FRUIT BUD FORMATION AND DEVELOPMENT IN THE CONCORD GRAPE

by

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B. S., Massachusetts State College, 1930

A THESIS

submitted in partial fulfillment of the

requirements for the degree of

MASTER OF SCIENCE

KANSAS STATE COLLEGE
OF AGRICULTURE AND APPLIED SCIENCE
1931

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INTRODUCTION

The purpose of this investigation is to determine the time of formation and development of the floral parts of the Concord grape. The exact time of fruit bud formation in the grape has received but little study. Fruit growers should know when the flower clusters are being formed so they can follow proper cultural practices, which include fertilization, cultivation, pruning and protection from pests; knowledge that must be applied a year in advance of the grape harvest.

The practical importance of this problem is apparent. A weakly vegetative cane has buds of low fruiting capacity. A strongly vegetative cane also has buds of low fruiting capacity. An intermediate cane has buds of maximum fruiting capacity. At the time of fruit bud formation the grower must be familiar with the condition of his vineyard to insure the formation and development of an adequate number of highly productive fruit buds. The proper formation and development of these buds must precede the production of a profitable crop the following year.

Leaf buds and flower buds of the grape at their initiation are formed from the same kind of tissues and early in their development it is difficult to distinguish one from the other even when microscopic sections of the buds are examined. Later in their development microscopic sections show the floral parts very distinctly.

LITERATURE REVIEW

Gladwin (4) states that the grape bud or eye is a compound one, consisting frequently of three distinct buds enclosed within the same scales; the primary or fruit producing bud; the secondary, a wood or sterile bud but sometimes a fruit bearing one, and the tertiary bud which is an undeveloped wood bud that expands as a shoot only when the others in the same eye have been injured or destroyed. The primary bud is the principal fruit bearing organ but it may develop into a shoot only. The secondary bud produces but a small amount of fruit at any time and this usually takes place only when the primary bud in the same eye has failed to grow. With vigorous young vines the secondary bud often matures one or two clusters of fruit even when the shoot from the primary bud is carrying the

usual quota.

The investigations of Partridge (6) on the relation of diameter to the fruitfulness of the cane show that diameter can be used as a criterion in the selection of fruiting wood and that "pencil size " canes are more fruitful than other types of canes.

Schrader (9) suggests that under a given vegetative condition the following relations between the growth in length of a "pencil size" cane and its fruitfulness will prevail:

1. Strongly vegetative canes have buds of low fruiting capacity.

2. Moderately vegetative canes have buds of maximum fruiting capacity.

3. Weakly vegetative canes have buds of low fruiting capacity.

Angelo (1) states that the productiveness of a Concord cane increases for canes up to a diameter of 9 cm.

According to Pickett's investigations (8) concerning cane diameters and fruit production of the Concord grape, the cane diameters which measured from twelve sixty-fourths to thirty sixty-fourths of an inch between the fifth and sixth nodes showed great variations in yield.

The fruit production on individual canes measured between the fifth and sixth nodes varied from 54 ounces on a cane measuring twenty seven sixty-fourths of an inch in diameter to 266 ounces on a cane fifteen sixty-fourths of an inch in diameter.

From the evidence presented in the foregoing paragraphs it seems evident that canes about one-fourth of an inch in diameter are the most productive. All the buds collected for this problem were taken from canes exactly one-fourth of an inch in diameter between the fifth and sixth nodes.

In regard to the formation of the flower parts Goff (5) found incipient development during late summer or autumn in the grape though the differentiation was not nearly so complete as with other fruits. He also states, "With fruit like the grape with which the flowers are borne laterally on shoots of the same season, there is not convincing evidence as to whether or not the fruit bud is always predetermined".

Bioletti (3) observed in California that fruit bud differentiation in the grape, Vitis vinifera, occurs during the season before the buds open.

Perold (7) states that shoot primordia appear when the

buds first show in the axils of the leaves and subsequently the blossom primordia appear.

The evidence presented indicates that there are rather diversified opinions regarding the exact time of fruit bud initiation. However, it seems almost certain that the floral parts are formed the year before the fruit is borne although the exact time of differentiation is not known.

One of the aims of this study is to microphotograph sections of buds in their various stages of development as evidence of the time during which initiation and development takes place.

MATERIALS AND METHODS

Row 7 of the Concord variety of grape trained to the Munson system in the vineyard of the Kansas Agricultural Experiment Station was reserved for this investigation. The cover crop clean cultivation system of soil management is used. It consists of sowing hairy vetch in August and plowing or disking it under in the early part of May. Throughout the summer the soil is disked frequently to conserve soil moisture by preventing weed growth. The vines

in this row were not pruned until the end of this experiment, March 31, 1931. The first buds were collected September 20, 1930 and the last collection was taken on March 31, 1931. From forty to fifty buds located between the second and twelfth buds on canes one-fourth of an inch in diameter were brought to the laboratory each week. A razor blade was found to be the best implement for collecting the buds. Part of the cane was cut off with each, so the basal portion of the bud would not be disturbed. The buds, as soon as cut from the cane, were put into four ounce bottles containing a two per cent solution of formaldehyde. The bottles which contained the buds were labelled on the outside with a gummed label and on the inside with a piece of paper that was put into the solution with the buds. These bottles were tightly stoppered and stored at room temperatures.

The experimental methods of sectioning the buds consisted of two distinct types:

1. That of embedding the buds in paraffin to be sectioned on the rotatory microtome.

2. That of sectioning the buds by various methods on the hand microtome.

The following method, from Chamberlain (3) was used

to dehydrate, infiltrate and embed the buds in paraffin.

First, the outer bud scales and excess basal portion of ten buds were removed. The buds were transferred to a porous container and immersed in a pan of water for four hours or until they were thoroughly washed and free from formaldehyde. As soon as the buds were washed they were transferred to a vial containing a 30 per cent solution of alcohol where they remained for ten hours. They were then transferred to a 50 per cent solution of alcohol for another ten hours and then to a 70 per cent solution of alcohol for ten hours more. Then the buds were transferred through 85, 95 and 100 per cent alcohol for twenty four hours each.

After subjecting the buds to this series of alcohol they were next put through a series of xylol. They remained in 25, 50 and 75 per cent solutions of xylol for twelve hours each and in the 100 per cent xylol for three days.

Since alcohol has a very strong affinity for water, the water was gradually replaced by the alcohol. Xylol completely replaces the alcohol and is a solvent for paraffin. As soon as the buds were transferred to the 100 per cent xylol a little paraffin was added at a time until the xylol was unable to dissolve any more. Then the vials

containing the buds, xylol and paraffin were put into an oven at 60 degrees Centigrade and left there for three days. The paraffin and xylol were decanted and pure melted paraffin was added to the buds and left in the oven for ten more days to make sure that enough time had elapsed for proper infiltration. At the end of this period the buds were embedded in paraffin by pouring melted paraffin into paper trays and plunging the buds into it. The paraffin was quickly cooled in cold water to prevent it from becoming granular.

Buds collected in September, October, November, December, January and February were embedded in this manner. Cube shaped pieces each one containing a bud were cut from the mass in which all of the buds of the same collection were embedded. These cubes were fastened on a disc by means of melted wax and put on the rotatory microtome and sectioned at thicknesses varying from 10 to 60 microns. The final results were unsuccessful. The sections either broke or crumpled up because the buds could not be wholly infiltrated with paraffin because of the bud hairs which would not absorb it. Several fair sections were obtained but these were no better than sections cut on the hand microtome. This method will be described later.

It was thought that by boiling the buds in a 50 per cent solution of potassium hydroxide for two minutes, the hairs would be dissolved and could be put through the same process but the results were again negative.

The second method was that of sectioning the buds on a hand microtome. A piece of elder berry pith about an inch long was squared with a sharp razor and split lengthwise. A small niche was cut so that a bud would fit into it snugly. The two halves of pith were pressed together and inserted in the microtome. The thinnest possible sections were then made with a sharp razor. Only longitudinal sections of the bud were made so a representative section of the bud showing all of the different tissues could be secured. The best sections were cut when the entire blade was drawn through the bud. When a straight motion was used the results were not satisfactory. Twenty five buds of each collection used were sectioned. As soon as a section was cut it was transferred to a dish containing a 50 per cent solution of alcohol. About fifteen sections were made from each bud but only the best ones were saved. These were the ones that were not crushed or cut too thick.

Of the many stains tried Gram's iodine gave the best results. When the best sections had been selected they

transferred from the solution of 50 per cent alcohol to a solution of safranin for thirty minutes to one hour. The safranin was then removed with a pipette and the sections were washed with distilled water until the reddish color was no longer present in the solution. Each time the buds were washed the water was drawn off with a pipette so the sections would not be broken, as might occur in transferring them from one dish to another. Gentian violet solution was next added to the buds for twenty seconds after which the buds were again washed several times with water. Gram's iodine stain was next added and drawn off at the end of three minutes. Then the sections were destained in either 95 or 100 per cent alcohol until the excess stain was removed and the tissues made more distinct in appearance. It required about ten minutes in 95 or 100 per cent alcohol to destain the buds. The alcohol was drawn off and the sections were cleared in a solution of clove oil orange G for five minutes, after which they were put in 100 per cent xylol and kept thus until they were mounted in balsam on glass slides.

The method last described gave the better results. All the illustrations are microphotographs from sections so made.

Over 10,000 sections were cut and observed under the microscope but only 300 were mounted in balsam on glass slides. From these 300 a series of typical ones was microphotographed.

CONDITION OF VINES

On September 20, 1930 when the first collection of buds was made, the vines were still growing. They continued to grow to a slight degree until October 25 when they were severely frosted. On November 1, the vines were leafless and in a dormant condition. The first noticeable swelling of the buds was observed on March 6, 1931. On April 20 the fruit clusters and leaves were observed on the vines.

OBSERVATIONS AND RESULTS

The microphotographs on the following pages show the development of the floral parts in the primary bud of the Concord grape.

Microphotograph Plate Ia shows that the floral parts were already developing by September 20.

Plate Ib shows the development made by the bud between September 20 and November 1. Although the floral parts are no more distinct than in September the flower stalk shows growth.

Plate I

a

b

The microphotograph Plate IIa shows the development of the bud on December 5. The flower stalk is larger. Also the peduncles along this stalk may be easily recognized.

Plate IIb, which shows a bud collected on February 7, does not show any further development than the one taken December 5. Little if any development occurs during the dormant period. One large and one small flower cluster are easily observed in this photograph.

Plate II

a

b

Microphotograph Plate IIIa shows a section of a bud which was collected February 28. The peduncles along the stalk are more distinct but no further development can be observed.

Plate IIIb shows to a better degree the developing peduncles along the stalk. The bud was slightly expanded when this section was made. The small leaves surrounding the flower cluster are beginning to develop.

Plate III

a

b

The next two microphotographs, Plate IVa and Plate IVb, illustrate the rapid development made by the flower clusters as the bud swells in the spring. These buds were collected March 31.

Plate IV

a

b

The last two microphotographs, Plate Va and Plate Vb, are of buds on lateral canes which were collected December 5 and March 31 respectively. The development of the floral cluster is not as great as that of a bud located on a cane.

Plate V

a

b

This set of microphotographs shows that the floral cluster develops gradually in the late summer and early winter up to the time that the vines become dormant which was observed to be about December 5. No further development takes place until the buds begin to swell in the spring about March 15. From then until the bud opens the growth is very rapid.

From all the sections studied it seems certain that fruit bud formation and development ceases as winter approaches.

There is no noticeable change in the development of the floral cluster until the latter part of February when further development takes place. As the buds swell in the spring, until they open, the flower parts become larger and more distinct. The microphotograph of the bud section taken March 31, shows the size of the flower cluster just before the bud scales parted.

Several other interesting facts were noted during this investigation and seem worthy of recording:

1. Fruit bud formation is not as complete on lateral shoots which arise from one year wood as on the cane itself between the second and twelfth buds.

2. In general, there is little variation between the second and twelfth buds on a cane. It is

thought that the third to sixth buds will show complete differentiation earlier than those buds beyond these, but as yet there is no definite evidence to be presented.

3. In many cases the secondary bud was sectioned with the primary bud. The floral clusters were much smaller than in the primary bud and also appeared to be less developed. Fruit bud formation was observed in an estimated 20 per cent of the secondary buds although it was not as complete as in the primary bud.

4. On canes of medium vigor one fourth of an inch in diameter sections of buds made beyond the twelfth bud showed fruit bud differentiation to be almost as complete as with the second to twelfth buds.

5. As many as four flower clusters were observed in sections made from one bud. These clusters varied considerably in size.

6. It was estimated that about 5 per cent of the buds sectioned were sterile, did not have flower parts formed in them.

CONCLUSIONS

1. Fruit bud formation in the grape began before September 20 in 1930. It is a gradual process of development.

2. Fruit bud formation or development does not take place during the winter months while the vines are dormant.

3. The floral parts develop considerably before the bud opens in the spring.

4. A fine honed razor was found to be the best implement for making sections of the buds.

5. Safranin and Gram's iodine gave the best staining results on the sections.

6. The presence of so many epidermal hairs in the buds made it impossible to properly infiltrate them with paraffin.

ACKNOWLEDGMENT

The author, with the deepest gratitude, wishes to acknowledge the assistance of Professor R. J. Barnett, who suggested the problem, and of Associate Professor Nora E. Dalbey, who was in charge of the histological work.

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