Table 2

| Temperature | Node number 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| 24° C. | 4·5 | 13·7 | 27·5 | 32·0 | 41·0 | 50·0 | 54·5 | 54·5 |
| 15·5° C. | 67 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

All produced male flowers at each node; but development of female flowers was strongly delayed at the higher temperature. Percentage femaleness, shown in Table 2, was determined as in the previous experiment.

Female plants of *Cannabis sativa* L. are known to produce male flowers under certain conditions[3]. My investigations indicate that environmental conditions affecting the sex of monoecious *Cucurbita* and *Mercurialis* affect female hemp similarly. Female plants can be induced to grow through a male phase before reaching their normal female expression.

When plants were grown in continuous light for 45 days at a day temperature of 21°–26° C. and a night temperature of 15·5°–21° C. and then transferred to 8-hr. photoperiods at the same temperature, male flowers were produced at the lowest flowering node (node 7 or 8) of the female plants.

These results are particularly interesting as they indicate the possibility that growth of female as well as monoecious plants through a male phase before they produce female flowers is a general phenomenon. Female plants normally reach the female phase before flowers develop and usually produce no male flowers, but by artificially delaying the attainment of femaleness, male flowers are produced.

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## Soil Transmission of Scottish Raspberry Leaf-Curl Disease

Leaf-curl is the most important virus disease occurring in the raspberry-growing districts of eastern Scotland, where it has been known for many years[1]. It seems to be caused by raspberry ringspot virus, which can be transmitted by mechanical inoculation from raspberry plants with leaf-curl disease to plants of *Chenopodium amaranticolor* Coste and Reyn. and several other species[2]. None of the many kinds of arthropods tested as possible vectors transmitted the virus[2], and it seemed likely that the virus might be soil-borne.

In May 1955, soil was collected from the site of a recent severe outbreak of raspberry leaf-curl, potted and kept in a heated, insect-free glasshouse. Raspberry root-cuttings of the variety Malling Jewel were planted in the pots and also in pots containing the steam-sterilized potting mixture (John Innes potting compost No. 2) usually used. No symptoms of virus infection were observed in 1955; but in April 1956 fifteen out of thirty-two plants growing in soil from the leaf-curl site showed symptoms of leaf-curl. Local lesions were produced in leaves of *Chenopodium amaranticolor* inoculated with sap extracted from the leaves of each raspberry plant with symptoms: the *C. amaranticolor* plants were not infected systemically. Plants grown from root cuttings in sterilized potting mixture showed no symptoms of leaf-curl, and sap from them produced no lesions in leaves of *C. amaranticolor*.

It is also interesting that soil collected from the site of this particular leaf-curl outbreak harbours at least two other viruses. A virus of the tobacco-necrosis type was isolated from the first roots that grew on Malling Jewel root-cuttings planted in soil from the leaf-curl site: three out of eight plants contained the virus. No virus was detected in the roots of control plants grown in sterilized potting mixture. The virus resembled the tobacco necrosis viruses in producing large, discrete, necrotic lesions in the inoculated leaves of French bean variety Prince, in infecting plants of many other species without becoming systemic and in having a thermal inactivation point of between 90° and 95° C. when heated for ten minutes. No previous record is known of a virus of this type in raspberry.

Cadman[2] showed that sugar-beet seedlings became infected with a virus of the ringspot type when grown in potted soil from this leaf-curl site. I have repeatedly confirmed this finding by inoculating sap from macerated seedlings on leaves of *C. amaranticolor*, which develops local lesions and systemic symptoms when infected with this virus. Most of the infected seedlings were symptomless, and the virus appeared to be present more often in the roots than in the shoots of seedlings and never in the shoot only. No virus was isolated from sugar beet grown in sterilized potting mixture. Cross-protection tests in *Nicotiana tabacum* var. White Burley and in *Petunia nana* failed to show any relationship of the virus from sugar beet to raspberry ringspot virus. Its properties will be described elsewhere. Soils which, like the one used in these experiments, harbour three distinct plant viruses may be exceptional; but it seems more likely that soil-borne viruses are much commoner than has hitherto been suspected.

Raspberry ringspot virus and the ringspot virus from sugar beet both seem to resemble viruses of the tobacco-ringspot group. Many viruses of this type have been described, and they cause numerous diseases of economic importance: none is known to be transmitted by an arthropod vector from plants not infected by another virus, although it has been suggested that tobacco ringspot virus is transmitted by the aphid *Myzus persicae* from *Gladiolus* plants also infected with yellow bean mosaic virus to healthy *Gladiolus*[3]. The results described above now suggest that viruses of the tobacco-ringspot type may commonly be transmitted through the soil.

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