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Incidence of Phytophthora pod rot disease of cacao at different heights in the tree

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Abstract

The rate of infection of pods by *P. palmivora* at the lower trunk of a cacao tree is always higher than of those in the canopy. This is often held as a proof that the soil is the primary source of infection. An experiment has indicated that climatic conditions at the beginning of the rainy season in Western Nigeria do not favour infection of pods in the canopy, which may also explain the said phenomenon.

Introduction

The first cacao pods infected by *Phytophthora palmivora* at the onset of the rainy season are often found on the lower part of the tree trunk .This has been frequently observed in cacao farms. Grimaldi (1958) stated that in the Cameroons all pods infected in June and July 1956 were found not higher than 50 cm from the ground. Newhall et al. (1966) reported in Costa Rica that 2–3 times as many infected pods were found below 120 cm than above this level.

Observations in Nigeria

In the collection of Trinitario and South American clones at the Gambari Experimental Station (Western Nigeria) (cf. Weststeijn, 1966) the height at which diseased pods were found, was recorded in 1963 and 1964 between May and July, which are the first three months of the *Phytophthora* pod rot season.
In addition an experiment was done in 1964, in which approximately 10% of the pods on the trunk and 10% of those in the canopy of a dozen well producing trees was artificially inoculated during the first week of May. The subsequent development of the disease in those trees was observed by recording seperately healthy ripe and *Phytophthora*-infected pods, including immature ones, for the levels: 0–50 cm, 50–120 cm, 120–250 cm and above 250 cm. All recorded pods were harvested before recording. Non-inoculated trees were used as controls.

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Table 1. Infection rate at different heights in the trees of collection of clones in 1963 and 1964

	0–50 cm			*50–120 cm*			*> 120 cm*		
	pods harvested	*pods infected*	*% inf.*	*pods harvested*	*pods infected*	*% inf.*	*pods harvested*	*pods infected*	*% inf.*
May 1963	507	122	24	962	109	11	7311	96	1
June–July 1963	289	242	84	489	297	61	2116	669	32
May–July 1963	796	364	46	1451	406	28	9427	765	8
May 1964	—	80		—	45		—	52	
June–July 1964	—	643		—	391		—	463	
May–July 1964	—	723		—	436		—	515	

Tabel 1. Mate van infectie op verschillende hoogten in de bomen van de klonen kollektie in 1963 en 1964

Results

The data obtained in 1963 from the collection of clones show, that the disease incidence decreases sharply with increasing height, while the number of pods increases (Table 1). This decrease is more pronounced during the month of May, when many pods are on the trees (mid-crop) and the rainfall is still limited, than during following months.
For 1964 no figures for healthy pods are available, but as the total number of pods in the canopy of a cacao tree is always much higher than that on the trunk, the numbers of diseased pods at the different heights as given in Table 1 confirm the findings of 1963.
Table 2 shows that above-ground sources of infection, which are equally distributed over the different parts of the tree, do not have a permanent influence on the pattern of spread of the disease in the trees. The number of infected pods on the treated trees

Table 2. Influence of artificial inoculation on infection rate at different heights in the trees

	0–50 cm		50–120 cm		120–250 cm		>250 cm	
	pods on the trees*	pods infected	pods on the trees*	pods infected	pods on the trees*	pods infected	pods on the trees*	pods infected
Artificially inoculated								
May 1964	40	9	54	10	96	8	232	20
June 1964	29	17	38	16	56	11	110	0
May–Oct. 1964	47	30	99	62	263	68	598	35
Controls								
May 1964	96	6	100	2	131	0	271	1
June 1964	88	39	82	25	106	8	182	0
May–Oct. 1964	120	95	155	101	283	112	909	142

* Estimated number of pods of more than 2 months old actually hanging on the trees during the relative periods

Tabel 2. Invloed van inoculatie op de mate van infectie op verschillende hoogten in de boom

were considerably higher than that of the controls in the first month after inoculation, because the inoculated pods were included in the counts. In the second month this difference was much smaller, and it did not occur anymore when the figures for the entire season were compared. It was noted that the disease incidence above 250 cm was reduced to zero in June in the inoculated trees as well as in the controls notwithstanding the higher rate of infection in the former during the previous month.

Discussion

The data collected during the early months of the rainy season in Western Nigeria support the findings in other countries that at the beginning of an epidemic infected pods are predominantly found at the lower trunk of the tree. Some authors (Grimaldi 1958; Okaisabor, 1965) conclude that therefore the soil is probably the primary source of infection, which implies that by that time of the year little inoculum is reaching pods in the canopy. This, however, might not be the only factor involved, because in the experiment mentioned above even 10% of infected pods in the canopy as primary source of infection did not give rise to a higher number of infected canopy pods than on the control trees. The climatic conditions, notably the lower relative humidity in the canopy of a cacao tree in the beginning of the rainy season in Western Nigeria, also seem to be a limiting factor for infection of pods in the upper canopy of the trees, even if inoculum was present at that height. This effect depends much on the density of overhead shade and on the thickness of the cacao-canopy itself.
Furthermore, pods at lower heights are not only subjected to more favourable climatic conditions but also to a higher inoculum density, because the fungal propagules are mainly transported in raindrops, which usually descend, so that spores which survived the dry season on an above-ground part of the tree are more likely to infect pods below its site of "overwintering" than above it. Spore-dispersal by air is thought to be unimportant (Thorold, 1952) or non-existing (Wharton, 1953).
A higher incidence of *Phytophthora* pod rot disease on the lower trunk may, therefore, be explained not only by the proximity of the soil as source of infection, but also by the more favourable climatic conditions for infection and a higher inoculum density from above-ground sources of infection.

Samenvatting

Phytophthora vruchtrot van cacao op verschillende hoogten in de boom

In Nigeria evenals in andere landen is waargenomen dat door *P. palmivora* aangetaste cacaokolven in het begin van de regentijd vooral voorkomen aan de stam en dat het aantastingspercentage van de stamvruchten over het gehele seizoen genomen aanzienlijk hoger ligt dan dat van de vruchten in de kroon. Een proef waarbij ongeveer 10% van de stamvruchten en ook van de vruchten in de kroon werd geïnoculeerd bij het begin van de regentijd, wees uit dat in deze periode van het jaar de klimaatomstandigheden in de kroon waarschijnlijk ongunstig zijn voor infectie.
Een hoog percentage aangetaste stamvruchten in genoemde periode mag derhalve niet zonder meer gezien worden als bewijs dat de grond in het begin van de regentijd de enig belangrijke besmettingsbron van de ziekte zou zijn.

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