Production of Seedless Hops by Interspecific Pollination

THE difficulty in inducing hop cone formation through the application of growth-stimulating substances has been well illustrated by Seeley and Wain[1] who found that, at best, it was possible to achive only temporary stimulation of cone growth in experiments using some 22 growth-stimulating substances, as well as pollen extracts.

In order to test the stimulation produced by foreign pollen, a small-scale experiment was conducted using the cultivated variety Late Clusters (of the species *Humulus lupulus L.*) and crossing this with the wild hop, *Humulus japonicus* Sieb. and Zucc. These two species, *H. lupulus* and *H. japonicus*, are very distinct. The former is a perennial with a chromosome number[2,3] of 20 and the latter an annual of 17 chromosomes in the male, 16 in the female[4].

Table 1 contains measurements, based upon 30 samples, from unpollinated and pollinated cones.

Table 1

	Average length (mm.) of bracts	Average length (mm.) of bracteoles	Average length (mm.) of internodes	Average No. of nodes
Pollinated with *H. japonicus* pollen	12·9	14·7	1·5	8·4
Unpollinated	10·1	11·3₂	1·0	11·1

The stimulation of bracts, bracteoles and internodal length in the cone of Late Clusters produced by pollen of *H. japonicus* is very noticeable, though it is unquestionably less than that produced by pollen from the male plants of Late Clusters. Fig. 1 shows pollinated (*H. japonicus* pollen) and unpollinated cones collected at the same stage of maturity.

Early workers, including Salmon and Amos[5], had shown the importance of pollination (by pollen of the same species) upon increasing yield. Their results indicated, as in this experiment, that pollination decreased the number of nodes formed, though they did not discuss this effect which is based upon the indeterminate growth of the cone apex. Pollination brings this apical growth to a halt. The length of time during which such growth continues without pollination varies with variety, being longer in a variety such as Late Clusters than Fuggles. These facts help to explain the difference among varieties in the influence of pollination upon yield. In some varieties the smaller size of bracts and bracteoles in unpollinated cones is offset by a continued growth of the apex, and a resulting increase in their number. Conversely, in those varieties in which apical growth ceases early, pollination is vital for the stimulation it produces upon bract and bracteole size.

As with normal pollination, the effect of interspecific pollination is to reduce greatly the critical 'burr' stage, when the cone is so susceptible to disease.

Following interspecific pollination, the ovary is stimulated at the same time as the internodes, bracts, and bracteoles. However, since fertilization does not occur, due to the difference in chromosome number between the species, no embryo, endosperm or seed develops. The matured pistil, much smaller than the normal product of pollination, remains empty.

It is not possible to draw conclusions regarding the commercial usefulness of such interspecific pollination in hop cultivation. Extensive experiments would be necessary to determine the extent to which such pollen will effectively carry by wind, the practicability of growing the weed hop in cultivated fields and the desirability of the cone, formed without seeds but containing abortive pistils. This does, however, illustrate a principle which may prove of some importance, namely, that stimulation may be produced in hops by pollination which cannot lead to fertilization, and consequently, seed formation. Moreover, it suggests that the triggering mechanism for stimulation of cone growth in hops must occur at the time of pollination, with fertilization providing only a secondary boost, if any boost at all.

Fig. 1. Cones pollinated with pollen from *H. japonicus* on left; unpollinated cones of late clusters on right. Scale in mm.

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Vein Anastomoses in the Leaves of Long Shoots of *Ginkgo biloba*

IT has recently been found that four types of vein unions occur in the leaves of *Ginkgo biloba* L. and that long shoots have a significantly higher average per cent of leaves with anastomoses than short shoots[1]. In the present examination of 2,249 leaves collected from 154 long shoots from 16 trees it was found that the leaves from the median portion of the long shoots have a higher per cent of anastomoses than either the basal or apical leaves. It was also found that considerable variation existed in the percentage of leaves with anastomoses in the samples taken from various trees. An average of 33 per cent of the 2,249 leaves had one or more anastomoses; but the range in the individual 16 trees extended from a low of 7·3 per cent to a high of 71·2 per cent.

By collecting the leaves in a manner so that the position of each leaf on its shoot was known, the percentage of leaves having anastomoses could be determined for each leaf position. Because of multiple anastomoses occurring in many leaves, the total number of anastomoses at each leaf position is best expressed as an anastomosis index, which is derived by dividing the total number of anastomoses by the total number of leaves at a given leaf position. In Fig. 1 results are presented which show the relationship between anastomosis index and leaf position. The median leaf positions (10–13) show an anastomosis index more than double that of the most basal (1–5) and the most apical (19–20) leaf positions.