

PHASES OF SEASONAL GROWTH OF THE AVOCADO TREE

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OPSOMMING

Daar word drie fases in die jaarlikse groeisiklus van avokadobome onderskei. Die eerste fase begin met blomdifferentiasie, gevolg deur die tweede fase van bloei, bevrugting, vrugset en vrugval. 'n Kritieke periode word aangedui vanaf die tyd van bevrugting (September) tot aan die einde van die vrugvalstadium (Desember). Enige faktor wat die boom se normale ontwikkeling verhoed (soos vogspanning) sal ook produksie nadelig beïnvloed. Die derde fase word gekenmerk deur vinnige vruggroei en dit behoort die "regte tyd" te wees vir die toediening van misstowwe.

SUMMARY

Three phases in the annual growth cycle of avocado trees have been identified. The first phase begins with floral bud differentiation, followed by the second phase of flowering, pollination, fruit set and fruit drop. A critical period for production is identified from the time of pollination (September) until the end of fruit drop (December). Any factor that causes stress during the critical period will adversely effect production. The third phase is characterized by rapid fruit growth and should be the "right time" for the application of fertilizers.

INTRODUCTION

This is not a research report. It is an article that speculates on the practical implications of the various phases through which an avocado tree passes during the course of a year. If the article succeeds in stimulating research in a small way, it will fulfill its purpose. The views and theories expressed are to a large extent based on the research of Robertson (1969).

The avocado tree is a living organism that goes through certain phases during the year and these stages have to be clearly defined and considered in orchard practices such as irrigation, fertilization, weed control and planning.

Floral differentiation in deciduous fruit trees occurs during the summer of the previous year. In the case of deciduous fruit trees leaf drop follows when winter sets in and a period of dormancy precedes the flowering in the spring. The stages are clear and easy to observe. The avocado, however, is an evergreen tree and the stages of vegetative growth, flowering, fruitset and fruit growth are not so clearly distinguished, but a definite

pattern exists.

According to the studies of Robertson (1969) who carried out his research at Nelspruit on the Fuerte cultivar, floral and bud differentiation commences in autumn. Before this stage the buds are almost exclusively vegetative. The floral bud differentiation continues during April and May, and the first flowers appear towards the beginning of June. Flowering takes place during the cool winter months and fruitset only commences at the end of September.

Consider the information in Figure 1. The seasonal cycle of floral and fruit development is presented from the end of March over a period of 13 months. For the sake of this discussion, three phases are identified, beginning with floral bud differentiation and ending 13 months later when the fruit reaches its final stage of gradual growth.

Phase 1

This phase represents the stage during which the tree prepares itself for the following season's crop. Robertson (1969) showed that in the case of the Fuerte cultivar, floral bud differentiation started by the end of March at Nelspruit. Observations in other areas show that March can only serve as a guideline and that this particular stage can occur earlier or later, depending on any particular area. Floral bud differentiation continues until June and perhaps later.

The significance of phase 1 is not yet fully appreciated. The producer may feel that he must do everything possible to encourage flower production, but less than 1% of all flowers develop into fruits. Nature is very wasteful in this respect. There is no evidence yet that abundant flowering is an indication of a big crop.

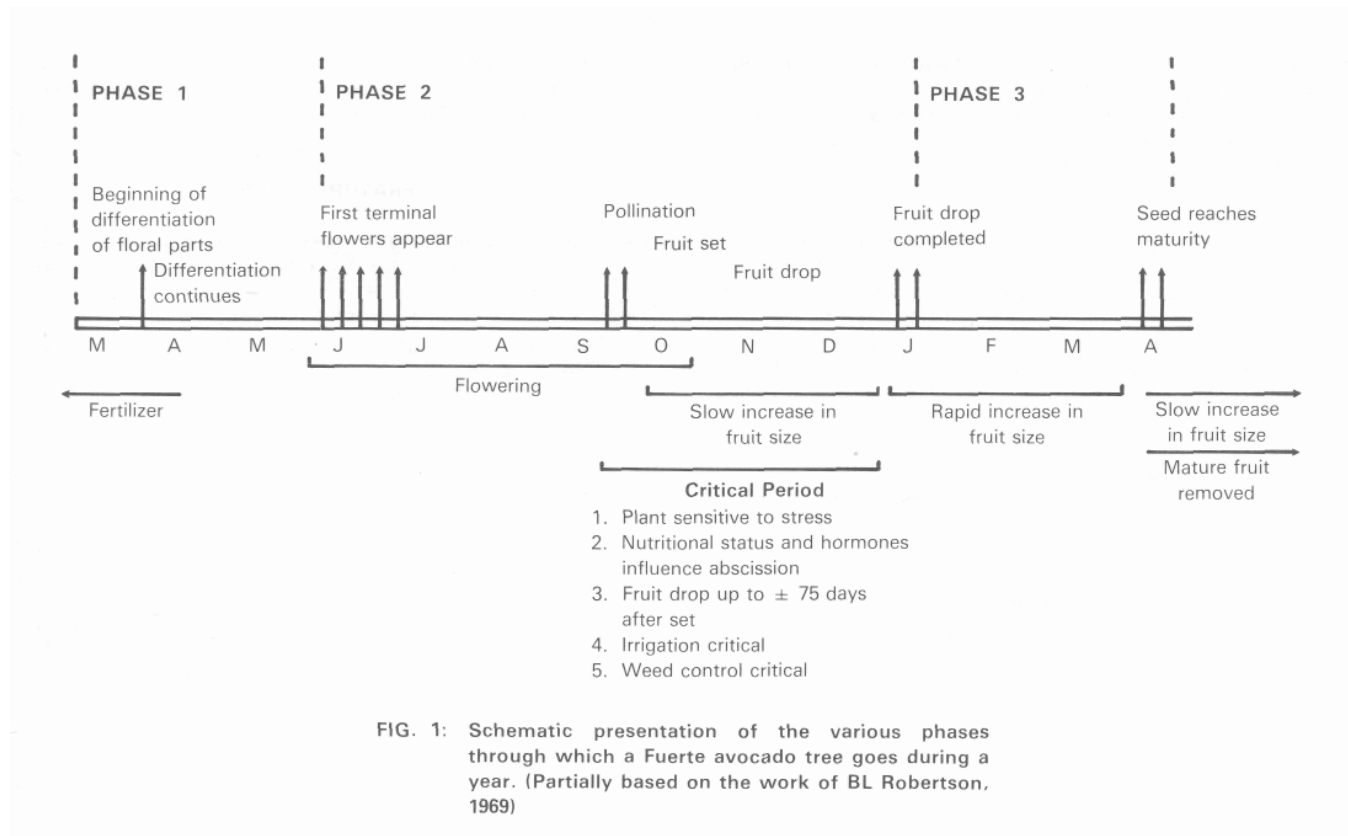
There is a tendency to apply fertilizer during this period and it cannot be faulted at this stage of our knowledge. One expects that regular irrigation during this phase would prepare the tree for the vitally important phase 2.

Phase 2

Flowering starts in June according to Robertson (1969) and continues until October. June, July and August are the coolest months of the year and several workers reported that the floral cycle and fruit set can be upset by temperatures below 20°C (Lesley & Bringhurst, 1951; Lichou & Vogel, 1972; Sedgley, 1977). It was strongly indicated by Robertson (1969) that the winter temperatures at Nelspruit are too low for successful fruitset during the months mentioned above.

The flower is capable of successful pollination for only a few hours when it is open in the female stage. According to Sedgley (1977) temperatures between 12 - 17°C a low percentage flowers open in the female stage but the majority open as males only. Pollination at these temperatures is usually unsuccessful, because the pollen germ tube fails to reach the ovary. In such an instance pollination takes place but fertilization fails. The effect of this type of pollination sometimes stimulates the ovary walls but the stimulation becomes exhausted within a week or two and the fruitlet will abscise (Sedgley, 1977).

Low temperatures apparently also influence the activity of bees (Lesley and Bringhurst 1951). Cross pollination and the role of bees are possibly greatly under-estimated especially in the light of Sedgley's work which shows that although self pollination occurs it does not result in fruit set and Lesley and Bringhurst (1951) work which indicates the importance of bees.



Between 20 - 25°C flowers open normally and female and male occur. At these temperatures there is an overlapping of female and male stages for several hours. The most successful fruit set takes place at these temperatures.

Above 28°C flowers are inclined to absciss and when they open, the male stage is seldom reached. Sometimes individual buds or floral branches absciss before the flowers open at temperatures above 28°C.

Robertson (1969) found that fruit set takes place from the end of September at Nelspruit. The fruit set and fruit drop stage is the most critical period from a producers view point. Up to this stage, floral differentiation occurred, followed by flowering and pollination, but the fruitlets dropped. This is the heart of success or failure of fruit production.

Fruits which drop after fruit set can be divided into two categories:

1. Fruits resulting from flowers which have been pollinated, but subsequent fertilization

failed.

2. Fruits resulting from successful pollination and fertilization, with normal embryos.

The second category present the greatest problem to the producer whose main concern is to obtain high yields. This important facet of avocado production has been neglected for too long. What causes the abscission of perfectly normal fruits? Is it water stress, too much or too little fertilizer, temperature effects or a hundred other causes? We have to find the answers to these questions if we wish to maintain and increase in production.

Fruit drop is completed towards the end of December. The size of the crop has now been established. The critical period is over.

During phase 2 the fruits increase slowly in size. Phase 2 is a shaking out process. The emphasis during this phase is not on fruit growth but on selection. If vegetative growth is stimulated at this point by the application of fertilizers, the tree will respond in favour of vegetative growth and fruit drop will be encouraged.

Phase 3

From the end of December the fruit grows rapidly ($\pm 1,9$ grams per day, according to Robertson, 1969). The eventual size of the fruit is determined during this phase. Kalmar and Lahav (1976) found that the fruit growth rate is always the greatest after an irrigation. The tree draws on water which is "stored" in the fruit. During periods of water stress the fruit size will be affected during drought. Although growth flushes may occur during spring, the tree will be inclined to produce vegetative growth during this phase and it seems the optimal time to apply fertilizer. Any action that the farmer takes during this phase to stimulate growth of leaves will benefit the size of the fruits. The efficiency of the leaves will be reflected in the quality and size of the fruits.

During this period it is determined whether the majority of the crop will consist of undergrade, medium or oversized fruits.

Phase 3 is completed when the seed reaches maturity and a reduction of fruit growth sets in towards the end of April. In most areas in South Africa harvesting is in full swing by the end of Phase 3. Phase 1 has already started by now and overlaps with Phase 3.

DISCUSSION

Rather limited information is available from literature sources but one is able to identify the three phases which are of great importance to the producer. It is also possible to identify the latter part of phase 2 as the critical period from a production point of view. This critical period has been largely ignored in irrigation, fertilizer and weed control experiments. Kalmar & Lahav (1976) and Langenegger & Koen (1978) showed that an avocado tree's response to mineral nutrition is rather disappointing and that heavy fertilization may have a negative effect on yield. The critical period and the effect of time and quantity of nutrient applications on fruit set have however, not been adequately investigated. In theory there appears to be a "wrong time" (September to December) and a "right time" (November to April) for the application of nitrogen.

In South Africa the critical period is sometimes characterized by drought and very hot conditions in October, November and December. Any water stress during this period is bound to encourage fruit drop. Likewise over irrigation must also be avoided during this period, because apart from the fact that it will encourage *Phytophthora* root rot, the tree will not function normally and this could effect fruit set and fruit drop.

One may expect that the effect of weeds on the crop will be most pronounced during the critical period, especially from October.

It would be wrong to ignore irrigation and weed control in December as fruit size is an important consideration.

From the discussion so far, it is clear that disturbance of roots should be avoided at all costs during the critical period. Some growers disc or plough or plant cover crops in order to control weeds. The merits of the various weed control systems are not under discussion here. Whatever weed control system is followed, special care must be taken to prevent root disturbance with implements during the critical period.

A few areas for research may now be identified:

1. The effect of temperature, humidity, photoperiod and light intensity on flowering, pollination and fruit set need to be investigated in more detail. Although certain temperature studies have been done, the full range of possibilities have not been covered. In South Africa where Fuerte, Mass, Edranol and Ryan are responsible for the bulk of our production, relatively little is known about the temperature requirements for fruit set for these cultivars.

2. It is logical that any stress or shock during the fruit set and fruit drop period will be detrimental. An investigation of the effects of irrigation, fertilization and weed control during the critical period is a very urgent matter.

It seems as if the whole question of cross pollination, pollen pistil compatibility amongst avocado cultivars as well as hormonal balance, need to be investigated afresh.

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