Variability of Morphological and Chemical Quality Characters in Flowers of Male Hops

S. N. Brooks and S. T. Likens

HOPS (Humulus lupulus L.) are used almost entirely in the making of fermented malt beverages. Only the dried inflorescence of the female plant is used commercially. The female inflorescence, which is about two inches long, is a catkin or strobile, called a cone, with papery bracts and bracteoles. The value of the hop lies in its contents of bittering substances and essential oils which provide both flavor and aroma, as well as some preservative and protein-coagulating properties. The bitter substances, made up principally of alpha- and beta-acids and related compounds, are produced in tiny granular glands borne on the surfaces of the bracts, bracteoles, and seeds. These glands, called lupulin granules, also contain the essential oils. Similar, but fewer, glands occur on the flowers of male hops (Figures 1 and 2).

Although the male hop has no commercial value, it contributes half of the genetic material to the female variety and is just as important as the female parent in a breeding program. The male hop flower is inconspicuous and does not correspond morphologically to the flower or inflorescence of the female. Hence, many difficulties are encountered in evaluating the male plants for their potential breeding value. Heretofore, the principal means of evaluating them has been expensive and time-consuming progeny tests. Only commercially important characters such as vigor and earliness have lent themselves to pheno typic evaluation. The potential for transmitting the bittering principle, essential oils, and yield of strobiles have been evaluated only through progeny testing.

The present investigation was designed to provide information on the variability of morphological and chemical quality factors in male hop clones and to estimate the selection potential of these factors. Any technique which would furnish a means of measuring such factors in the early selection of males would be of great importance in a hop breeding program. Selection could be made first on the basis of phenotypic observation, and then fewer lines could be used in crossing to test their breeding potential. Early elimination of many of the clones on the basis of phenotype would allow better and more extensive testing of the few remaining ones for the same expenditures in time and money.

REVIEW OF LITERATURE

Hop breeding is complicated because several important characters are expressed only by the female plant. The literature points to a major need for a phenotypic method for evaluating male hops without resorting to progeny testing.

Dark (2) listed four main disadvantages of hops as a subject for genetic studies: (a) a seedling hop usually does not flower until its second year, and some characters may not become stabilized until the fifth, (b) separation of the sexes and commercial methods of propagation have produced heterozygous and unrelated males and females, (c) many of the commercially important characters cannot be measured objectively, and (d) the habit of wind pollination creates technical difficulties in controlling cross-pollination.

Some of the earliest work on the study of variability in male hops was done by Wormald (13). Male plants were found to vary in time of flowering, vine color, leaf color, and length of lateral branches, in addition to the number of glands per unit area on the leaves. The glands on the lower surfaces of the leaves varied from 120 to 190 microns in diameter. Full bloom usually occurred 7 to 10 days after initial bloom, and several plants remained in bloom for 2 weeks. Selection for one or more characters appeared to be feasible.

Ehara (4) reported that a 3-year-old Nagano male (H. lupulus) in Japan produced an average of 2,000 to 3,000 flowers per vine. According to Hamaguchi (7), hop vines in Japan begin flowering in the laterals produced near the center and then flowering proceeds upwards and downwards on the main vines. Salmon and Wormald (10) found that plants varied in their date of flowering from year to year by as much as 10 to 12 days. Fore and Sather (6) reported that some plants began to shed pollen as early as June 15, but the latest plants began to shed towards the end of July. The total pollen shedding period varied from 4 to 52 days among plants with an average of 25 days per male plant.

In 1915 Schmidt (11) concluded that the transmission of lupulin percentage by the females is a complicated process in which the female progeny were usually lower than the female parents. In this study the values for lupulin percentage included both total

Figure 1—Male flowers which have shed their pollen and separated from the plant. Resin glands are visible on the sepals and in the receptacle and dorsal furrows of the anthers (anthers are about 2.5 mm. long).

Figure 2—Diagrammatic sketch of resin gland (gland diameter is about 130 microns).