Scanning electron microscopy of the developmental stages of the Sultana inflorescence

by

P. B. Scholefield and R. C. Ward

Introduction

The development of the Sultana (Vitis vinifera L.) inflorescence from initiation to flowering has been investigated previously by Barnard and Thomas (1933), and Winkler and Shemsettin (1937). In Southern Australia, the inflorescence primordium is initiated in an axillary bud in late November. It then develops rapidly until the onset of organic dormancy in the following January. Little further development occurs in autumn and winter until early-mid August when the inflorescence primordium begins to increase in size and complexity (May 1964). The buds burst in early September and the flowers differentiate shortly after. Floral parts develop until anthesis in November.

Using other cultivars, Alleweldt and Balkema (1965), Alleweldt and Ilter (1969), and Agaoglu (1971), have reported floral parts on the inflorescence primordium in late autumn of the season of initiation.

Fig. 1: (A) May 6th; Inflorescence primordium from a dormant bud. No floral development is evident. X 130. (B) August 2nd; Inflorescence primordium from a dormant bud. Note the comparable size and stage of development with May 6th primordium. X 120. (C) August 2nd; Portion of an inflorescence primordium. X 185. (D) August 28th; Division and expansion of the inflorescence primordium at the time of budburst. X 115. (E) August 28th; Three floral apices with bracts. Calyx not yet differentiated. X 225. (F) September 13th; Group of individual flowers with calyx differentiated. X 95.

BP = branch primordium, B = bract, F = flower.
In a recent review, PRATT (1971) commented on the need for clarification of the time of flower initiation.

Previous workers have used transverse and longitudinal sections of inflorescences or flowers and, in some cases, the interpretation of the micrographs is difficult.

SATTLER (1968) described a method of staining and examining whole specimens under ethyl alcohol, which allowed a three dimensional analysis.

The Scanning Electron microscope gives similar results but with greater accuracy. TROUGHTON and DONALDSON (1972) used it to survey a wide range of plant structures.

Materials and Methods

Sultana vines, forty-five years old, growing in the irrigated vineyard of C.S.I.R.O., Division of Horticultural Research, Merbein, Australia, were used as a source of material. Samples of inflorescence primordia or inflorescences were taken from buds at nodes eight to eleven of mature shoots on May 6th and August 3rd, and from shoots arising from these bud positions after budburst on August 28th and 30th, September 6th, 13th, and 28th; and October 12th, 1973. Budburst commenced on August 28th.

Portions of the dormant shoots from May 6th, and August 3rd were kept in polythene bags in a cool room at 3 °C and the inflorescence primordia dissected under a binocular microscope immediately prior to examination. At all other sampling dates, the inflorescence or inflorescence portion was taken in the field, fixed in a solution of 3 percent (v : v) glutaraldehyde in 0.1M Sodium cacodylate buffer (pH 6.8), and stored in this solution at 3 °C.

The specimens were placed on, or attached with DAG 915 to an aluminium SEM stub. Large specimens were placed on a fine sewing needle mounted, point up, on the stub.

Mounted fresh, specimens were placed directly into the chamber of a Cambridge Stereoscan S4-10, and examined using a very low electron gun accelerating voltage of 3kV (TROUGHTON and DONALDSON, pers. comm.). This allowed each specimen to be examined for at least five minutes, reducing damage from the electron beam, and

1) DAG 915, silver in m.i.b.k. Acheson Colloids Company, Prince Rock, Plymouth, England.
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enabling surface detail to be resolved until gross distortion, due to the vacuum, occurred.

At least ten specimens were examined for each sampling date.

Results and Discussion

Scanning electron micrographs showing inflorescence development from May 6th to October 12th are presented in Figs. 1 and 2.

The structure of the inflorescence primordium in the dormant buds (Fig. 1 A, B, C) correlates with the longitudinal sections of BARNARD and THOMAS (1933) and WINKLER and SHEMSETTIN (1937), but the method allows greater appreciation of the spatial arrangement of the component parts.

The inflorescence primordia in Fig. 1 A and B are structurally similar, indicating little development between May 6th and August 3rd. They consist of many growing apices, each subtended by a bract. In the development of the inflorescence primordium, these apices divide many times to become a branch of the inflorescence with many flowers. For this reason, the growing apex in the inflorescence primordium will be called a branch primordium (BP).

Differentiation of flowers is not evident on May 6th or August 3rd. This agrees with BARNARD and THOMAS (1933) and WINKLER and SHEMSETTIN (1937) but is contrary to the findings of ALLEWELDT and BALKEMA (1965), ALLEWELDT and ILMER (1969), and AGAOGLU (1971). BARNARD and THOMAS (1933) reported that flower differentiation occurred over the whole inflorescence almost simultaneously. As a Sultana inflorescence often consists of a thousand flowers, it is very difficult to imagine an inflorescence primordium branched to this extent in a dormant bud. This would be the case if flower differentiation began in autumn.

The basal branch primordium of Fig. 1 B has divided, giving several sub-branches subtended by two bracts. It is possible that ALLEWELDT and BALKEMA (1965), ALLEWELDT and ILMER (1969), and AGAOGLU (1971) may have mistaken a section of this type of structure for a flower. However, more studies are required on a series of cultivars under different climatic conditions to clarify this matter.

At budburst, rapid growth and division of the inflorescence primordium occurs (Fig. 1 D). BARNARD and THOMAS (1933) and MAY and ANTCLIFF (1973) show sections of floral apices divided into three. A similar structure is shown in Fig. 1 E. Further development of these flower primordia give the flattened structures shown in Fig. 1 F on September 13th, with sepals beginning to form. Thus, individual flowers with floral parts are first observed on September 13th.

The development to complete flowers is shown in Fig. 2 A—F.

The new method, described here, is simple and provides a means for answering the many problems still unsolved in the ontogeny and development of the grape inflorescence.

Summary

Development of the inflorescence primordium of Sultana, as observed in the Scanning Electron Microscope (SEM), is described. The technique is simple and requires no elaborate tissue preparation. Interpretation of inflorescence development is easy and precise because of the resolution and depth of field of the SEM. The first evidence of differentiation of floral parts was observed in spring for Sultana under Australian conditions.
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Literature Cited


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P. B. Scholefield
CSIRO
Division of Hort. Res.
Merbein, Victoria 3505
Australia