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Participatory cocoa (*Theobroma cacao*) selection in Cameroon: *Phytophthora* pod rot resistant accessions identified in farmers' fields

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Abstract

As part of a participatory selection programme, promising individual trees were selected in 2004 in cocoa farms of southern and western Cameroon regions for yield and for low incidence of *Phytophthora* pod rot (Ppr) caused by *Phytophthora megakarya*. The aim of this study was to compare the levels of resistance to Ppr between farm accessions (FA), introduced and local genebank accessions (GA). In total, 234 FA were grafted in the nursery together with 22 introduced GA and 73 local GA, and tested for resistance to *P. megakarya* by leaf disc inoculations. The introduced GA, that were reported as resistant to Ppr in other countries, proved to be more resistant than the selected FA and unselected FA and also more resistant than the 3 control clones for Ppr resistance used in the study. However, approximately 10% of the FA were as resistant as the average of the introduced GA, showing the potential of selection for resistance to Ppr in farmers' fields. The average level of resistance of the FA was relatively higher than that of the local GA. The FA selected for yield and low Ppr incidence in the field were more resistant in the leaf disc test than the unselected FA. The use of FA and of farmers' knowledge in the participatory selection process is valuable in obtaining Ppr-resistant cultivars.

Keywords: *Phytophthora megakarya*; Black pod; Leaf disc inoculation; Farmers' knowledge; Breeding; Participatory selection

1. Introduction

Cocoa is a perennial crop widely cultivated in Africa, Asia and America. In Cameroon, production, based on smallholder farmers, has been fluctuating around 110 000 and 160 000 tonne over several decades, with a maximum of 180 000 tonne recorded in 2005 (ICCO, 2005). This stagnation is due to several factors, the most important being the pod rot disease caused by *Phytophthora megakarya* (Ppr). In Cameroon, cocoa-breeding activities in the 1960s and 1970s emphasized the development of high yielding hybrid cultivars. These are mainly crosses between introduced Upper Amazon genotypes and accessions selected in the traditional cultivars (seedlings from Trinitario and Lower Amazon types). In spite of the distribution of these cultivars, cocoa plantations in Cameroon continue to be low yielding, with an average of 200–600 kg of dry cocoa per ha (Efombagn, 2005). One of the main reasons is the high Ppr incidence, with losses of 60–80% of the crop being common in the absence of control measures. The hybrid cultivars are considered by the farmers to be more susceptible to Ppr than the traditional cultivars. Therefore, farmers have continued to be compelled to apply frequent chemical control, with copper-based or systemic fungicides. These are damaging for the environment, increase significantly production cost compared to the limited income from cocoa sales, and are therefore not available to all farmers.

During the 1990s, resistance to Ppr received considerable attention. An early screening test based on leaf disc inoculations was developed (Nyassé et al., 1995) that proved to be correlated with field level of infection (Tahi et al., 2000). From 1998, breeding for resistance is receiving increased attention in Cameroon, including through an international collaborative effort. This included recent

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introductions of Ppr-resistant accessions through intermediate quarantine at the University of Reading, UK. A participatory cocoa selection programme was initiated to complement conventional breeding activities. Globally, participatory crop improvement emerged recently as an alternative approach for developing countries in response to the recognition that conventional breeding has brought little improvement to small-scale farmers (Lipton and Longhurst, 1989; Kerr and Kolavalli, 1999). Conventional or formal plant breeding programmes conducted in developing countries have been criticized for ignoring indigenous germplasm and failing to breed for adaptation to conditions faced by small-scale farmers (Atlin et al., 2001).

Based on farmers' knowledge and breeders' inputs, outstanding farm accessions (FA) with respect to low Ppr incidence and high yield were selected through a participatory approach during field surveys conducted in 2004 in the two major cocoa producing areas of Cameroon (Efombagn, 2005). Collection of the selected and unselected FA was carried out, and they were grafted in nurseries on-station for subsequent evaluation. The aim of the study was to compare levels of resistance to Ppr of the selected and unselected FA, evaluated by leaf disc inoculation, with the resistance of introduced and local genebank accessions (GA).

2. Material and methods

2.1. Cocoa genotypes

In total, 196 selected FA and 38 unselected FA collected from 120 cocoa farms, 73 local GA and 22 introduced GA (Table 1) were used in this study. Farms composed of hybrids or traditional cultivars were randomly selected in different localities. The local GA accessions are both cloned F1 progenies (Upper Amazon × Trinitario) and Trinitario clones selected in the field in 1960s and transferred in genebanks at the IRAD Nkoemvone Research Station (southern Cameroon). The introduced GA were part of an international exchange of accessions selected for Ppr resistance, through the intermediate quarantine centre at the University of Reading (RUQ), UK. Among the introduced GA group (Table 1), PNG accessions were created in Papua New Guinea, and the remaining accessions originated from Latin America and provided to RUQ through the International Cocoa Genebank (ICG), Trinidad.

The FA originated from the two main agro-ecological cocoa growing zones of the country designated in this study as "southern" and "western" regions. Selection was made by the farmers in the presence of the breeder. The criteria used by the farmers were the incidence of Ppr or the high yield potential observed in each selected FA over several years of production. Out of the 196 selected FA, 101 trees were classified as 'less infected with Ppr' than the level of infection in the plot and 95 as 'higher yielding' than the level of production in the plot. Furthermore, part of these trees (196 selected FA and 38 unselected FA) were identified by the farmers as belonging to the traditional cocoa cultivars ($n = 99$) or to hybrid cultivars distributed from seed gardens from the 1970s onward ($n = 135$). More than 95% of the traditional cultivars are Amelonado like (lower Amazon cocoa type) and the remaining ones are Trinitario like. Hybrid cultivars are trees from F1 or F2 progenies created by mating between Trinitario and Upper Amazon parental clones in seed gardens.

All the accessions were established by grafting in the nursery under uniform shade, which is an important condition to obtain uniform results in the leaf disc test

Table 1
Clones and farm accessions used

Accession groups	Origin	Number of accessions
Farm accessions (FA)[a]	Southern Cameroon	103
	Western Cameroon	131
Local genebank accessions (GA)[b]	Nkoemvone station, Cameroon	73
Introduced genebank accessions (GA)[c]		22
PNG155; PNG197; PNG210; PNG218; PNG299; PNG340	Papua New Guinea (PNG)	6
PA70; PA120; PA150, EET59; EET399; LCTEEN162/5; LCTEEN302; IMC20; IMC40; SCA6; SCA9; MA12; B5/7; POUND7/B; AMAZ15/15; COCA3370-5	International Cocoa Genebank, Trinidad (ICG, T)	16
Control clones[d]		3
SCA6 (resistant)	Peru	
SNK413 (moderately resistant)	Nkoemvone, Cameroon	
SNK64 (moderately susceptible)		

[a]Cocoa trees selected by the farmers in their plantations, in the presence of breeders.
[b]Cloned F1 progenies (Upper Amazon X Trinitario) selected on-station and Trinitario clones selected in the field in 1960s and transferred in genebanks at the IRAD Nkoemvone Research Station (Southern Cameroon).
[c]Accessions introduced at IRAD (Cameroon) through the intermediate quarantine centre of the University of Reading, UK.
[d]Clones selected as controls according to results published by Iwaro et al. (2005) and Nyassé et al. (2003).