| 10-2        | 25            | 8.1                        | 19.3                              | 16                    | 12     | 12    | 0          | 40    | Good         |
| 10-13       | 20            | 6.7                        | 19.6                              | 50                    | 0      | 15    | 0          | 65    | Fair to good |
| 10-31       | 20            | 5.7                        | 17.9                              | 25                    | 10     | 0     | 0          | 35    | Good         |

\* Maturity sample at harvest was taken at random one from each the north and south side of each tree. Storage sample was a commercially packed basket.

Prunes From T. L. Gray Orchard, Picked and Stored September 5, 1931.\*

| Date tested | Number tested | Average firmness in pounds | Average sugar content in per cent | Percentage shriveling |        |       |            |       | Flavor            |
|-------------|---------------|----------------------------|-----------------------------------|-----------------------|--------|-------|------------|-------|-------------------|
|             |               |                            |                                   | Light                 | Medium | Heavy | Very Heavy | Total |                   |
| 9-5         | 20            | 11.7                       | 20.6                              | 0                     | 0      | 0     | 0          | 0     | Good              |
| 9-22        | 20            | 9.1                        | 20.0                              | 10                    | 0      | 0     | 0          | 10    | Good              |
| 10-2        | 25            | 8.7                        | 21.6                              | 16                    | 12     | 0     | 0          | 28    | Good              |
| 10-13       | 20            | 7.1                        | 21.8                              | 45                    | 25     | 0     | 0          | 70    | Good to very good |
| 10-31       | 20            | 6.1                        | 20.1                              | 15                    | 5      | 0     | 0          | 20    | Very good         |

\* Maturity sample at picking time was taken from the sorting table as the basket was being filled.

### Recommendations to Growers

On the basis of the five-years' data secured in this study, the following recommendations are made:

1. For the best carrying and dessert qualities, prunes for immediate shipment to eastern markets should be harvested at pressures ranging from 12 to 8.5 pounds. The minimum pressure can be reduced to 8 pounds without serious loss, while in late seasons the maximum pressure can be extended to 13 pounds.

2. Storage of the Italian prune at temperatures of 32° to 35° F. for limited periods is practicable, and is recommended as a measure for stabilizing the markets throughout the picking season by regulating shipments in accordance with supplies and demands.

3. It is possible to slightly extend the normal shipping season through storage holdings. For this purpose only the earliest pickings, ranging in pressure from 11.5 to 9.5 pounds, should be used.

4. All fruit to be stored should be carefully culled, particular pains being taken to remove soft specimens, as these break down early and shorten the storage life of the pack as a whole.

5. The earliest possible refrigeration following picking is essential to the most successful storage and is highly desirable for direct shipments as well.

6. Stored prunes should be moved in time to be in the hands of the retail trade before the pressure has fallen below 7 pounds. For fruit stored at Idaho points this necessitates shipment before the pressure has fallen below 8.5 pounds.

7. Stored prunes deteriorate and soften at a rapid rate following removal to higher temperatures. This makes the pressure test a better measure than appearance of the length of time that they will continue to hold up.

8. In view of the rapid breakdown of prunes upon removal from storage to higher temperatures it seems advisable under present conditions that fruit to be held for long periods (two weeks or more), and fruit picked at pressures below 9.5 pounds be stored close to the point of consumption.

9. For the greatest success in both direct shipments and storage of prunes it is necessary that the stage of maturity be determined for each orchard individually, since there is a wide variation in ripening in different orchards.

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