Preliminary Observations on Resistance to *Ceratocystis cacaofunesta* in Cocoa seedling Progenies in Bahia, Brazil

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Introduction

The economic and social impact observed in Bahia since 1989, with the introduction of witches´ ´broom disease (*Moniliophthora perniciosa* Aime & Phillips-Mora) of cocoa (*Theobroma cacao L*.), demanded efforts to obtain genotypes resistant to the disease, which are productive and also present other desirable agronomic traits. However, a new disease "Ceratocystis wilt" appeared in the cocoa-growing region of Bahia, in 1997, on grafts in the greenhouse, and, in 1998, in adult cocoa trees (Bezerra 1977; Bezerra *et al*. 1998) and, in 2001 in Espírito Santo (Almeida *et al*. 2005). Since then, it has been the cause of significant losses, as has been observed visually in the Active Germplasm Bank of the Cocoa Research Center in Ilhéus, Bahia, Brazil, where a great number of Trinitario and Criollo cocoa plants have been destroyed by Ceratocystis wilt. This disease caused by the fungus, *Ceratocystis cacaofunesta sp*. nov. (Engelbrecht & Harrington 2005), is lethal to the cocoa tree.

Ceratocystis wilt commonly occurs in Central and South American countries (Silva *et al*. 2007). In countries where the disease occurs, several clones appeared to be resistant to the pathogen. In Ecuador, the clones IMC 67, Pound 12, SPA 9 (Delgado and Echandi 1965, Soria and Salazar 1965) and PA 121 (Soria and Salazar 1965), and in Colombia, the clones ICS 6, TSA 654 (IMC 67 x SCA 6) and ICS 95 presented high resistance levels (Barros 1981), as did the clones IMC 67, POUND 18 and TSA 654 in Trinidad (Gonsalves 1996). In these countries, highly productive clones such as SCA 6, ICS 1, ICS 39, ICS 89, UF 654, UF 667 and UF 668 (Soria 1973) are considered as more susceptible in the field.

The selection of resistant genotypes to the Ceratocystis wilt, considered as the more economical and effective means of managing the disease, was the approach taken by researchers of the Cocoa Research Center (Cepec), in Ilheus, Bahia. To accomplish this, several trials were conducted in a search for resistant materials, in an attempt to avoid the disease from developing into a problem seriously threatening the cultivation of cocoa in Bahia, as was the case in other countries where the disease is present. With this objective, seedlings of 23 crosses were evaluated for resistance to *C. cacaofunesta.*

Materials and Methods

In the greenhouse, different numbers of seedlings, varying from 11 to 88 at 10 months of age for each one of the 23 crosses were inoculated at same time through an incision made with a scalpel above the first internodes. Thirty (30) μl of a suspension of *C. cacaofunesta* isolate at 3.0×10^4 CFU/mL of Cf 20 were deposited into the incision. Then moistened cotton was applied below the incision followed by a plastic adhesive tape cover to form a moist chamber. After 48h, the cotton and the plastic adhesive tape were removed from the inoculation point.

Sixty days after the inoculation, the inoculated seedlings were evaluated by registering the number of dead seedlings. This methodology was used by Silva *et al* 2007.

Results and discussion

Table 1 shows that the percentage of dead seedlings per cross varied from zero (CASA 1 x CCN 10) to 95% (EET 392 x CCN 51).

The data suggested that the progenies originating from crosses involving CCN 10 and CCN 51 (Table 1) presented the largest rate of mortality. Lower levels of mortality were found when these two clones were crossed with more resistant materials like TSH 1188, CASA (selected in the Sao Jorge farm for productivity in Bahia, Brazil) and CC 10. The progenies of the crossings with the clone CC10 presented a low mortality percentage, except when the other progenitor was the clone EET 45. Low percentages of dead seedlings were observed in the progenies of TSH 1188. The resistance of TSH 1188 might have come from IMC 67 (Delgado and Echandi 1965) or POUND 18 (Gonsalves 1996). However, when TSH 1188 was crossed with the highly susceptible clones, CEPEC 515 and CCN10 (Silva *et al*. 2004), the percentage of dead seedlings was 64 and 41%, respectively (Table 1). The crosses involving CEPEC 515 resulted in high percentages of dead seedlings, in general. An inexplicable result was verified for the progeny of the cross CEPEC 515 x CCN 51, with only 19% dead seedlings, where a higher value of mortality would have been expected.

The crosses involving SGU 54 presented relatively low percentages of dead seedlings, mainly when crossing with TSH 1188 (8%). However, it was much higher when crossed with CEPEC 515 (58%). The cross TSH 1188 x SGU 54 presented one of the lowest percentages of dead seedlings, and this was expected since both parents were resistant. A similar finding was reported previously by Gonsalves (1996). Usually, the genetic materials of the type ‘common’ from Bahia and also from the Upper Amazon present resistance to *C. cacaofunesta*, whereas the Criollo type is susceptible to this fungus. However, there are some exceptions, as the clones PA 169, POUND 7, SCA 6, SCA 12, that are of Upper Amazon origin are susceptible, while the DR 38, a Criollo type, is resistant (Soria and Salazar 1965). In fact, the Amazon clones such as PA 169 and RB 39, despite being included only in one cross, appeared to be susceptible, and registered in the high percentage of dead seedlings in crosses with CCN 10 (Table 1).

Conclusions

Preliminary studies, based on the data used to generate the frequency distributions of dead seedlings in the progenies, suggested that the clones CCN 10, CCN 51 and CEPEC 515 transmitted susceptibility, while the clones CC 10, CASA, SGU 54 and TSH 1188 transferred resistance to *C. cacaofunesta*.

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Table 1. Data for 23 seedling progenies of cacao inoculated with *Ceratocystis cacaofunesta*

CROSS	NIS*	% DS
EET 392 X CCN 51	21	95
CEPEC 94 X CCN 10	88	92
RB 39 X CCN 51	56	89
PA169 X CCN 10	26	88
EET 45 X CC 10	44	70
TSH 1188 X CEPEC 515	76	64
CCN10 X VB 1151	55	62
CEPEC 523 X CCN 51	28	61
CEPEC 515 X SGU 54	77	58
TSH 565 X VB 184	11	45
TSH 1188 X CCN 10	51	41
TSH 565 X VB 1139	17	35
VB 184 X SGU 54	41	32
CASA X CCN 10	18	22
CEPEC 515 X CCN 51	21	19
CC10 X CCN 10	54	19
VB 184 X SIC 19	77	16
TSH 1188 X VB 1151	61	15
TSH 1188 X CC 10	23	13
CEPEC 42 X SIC 19	18	11
TSH 565 X CSJ 70	12	8
TSH 1188 X SGU 54	61	8
CASA 1 X CCN 10	15	0

* NIS = number of inoculated seedlings; DS = percentage of dead seedlings
CASA 1 x CCN 10 = F_2 population from open pollinated F_1 tree (CASA x CCN 10)