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Resistance levels in Coffea arabica to Gibberella xylarioides and distribution pattern of the disease

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Abstract

Coffea arabica trees in a collection at Jimma, Ethiopia, are often attacked and killed by *Gibberella xylarioides*. Statistical analysis shows a varietal pattern of attack. However, an influence of disease loci is also probable. Varietal differences open the possibility of control with resistant varieties. Localized outbreaks of the disease may permit temporary control by tree eradication and soil treatment.

Introduction

Dying of trees in *Coffea arabica* L. is a major problem in many areas of Ethiopia. Kranz and Mogk (1973) reported the isolation from dying trees of *Gibberella xylarioides* Heim et Saccas, of which *Fusarium xylarioides* Steyaert is the conidial stage. This fungus is a well-known parasite of other coffee species in West and Central Africa (Saccas, 1951; 1956). Later isolations from different parts of Ethiopia, made at Jimma Research Station, nearly always yielded *G. xylarioides* but only the 'female strain' (Booth, 1971). Isolates from ascospores never produced the 'male strain'. The disease cycle is not fully known, but careful observations showed that in most trees die-back starts unilaterally and later extends to the whole tree. The affected trees die in two to three months after appearance of the first symptoms. Inspection of dying trees revealed bluish-black streaks under the bark near the collar. Stromata producing perithecia were observed in the bark. Ascospores could only be found in August and September at the end of the rainy season.

Practically all the trees that died in the French coffee collection at Jimma were killed by this typical *Fusarium* wilt. The collection was planted in the field in 1968 and the first casualties date from about 1970. Some differences between lines within the collection were observed and outbreaks seemed to occur in focal patterns. These two aspects were studied and are reported in this paper.

Material and methods

The French collection at Jimma Research Station was planted in 1968 from coffee seeds collected in Ethiopia by a French coffee mission during 1966. It also includes some Indian lines and some material collected by Dr Samu-Negus Haile Mariam, former director of the Station. Individual lines are planted in plots consisting of eight

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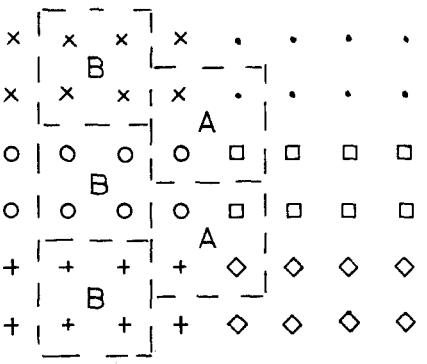

Fig. 1. Arrangement of coffee lines in the French collection of Jimma Research Station. Each symbol indicates a different line. Plots of eight trees: A = plots 'between lines', B = plots 'within lines'.

Fig. 1. Groepering van koffielijnen in de Franse collectie van het Jimma Research Station. Elk symbool geeft een lijn aan. Vakken van acht bomen. A = 'tussen lijnen' vak, B = 'binnen lijnen' vak.

trees distributed in two rows of four trees each. Each line is replicated a number of times. The total number of lines is 98. Dying of trees in the collection was recorded since 1973. Practically all trees that died showed infection with *G. xylarioides*. Records up to December 1976 were used for the present investigation. For calculation purposes it was assumed that trees that died before 1973 also died from the same cause. Based on tree arrangement in the field, subplotting in two ways was possible: Plots of four trees 'within lines' and plots of four trees 'between lines' (Fig. 1). Plots were classified from 0 to 4 according to the number of dead trees.

The following analyses were made:

'*Localized effect*'. The distribution of 'between lines' plots was compared with the binominal distribution of the plots expected if tree deaths occurred randomly. If a 'localized effect' occurred, plots with more than one dead tree should be more common than expected from the random distribution.

'*Lineal effect*'. The distributions of 'between lines' and 'within lines' plots were compared. If a 'lineal effect' existed, plots with more than one dead tree should be more common in the 'within lines' plot distribution.

Lines with six replications were compared with each other. No tests could be used that required assumptions about distribution of the dying of trees within these six plots, due to the probable 'localized effect' and to the large number of plots without any dead or missing trees. Twenty lines with six replications were compared with each other using Wilcoxon's two sample tests.

Results

Calculations are given in Table 1 and 2. The 'localized effect' is probable but not significant. The 'lineal effect', however, is highly significant.

As for differences between lines, the results are given in Table 3. The Indian lines S 1934 and S 288 are highly susceptible. Other Indian lines (less than six replications, not in table) S 795, S 947 and S 952 also show a high level of susceptibility. In the Ethiopian material all grades of susceptibility are present.

Discussions and conclusions

The data obtained in this investigation show that resistance of *C. arabica* to *G. xylarioides* exists. This resistance appears to express itself quantitatively. Since vertical

Table 1. Distribution of plots classified according to number of dead trees: 'between lines' plots compared with the binominal distribution expected if tree deaths in plots occur randomly.

Number of dead trees	0	1	2	3+4
'Between lines' plots	167	82	30	3
Expected distribution	158.73	98.06	22.67	2.33

$\chi^2 = 5.62$ d.f. = 2
$0.1 > P > 0.05$

Tabel 1. Vakken geordend naar het aantal dode bomen per vak. De verdeling van 'tussen lijnen' vakken vergeleken met de binominale verdeling die verwacht wordt indien het sterven van bomen in de vakken volgens toeval plaats vindt.

Table 2. Plots classified according to number of dead trees: Comparison of the 'between lines' and 'within lines' plots distributions.

Number of dead trees	0	1	2	3	4
'Between lines' plots	167	82	30	3	0
'Within lines' plots	242	61	29	11	9

$\chi^2 = 22.94$ d.f. = 4
$P < 0.001$

Tabel 2. Vakken geordend naar het aantal dode bomen per vak. De verdeling van 'tussen lijnen' vakken vergeleken met die van 'binnen lijnen' vakken.

Table 3. Differences between lines in resistance levels to dying of trees caused by *Gibberella xylarioides*. Percentage loss from 1970–1977. Lines marked with the same letter did not differ significantly at p = 0.05.

Percentage loss	Lines							
0–4	F37	F28	F30	F13	F17	SN1	F55	a
4–6	F35	F44	F23					ab
6–10	F21	F38	F12	F16	F40			abc
14	F60							abc
20	SN6							bc
26	F39							cd
42	S1934							d
58	S288							d

Tabel 3. Verschillen in resistentie tegen sterfte door Gibberella xylarioides. Percentage verlies van 1970–1977. Lijnen, aangeduid met dezelfde letter verschillen niet significant op het p = 0.05 niveau.

resistance to *Fusarium* wilts is found practically only in annuals (Robinson, 1976), it is likely that the resistance observed in the system *G. xylarioides/C. arabica* is horizontal and can offer a longterm solution to this disease problem. All the genetic material used in the breeding program for resistance to coffee berry disease (Van der Graaff, in press) will be screened for resistance levels to this *Fusarium* wilt.

The role of localized outbreaks as a starting point of the disease could not be fully established, but remains probable. Localized outbreaks may permit short-term control by eradication of affected trees and soil treatment. This is also recommended for the control of this disease on other coffee species in West Africa (Saccas, 1956).

Finally it should be noted that the phenomenon of localized outbreaks indicates that the fungus does not seem to persist in the soil. This is in accordance with the results of Saccas (1956) and may be explained by the fact that the fungus seldom forms chlamydospores (Booth, 1971).

Samenvatting

Verschillen in resistentie in Coffea arabica tegen Gibberella xylarioides en het verspreidingspatroon van de ziekte

Veel bomen van een collectie van *Coffea arabica* L. te Jimma sterven na een aantasting door *Gibberella xylarioides* Heim et Saccas. Door groepering van het materiaal op verschillende manieren (Fig. 1) zijn twee vergelijkingen mogelijk: (a) Tussen een theoretische verdeling berekend over de gehele collectie zonder plaats- of lijneffecten en een verdeling met plaatseffecten maar zonder lijneffecten (plaatseffect). (b) Tussen de verdeling zonder lijneffecten maar met mogelijke plaatseffecten en een verdeling met lijneffecten en mogelijke plaatseffecten (lijneffect).

De statistische analyse (Tabel 1) toont dat het plaatseffect net niet significant is maar dat de verschillen tussen lijnen een zeer hoge significantie bezitten (Tabel 2). Verschillen in gevoeligheid tussen een aantal lijnen zijn aangegeven in Tabel 3. De vrij waarschijnlijke plaatseffecten maken bestrijding van de ziekte mogelijk door vernietiging van aangetaste bomen en bodembehandeling. De duidelijke resistentieverschillen tussen koffielijnen maken controle op lange termijn met behulp van resistentie mogelijk.

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