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The Effect of Ringing on the Carbohydrate and Nitrogen Content of Mexican Avocado Seedlings

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Hodgson and Cameron (1) working with the Fuerte variety report that ringing combined with early fruit removal usually results in a satisfactory crop the following year provided that weather conditions during the bloom period are favorable. In a later report (2) they state that amount of crop appears to be the principal factor influencing the bearing behavior of this variety, though the effects of size of crops may be modified by other factors such as the mean temperature during the blossoming period. The results of girdling unaccompanied by early fruit removal have been contradictory or inconclusive.

In the hope that a study of the effect of girdling on chemical composition of the tree might aid in explaining certain aspects of bearing behavior, the study, here briefly reported, was undertaken.

Materials and Methods: Three-year-old Mexican avocado (Persea drymifolia), seedlings from the Subtropical Horticulture Laboratory orchard at the University of California at Los Angeles were used; one-half of the trees were ringed in October, 1935, and re-ringed in February, 1936. At tri-weekly intervals between October, 1935, and May, 1936, a ringed and unringed tree were dug and each divided into thirteen fractions. The trees varied in total fresh weight roughly between 2 and 7 kilograms.

Total nitrogen was determined in each fraction by the Kjeldahl-Gunning method. Carbohydrates (free reducing substances, total reducing substances and starch) were determined eolorimetrically by the picric acid method as described by Willaman and Davison (3). Starch was determined as glucose after hydrolysis with saliva followed by hydrochloric acid treatment. Clarification was omitted.

RESULTS

No distinct and consistent differences between ringed and unringed trees could be observed in the orchard. In the three last ringed trees the root system was definitely smaller than in the corresponding unringed trees. Prom the beginning of February leaves dropped off and the appearance of brown tips on the leaves became quite prevalent in both ringed and unringed trees. There was an indication that cambial activity started appreciably earlier in the tops of the ringed trees, since they peeled easier at an earlier date. However, there was little difference in the beginning of length growth. While there was some growth before the end of April it was inappreciable in comparison with the growth made afterwards. In some of the ringed trees a small

callous bridge (less than half a centimeter in width) formed, but no phloem could be found. The xylem was apparently not affected deeper than about six layers of cells by the cut made in girdling the trunk.

Some new primary roots were observed on all samples, indicating uninterrupted root growth throughout the winter. A tremendous new root development extending to within one inch of the soil surface was observed in the last unringed tree on May 9.

In the unringed trees there was indicated an increase in dry weight of tops and roots from October until about the end of March, after which date a decrease occurred. The roots remained at this maximum for about two months, from the end of January until the end of March. This seasonal variation in the dry weight coincides with and probably is in part due to changes in the starch content of the woody fractions. No consistent seasonal variations in the soluble carbohydrate and in the total nitrogen content are indicated by the data.

In the ringed trees the seasonal changes were somewhat different. The dry weight of the tops increased until the beginning of March and remained at a maximum until May, at which time it was necessary to discontinue the experiment. The roots of the ringed trees did not show any definite increase in the percentage dry weight, it remained more or less at the same low level as it was in November. Also, in the ringed trees the changes in dry weight were followed in general by similar trends in the starch content, however, the starch content decreased much more rapidly in the wood of the roots of the ringed trees than the percentage dry weight, and in some cases there was a definite decrease in starch accompanied even by an increase in dry weight. This suggests that some constituent or constituents other than starch may be responsible for changes in dry weight.

DRY WEIGHTS AND STARCH DIFFER

The dry weight (expressed as a percentage of fresh weight) was consistently lower in the roots of the ringed than in the unringed trees, while in the tops the reverse obtained. The dry weight of the tops of the ringed trees was higher than that of the unringed ones except at the maximum dry weight about the end of March. The root-top ratio, calculated on both the fresh and dry weight basis, is always higher in the unringed trees. The difference being very pronounced when the dry weight is chosen as a basis for comparison.

In all above ground portions, the starch content of the ringed trees was higher than that of the unringed trees; even in the leaves there was a slight but significantly higher starch content. In the roots the starch content of the ringed trees was in most cases much lower than that of the unringed seedlings. In an extreme case (in the wood of the primary roots of the last ringed tree) the starch amounted to only 8% of that of the corresponding unringed tree. The roots of the former tree were in a definite state of starvation, a considerable portion of the smaller roots having died.

The effect of ringing on the free and total reducing substances was rather slight. However, there was a definite indication that they are lower in the tops and higher in the roots of the ringed trees than in the corresponding portions of the unringed trees when

reported on a dry weight basis. An explanation of this finding will be offered in the following discussion.

Reducing substances are highest in the root bark, followed by trunk and branch bark, secondary roots (bark and wood not separated), leaves, twigs (bark and wood not separated) and lowest in the wood.

The effect of ringing on the total nitrogen content was similar to that on the free and total reducing substances, but, as a whole, less pronounced. Absorption of nitrogen must have been slight during the period in which collections were made, since no seasonal changes could be observed. Probably owing to this fact the differences in nitrogen between ringed and unringed trees were small.

DID NOT DETERMINE NITROGEN

It was hoped that a determination of the total amount of nitrogen in the roots and tops of all ringed and unringed trees might help in determining whether nitrogen had passed the ring or not. However, the variations between pairs and even within pairs of trees were large enough to make any of the observed differences insignificant. Determinations of the total amount of nitrogen per tree are only of value when the trees or branches are carefully matched as to size at the beginning of the experiment, and when the amount of growth made after ringing is large compared to the initial amount of growth.

The weight of the alcohol and benzene fraction did not show any consistent seasonal trend, nor was there any great difference between ringed and unringed trees. However, there was an indication that in woody fractions high in starch and presumably also other polysaccharides the weight of the alcohol fraction was relatively low and vice versa.

The benzene extract of root fractions was consistently heavier than that of all above ground fractions excepting the leaves. This difference is believed to be due to the presence of a reddish, resinous substance, which in its occurrence seems to be restricted to the roots. Saponification tests indicate no striking difference between the top and root fractions. The anise oil giving the characteristic odor to Mexican avocado leaves and twigs is volatile at 70°C and is, therefore, not included in the benzene fraction.

The nitrate nitrogen content was so small in all fractions, that a "total" nitrogen (reduced nitrogen) determination is a close approximation to the total nitrogen content.

The fact that no appreciable amounts of nitrate nitrogen were found is not conclusive proof that nitrogen is transported largely in organic form. The largest amounts of nitrate nitrogen were found in the bark of the roots and in the leaves.

Discussion. In a study such as this the choice of a reliable basis of computation is of primary importance. The results have been calculated only on a dry-weight basis. The data, however, may lead to erroneous conclusions, since a certain weight of a fraction high in starch and other storage materials will contain necessarily a smaller amount of soluble carbohydrates or nitrogen than the same weight of a fraction low in starch and other insoluble substances due simply to the larger proportion of tissue to storage

materials in the latter fraction. This may explain why the free and total reducing substances as well as the total N are apparently low in a tissue high in starch (e. *g.,* the tops of the ringed trees) and are higher in the roots of the ringed trees than in the corresponding unringed seedlings.

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References.

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