Indications of heritability of resistance of a cocoa cultivar to *Phytophthora palmivora* pod rot in Ghana

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SUMMARY

The cocoa cultivar Y44, a local selection from Ghana showed the least susceptibility to black pod infection in the field among 20 types tested in a clonal trial. Resistant breeding lines segregated from its first generation progeny grown in the field. The seedlings of the F_1 and F_2 generation inbreds tested artificially in the green house segregated into resistant and susceptible breeding lines. The proportions of the resistant lines were similar to that of a known resistant cross included for comparison. The resistance conditioned by Y44 therefore seems heritable and appears to be polygenic in character.

INTRODUCTION

The importance of using cocoa varieties resistant to black pod disease as a means of a long term control for the ubiquitous black pod disease has often been expressed. But the difficulty of locating suitable cultivars with heritable resistance to infection has slowed down the quest for such material. This paper reports on a cocoa cultivar that appears to possess heritable resistance to the blzck pod infection in Ghana.

MATERIAL AND METHODS

Yield and black pod infection in a clonal trial in Ghana were assessed over a five year period. The clones in this trial were described by GLENDINNING (1964). They are of the 'local hybrid' type of the Ghana cocoa collections. These are an assortment of Trinitarios and Criollo varieties and the product of inter breeding between these and Amelonado. They were assembled at Tafo by POSNETTE (1943).

The trial consisted of six randomised blocks of twenty of the local hybrids types, in square plots of 16 trees spaced 10 ft $\times$ 10 ft. The planting started in 1947 and finally completed in 1950, as the full sets of the rooted cuttings could no be produced at the same time. Fan cuttings only were used and the habit of growth was unlike that of seedling or chupon. Plantain was used as temporary shade under selected forest trees which were left as permanent over-head shade. The recording of yield and black pod infection began at the commencement of bearing and continued over many years. At each harvest healthy ripe and black pod infected pods were recorded separately and removed from the trees. The clones in the trial have now been seriously affected by the swollen shoot disease, and some replications or part of them completely destroyed. The five year period chosen for the study, June 1960 to May 1965, was at a time when the trial was in full bearing, and not mutilated by the swollen shoot disease.

The yield and black pod infection of all the clones for each of the five years studies were grouped into three, (*a*) results for the entire year, (*b*) yield and black pod infection during the epidemic period (June to mid October) and (*c*) yield and black pod infection for the non epidemic period (Mid October-May). The cumulative yield and disease infection during the five year period were then noted. The black pod infected ones were expressed as a percentage of the sum of the healthy ripe and infected pods. Other categories of pods harvested e.g. rodent damaged pods were left out of consideration.

RESULTS

The full report on the twenty selections tested in the clonal trial will be published elsewhere. Only four of the types have been chosen for comparison. They consist of the first two apparently least susceptible and the least two most susceptible types. Table I shows the accumulated grand total yield and black pod infection over five years and also the yield and black pod infection in the epidemic and non-epidemic periods of the years. The cultivars Y44 and S27 which gave similar crop losses to black pod over the five years had much lower losses to black pod than A22 and A12. But the differences among them were not statistically significant.

The proportions of crop that matured in the epidemic period and the rates of black pod infection in the different types varied widely from year to year. The ranges for the four cultivars under consideration are shown in the table. The mean proportions of crop occuring in all four during the epidemic period were not statistically significant. There were however,

significant differences at .05 level among the four in the levels of black pod infection. There was no significant differences between Y44 and S27. But both were significantly more resistant than A62 and A12. The apparent susceptibility of A62 and A12 as shown in the annual figures became clearly evident in the epidemic period.

The black pod infection did not cease completely in the non-epidemic period or less favourable months for black pod infection. There was however, no significant difference in the levels of infection among the types. The cultivar S27 has the advantage of maturing most of its crop (a mean of 88.7%) in the non epidemic period of the year.

TABLE I

YIELD AND BLACK POD INFECTION IN SOME COCOA SELECTIONS OVER A FIVE YEAR PERIOD IN GHANA

Type of cocoa	Grand total yield over five years		Yield in epidemic period (June to mid October)		Range of proportion of crop in epidemic period over five years	Yield in non-epidemic period (mid October to May)	
	Pods	% black pod	% crop	% black pod *		% crop	% black pod
Y44	14,192	16.3	31.6	22.4 a	15.2%-49.4%	64.8	13.5
S27	15,519	17.8	11.3	43.9 a	3.1%-17.1%	88.7	12.3
A62	10,576	33.2	25.3	58.7 b	11.9%-35.6%	74.7	24.5
A12	9,933	28.1	29.4	54.3 b	11.9%-57.9%	70.6	17.2

* Percentages of black pod not followed by the same letters are significantly different.

TABLE II

HERITABILITY OF RESISTANCE TO *PHYTOPHTHORA PALMIVORA* BUTL. CONDITIONED BY THE COCOA SELECTION Y44

Parents	Known field reaction	No. of pregerminated seeds planted		Percentage emerged after 10 days		% healthy seedlings after 2 months		% susceptible	No. of separate tests
		Inoc.	Uninoc.	Inoc.	Uninoc.	Inoc.	Uninoc.		
Y44 Selfed	R × R	652	165	58.1	94.5	48.5	(48.8) a 99.4	51.5	9
Y44 × T79/501	R × R	798	200	59.0	98.0	44.9	(45.4) ab 990.	53.1	9
Y44 × N8/131	R × S	400	86	43.3	98.2	26.3	(29.9) bc 88.0	73.7	5
Y44 × Na32	R × S	314	57	32.8	98.2	24.5	(24.5) c 100	75.5	4
Na32 × N8/131	S × S	467	104	26.9	94.2	15.8	(16.4) c 96.2	84.2	6
S27 Selfed		340	98	28.2	88.8	21.5	(24.2) c 88.8	78.5	5
Resistant breeding lines from Y44 selfed									
W20/20 Selfed	R × R	655	200	70.2	100	60.9	100	39.1	6
W19/20 Selfed	R × R	380	100	67.4	99.0	57.4	(58.0) 99.0	42.6	4
W22/9 Slefed	R × R	400	80	70.8	98.8	54.8	100	45.2	4

R = Resistant S = Susceptible ( ) Adjusted for deaths in the uninoculated seedlings.

In Table II, the reaction of the seedlings from the first generation inbred of the cultivar Y44 (Y44 selfed), to inoculation with *P. palmivora* was similar to those of the resistant cross Y44 × T79/501. It had 48.8% healty seedlings two months after inoculation compared with 45.4% for the resistant control included. The three selected parents of resistant breeding line from the Y44 first generation progeny growing in the field, also gave resistant reaction on selfing. The F_1 and F_2 inbreds of Y44 tested and the control resistant cross included for comparison, Y44 × T79/501, were more resistant, (significant at .05 level) than the progenies of Y44 crossed to the susceptible parents Na32 and N8/131. The cross between these two included for comparison for susceptibility segregated to the lowest proportion of resistant seedling 16.4% compared with 48.8% for Y44 selfed. The selfed progeny of S27 gave susceptible reaction in the seedling test.

DISCUSSION

The assessment of yield and black pod infection on the entire years' crop gives indications of the total loss of crop to the black pod disease, it dies not appear however, to give a true picture of inate resistance to infection. This problem seems to be largely obviated by showing the yield and black pod infection data separately in the epidemic and non epidemic periods. In these studies no significant differences were found among the types in the annual and non epidemic period losses to black pod infection, but significant differences were found among them in the epidemic period. Differences in susceptibility appear best assessed in this time of the cropping period. WESTSTEIJN (1966) came to similar conclusion in his studies of yield and black pod infection in different seasons of the year. The difference in infection between the cultivars Y44 and S27 were not statistically significant. But with its higher proportion of crop and yet lower percentage of infection than that of S27 which had the lowest percentage of crop in the epidemic period, Y44 is probably a better parent than S27 for black pod resistance. Of the types tested only S27 consistently matured a low proportion of its crop in the epidemic period (a mean of 11.3%). This confirms the observation by GLENDINNING (1964, 1966) that S27 matures most of its crop after October. This probably accounted for its low over all loss to black pod. Y44 also had low over all loss of crop to black pod but unlike S27 it had low percentage of black pod infection inspite of its relatively higher proportion of crop (31.6%) maturing in the epidemic period. The cultivar Y44 appears to possess different genetic make up from that of S27 for its resistance to infection in the field.

From the laboratory inoculation tests (AMPONSAH and ASARE-NYAKO, *in press*) it was observed that the first and second generation inbred of Y44 (table II) were not of uniform resistance. The proportion of resistant seedling that segregated were not significantly different from that of the resistant cross included for comparison (Y44 × T79/501). These were significantly superior to the susceptible cross Na32 × N8/131 also included for comparison. The field resistance shown by the cultivar Y44 appeared heritable by its first and second generation progenies and seems therefore to be genetic in character. The varying levels of resistance observed in the F_1 and F_2 progenies of Y44 suggest that the resistance conditioned by this cultivar is inherited in a quantitative manner. i.e. of multigeneric inheritance. It is of interest to note that the selfed progeny of S27 segregate into a small proportion of resistant seedlings. This was not significantly different from that of the susceptible cross, though higher. No genetic basis for the low field susceptibility of the cultivar S27 was observed in F_1 seedling tested by the new laboratory method. It's low over all loss to black pod infection may largely be due to its late cropping pattern.

LITERATURE CITED

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