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Seasonal changes in nitrogen concentration in avocado leaves associated with leaf age and fertilisation regime

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SYNOPSIS
Two years of severe nitrogen deficiency in avocado trees under field conditions, resulted in restricted growth, small pale leaves, early leaf shedding and reduced yield. In addition, N-deficient trees suffered more frost damage than healthy trees. After fertilisation had been resumed, three types of leaves were sampled monthly over the course of an entire year: the previous year's leaves, leaves from the spring flush and leaves from the second flush (summer). In all three leaf types and throughout the year, N-concentration was significantly lower in the N-deficient trees than in the fertilised ones. A significant difference was also found between spring and summer leaves.

In order to ensure accurate interpretation of leaf analyses - the most important tool for determining the N-nutrient status of the plant - only leaves from the spring flush should be sampled. Leaves from the spring flush can be differentiated easily from those of later flushes, according to their calcium content.

INTRODUCTION

It is well known that leaf age, position on the twig, fruiting, cultivar, soil type and cultural practices may all contribute to variations in the mineral concentration of avocado leaves (3). In order to obtain reliable results, it is most important to standardise sampling methods, so that the analyses will correlate with the nutritional status of the tree.

Almost all avocado leaves present on a tree are of that current year. It is recommended to sample healthy, unimpaired mature leaves of first growth of the current year, namely, leaves of the current spring's growth (3). However, it is very easy to err in determining the age of leaves, since leaves of the various flushes do not differ in shape or colour.

Seasonal changes in the mineral composition of avocado leaves have been extensively investigated and reviewed (1). Only Koo & Young (2) compared the nutritional concentrations of leaves from the early and late flushes of the avocado. They found that N was higher and Ca was lower in the second flush leaves and concluded that, since it was virtually impossible to distinguish between the leaves of the two flushes, it was advisable to sample both.

The study reported on here, was aimed at a more accurate determination of differences between spring and summer flush leaves, with regard to nitrogen level, since N is considered to have a great influence on the growth and fruiting of avocado trees.

MATERIALS AND METHODS

This experiment was conducted in an eight-year-old avocado plantation, on a low-lime grumusol soil with 60 per cent clay. The plantation was irrigated by the drip method, with 12 drippers each discharging 4 L/h/tree.

Nitrogen was injected as liquid NH4NO3 at a constant concentration of 40 ppm into the drip irrigation system. The results reported on refer to two treatments: one constantly supplied with N during the four years (from 1981-84) and the other, because of a technical failure, not at all supplied with N during 1982 and 1983 (Table 1).

TABLE 1 Amount of Nitrogen (kg/ha) supplied during four years.

Treatment year	+ N	- N
1981	190	161
1982	248	0
1983	254	0
1984	189	157

The trees deprived of N showed typical N-deficiency symptoms, expressed by restricted growth, pale, small-sized leaves and early leaf shedding. In addition, the total number of fruits and fruit sizes were significantly reduced and the trees were more susceptible to frost damage (4).

The experiment was conducted in six replications, each comprising 12 Hass and 12 Fuerte trees. For one year starting in April 1984, leaves were sampled monthly from the fertilised and non-fertilised trees to make a nutritional assessment.

Three types of leaves were sampled: (i) those remaining from the previous year (1983), as long as they were on the trees; (ii) leaves of the spring flush; and (iii) leaves of the summer flush. Each sample comprised three leaves from each tree, with a total of 36 leaves in each replication.

RESULTS

Nitrogen concentration in leaves increased in spring, the first phase of leaf growth. Later on, the level decreased gradually and stabilised in autumn and winter (Figure 1). In the following spring, the N-level decreased until the leaves were shed. The highest N-concentration was found in leaves of the summer flush and the lowest in leaves of the previous year. It was clear that nitrogenous fertilisation influenced the N-content significantly in all three leaf types.

The effect of leaf age and season on calcium concentration will also be reported on here, because of its importance as a tool to differentiate between leaves of spring and summer flushes.

Calcium concentration in the avocado leaf increased gradually from leaf emergence to shedding (Figure 2). Only the spring-flush leaves showed some stabilisation in Ca-content in autumn. There were marked differences in Ca-content - opposite to those revealed by the N-content - in the various leaves: the highest concentration was in the previous year's leaves and the lowest in summer-flush leaves. Nitrogenous fertilisation had almost no effect on the Ca-concentration in the leaves. However, leaves of fertilised trees always had a somewhat higher Ca-content than leaves of non-fertilised trees.

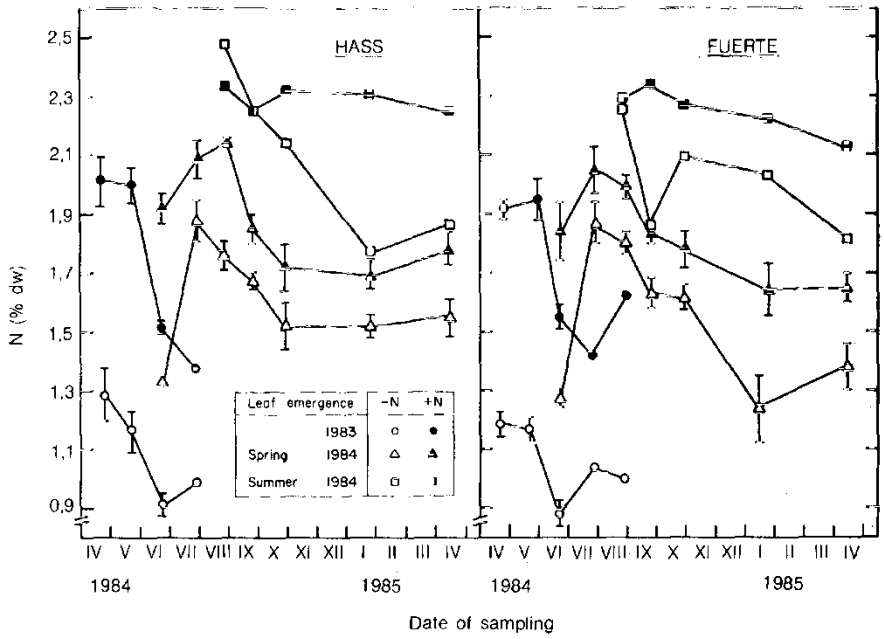

Fig 1 The effect of leaf age, fertilisation regime and sampling date on nitrogen content of the leaf.

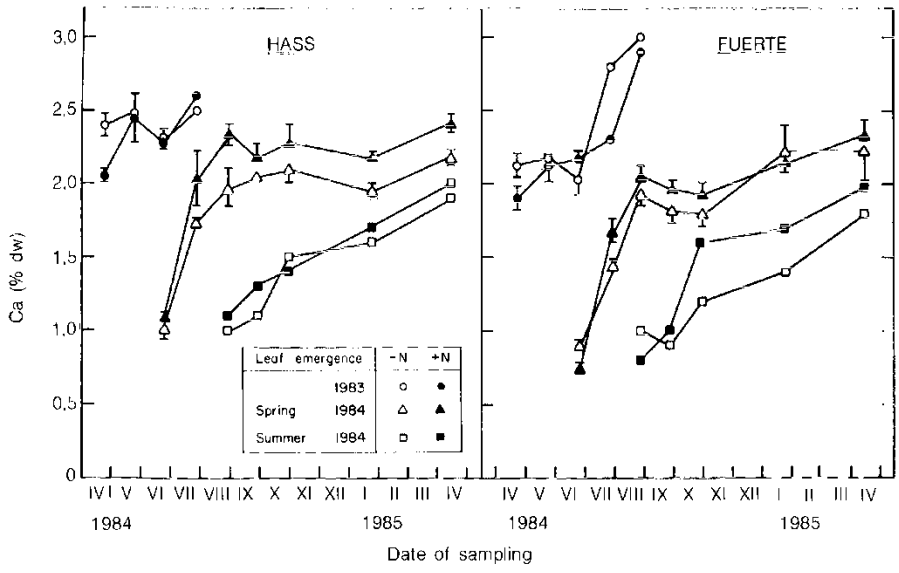

Fig 2 The effect of leaf age, fertilisation regime and sampling date on calcium content of the leaf.

DISCUSSION

Since significant differences in N-content were generally found in all leaf types, leaves can be considered a good tool to determine the nitrogenous nutritional status of avocado trees.

The N- and Ca-contents in leaves of the spring flush, are almost constant in autumn. This season can therefore be reaffirmed to be the best one for sampling avocado leaves. Since the previous year's leaves had already been shed at that time, only the spring vs summer flushes will be discussed here.

When comparing the critical N-levels (1,6 per cent in cv Feurte and 1,8 per cent in cv Hass), it is noted that N was always above the critical level in fertilised trees, as compared with a deficiency in unfertilised trees. This was found only in the spring-flush leaves. The N-level in the summerflush leaves was always above the critical level, both in fertilised trees and in those suffering from a severe N-deficiency. It is therefore concluded that leaves of the summer flush are not suitable for sampling, as long as the critical level of N for avocado is not increased.

Koo & Young (2), who sampled both spring- and summer-flush leaves, found the same differences as the authors. However, their conclusion was that, since it was virtually impossible to distinguish between leaves of the two flushes, a mixture of the two flushes should be sampled and analysed. The authors believe that, because of the large and significant difference in N-content, spring- and summer-flush leaves should be differentiated and only the spring-flush leaves should be sampled.

The significant differences in Ca-content between spring and summer leaves, enabled the authors to differentiate between them. In the recommended sampling season, autumn, the Ca-level in the summer-flush leaves never exceeded 1,6 per cent, while that of the spring-flush leaves was always above 1,8 per cent and often above 2 per cent. Therefore, spring- and summer-flush leaves can be easily distinguished between by determining their calcium level.

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