COCOA VARIETY ASSESSMENT IN ON-FARM PROGENY TRIALS IN CAMEROON

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ABSTRACT

In Cameroon, IRAD and CIRAD have collaboratively set up and implemented a participatory breeding program since 2006, consisting in the assessment of cocoa varieties under cocoa farm conditions.
The present communication describes the results obtained so far on progenies compared in three progeny trials set up in 2006 and 2007.
The first trial, set up in 2006, is composed of 12 trial plots, and allows the comparative assessment of nine progenies which are currently released to farmers.
Data analyses performed on yield and establishment ability showed high performances for the progeny issued from the cross IMC 67 * SNK 109 and low performances for the one issued from the cross T 79/501 * SNK 64.
Data analyses performed on mirid damage scores revealed a higher level of susceptibility for the progeny issued from the cross IMC 67 * SNK 109 and a lower one for the progenies issued from the crosses T 79/501 * SNK 64 and IMC 67 * SNK 64.
The assessed progenies showed a mean weight of one bean of dried cocoa ranging between 1,17g (SCA 12 * SNK 16) and 1,52g (SNK 109 * IMC 67).
The second progeny trial, set up in 2006, composed of four trial plots, allows the comparison between 16 cocoa progenies, issued from: commercially released progenies, progenies recently created at IRAD, progenies issued from on farm selection of promising trees.
Data analyses show a higher level of yield for the commercially released progenies and a lower level for progenies issued from on farm selection.
Data analyses of tolerance to Phytophthora megakarya, assessed using a leaf inoculation test showed a slightly higher level of tolerance for the progenies recently created at IRAD.
The third trial set up in 2007, is composed of six trial plots and allows the comparison between eight progenies: one recently created at IRAD, three commercially released progenies, two issued from on farm selection of promising trees, two issued from trees chosen at random in cocoa farms set up with traditional (german cocoa) or commercial cocoa progenies.
Data analyses show a high level of yield for the progeny recently created at IRAD (T 60/887 * POUND 7) and a low level for the progeny issued from traditional varieties (german cocoa).

INTRODUCTION

In Cameroon, IRAD and CIRAD have collaboratively set up and implemented a participatory breeding program since 2006, consisting in the assessment of cocoa varieties under cocoa farm conditions.
The present communication describes the results obtained so far on progenies compared in three progeny trials set up in 2006 and 2007.

MATERIAL AND METHOD

3 progeny trials were set up in 2006 and 2007:
PT1: set up in 2006, it is composed of 12 trial plots, and it consists in the comparative assessment of 9 commercially released progenies, issued from bi-clonal seed-gardens
PT2: set up in 2006, it is composed of 4 progeny trials, and it consists in the comparative assessment of 4 types of progenies (4 progenies per type)
PT3: set up in 2007,it is composed of 13 trial plots, and it consists in the assessment of 8 progenies

The traits under assessment are as follows:
Yield: expressed as the weight of fermented and dried cocoa per tree in PT1 and PT2 and as the number of pods per tree in PT3
Establishment ability: expressed as the % of tree originally planted which are still surviving
Tolerance to mirids: assessed by a visual score of the visual cumulative damages, on a scale from 0 (absence of damage) to 4 (severe damages) (Sounigo et al 2003)
Tolerance to black pod disease: assessed by a visual score of symptoms observed after leaf inoculation performed on young seedlings (Nyasse et al 1995) in PT1, PT2 and PT3 and by the % of trees infected by Phytophtora during the period 2010-2011 in one plot of PT2.

The statistical design of the 3 trials is described in the following table:

	PT1	PT2	PT3
Number of replications	Between 6 and 13	16	Between 4 and 12
Replication unit	Between 40 and 60 trees	15 or 16 trees	Between 40 and 60 trees
design	Unbalanced	Balanced	balanced
variables	Corrected values (% of the mean value of the trial plot)	Measurement values	Corrected values (% of the mean value of the trial plot)

RESULTS

General results

The estimated yield of the different trial plots for the 2011-12 campaign is as follows (fermented and dried cocoa):

PT1: mean value = 720 kg/ha, ranging between 400 and 1000 kg/ha
PT2: mean value = 600 kg/ha, ranging between 500 and 800 kg/ha
PT3: mean value = 440 kg/ha, ranging between 115 and 1000 kg/ha

ANOVA were performed in order to evaluate the significance of the effect of progeny , which was found significant for: yield in the 3 trials, establishment ability in PT1, tolerance to mirids in PT1 and tolerance to black pod disease (leaf test in PT3 and field observation in PT2)

Results from PT1: comparison between 9 commercially released varieties

The mean values and ranking for yield and establishment ability of the progenies tested in PT1 are indicated in the following table:

Progeny	adjusted yield value (%) and ranking (Newman-Keuls 5%)	Ranging of the adjusted yield values across plots (%)	Estimated yield (kg fermented and dried cocoa/ha)	Number of trial plots in which the progeny is assessed	Mean % of tree survival and ranking (Newman-Keuls 5%)
IMC 67 * SNK 109	160 [a]	96 - 275	1152	10	89 [a]
SNK 109 * T 79/501	117 [ab]	21 - 165	842	7	89 [a]
IMC 67 * SNK 64	116 [ab]	79 - 181	835	13	91 [a]
T 79/501 * SNK 13	108 [ab]	48 - 179	778	6	89 [a]
T 79/501 * SNK 109	96 [bc]	57 - 135	691	8	84 [a]
SNK 109 * IMC 67	95 [bc]	23 - 158	684	6	86 [a]
UPA 143 * SNK 64	87 [bc]	22 - 123	626	12	82 [a]
SCA 12 * SNK 16 and reciprocal	82 [bc]	60 - 109	590	6	79 [a]
T 79/501 * SNK 64	45 [c]	0,6 - 76	324	6	62 [b]

IMC 67 * SNK 109 shows the highest average level of yield and this level of yield is always at least as high as the mean plot value. This reveals a good stability of yield for this progeny across the different plots while these plots differ for their performances and their environment conditions (type of soil, level of management….). This progeny can be released at large scale since it is adapted to different conditions. A similar trend can be observed for IMC 67 * SNK 64.

On the other hand, progenies such as SNK 109 * T 79/501, SNK 109 * IMC 67 and UPA 143 * SNK 64 fail to show the same level of stability. These progenies appear as more susceptible to environmental conditions and one needs to identify which conditions are unfavorable to them in order to prevent their release in such conditions.

For example, T 79/501 * SNK 13 shows low performances on plots set up on savannah soil and its release should be restricted to planting on fallow or forest soil (data not shown).

The progeny T 79/501 * SNK 64, recently introduced because of the low level of susceptibility of SNK 64 to black pod disease, shows very disappointing performances, in all the trial plots. As a result, the release of this progeny has been stopped.

The mean values and ranking for tolerance to mirids of the progenies tested in PT1 are indicated in the following table:

Progeny	adjusted mirid damage score (%) and ranking (Newman-Keuls 5%)
IMC 67 * SNK 109	144 [a]
UPA 143 * SNK 64	111 [ab]
T 79/501 * SNK 13	107 [ab]
SNK 109 * IMC 67	105 [ab]
SNK 109 * T 79/501	95 [ab]
SCA 12 * SNK 16 and SNK 16 * SCA 12	90 [ab]
T 79/501 * SNK 64	90 [ab]
IMC 67 * SNK 64	88 [b]
T 79/501 * SNK 109	58 [b]

IMC 67 * SNK 109, the highest yielding progeny, shows a significantly higher level of susceptibility to mirids than IMC 67 * SNK 64 and T 79/501 * SNK 109.

Results from PT2: comparison between 4 types of progenies

The mean values and ranking for yield of the progenies tested in PT2 are indicated in the following table:

Progeny	Mean yield value (g of commercial cocoa per tree) and ranking (Newman-Keuls 5%)	Ranging of the yield across plots (g of commercial cocoa per tree)
Commercial varieties	1288 **[a]**	630 - 2045
New progenies created by breeders	971 **[ab]**	700 - 1400
Farmers' selections for yield	797 **[b]**	630 - 1470
Farmers' selections for tolerance to black pod disease	685 **[b]**	460 - 880

The progenies issued from mass selection in farmers' plots show a significantly lower level of yield than the commercially released ones.

Despite a significant effect of the progeny factor, the ranking of progenies for tolerance to black pod disease revealed a single group of homogeneous mean values when this trait was evaluated by leaf test inoculation On the other hand the following ranking was obtained when % of infected trees was analyzed.

Progeny	% of infected trees and ranking (Newman-Keuls 5%)
Commercial varieties	15 **[a]**
Farmers' selections for tolerance to black pod disease	6 **[ab]**
Farmers' selections for yield	2 **[b]**
New progenies created by breeders	1 **[b]**

These first results indicate that the commercially released progenies present a level of susceptibility to black pod disease significantly higher than the progenies selected on farm for yield and the progenies recently created at IRAD. This result seems to confirm the current concern of farmers about the rather high level of susceptibility to black pod that they observe on the commercially released varieties. Fortunately, the progenies recently created at IRAD seem to show a lower level of susceptibility to this disease.

Results from PT3: comparison between 6 types of progenies

The mean values and ranking for yield of the progenies tested in PT2 are indicated in the following table:

Progeny	adjusted yield value (%)	Ranging of the adjusted yield across plots (%)	Estimated yield (kg fermented and dried cocoa/ha)	Number of trial plots in which the progeny is assessed
T 60/887 * P 7	173 [a]	164 - 184	756	4
Mixture of commercial varieties	116 [a]	42 - 239	507	12
IMC 67 * SNK 64	109 [ab]	29 - 204	476	11
UPA 143 * SNK 64	105 [ab]	40 - 186	459	12
On farm selections for yield	102 [ab]	54 - 141	446	4
Unselected farmers' hybrids	99 [ab]	34 - 142	433	5
On farm selections for tolerance to BP	82 [ab]	21 - 123	358	4
Traditional variety (german cocoa)	40 [b]	13 - 67	175	6

The results show a higher level of yield for the progeny T 60/887 * POUND 7, this level of yield being high in the 4 plots where it is assessed, while all other progenies show contrasting levels of yield among the plots where they are assessed.

On the other hand, a low level of yield is observed for the traditional variety (german cocoa).

Contrarily to the PT2, PT3 failed to show any significant difference between commercially released progenies and progenies issued from farmers' field.

CONCLUSION

The first results of the trial plots set up on farm showed a large level of variation for the agronomic performances of the commercially released progenies, showing the need for replacing the lowest yielding ones by new progenies and restricting the release of some of them to favorable environmental conditions

The promising results obtained for T 60/887 * POUND 7 seem to indicate the possible use of this progeny for future commercial release once additional information is available on this progeny.

The traditional variety (german cocoa) consistently shows a low level of yield in our trial plots, which might be caused by a poor level of adaptation to the cultural practices adopted in our trial plots (absence of permanent shade).

The first results from these trials confirm the need for creating and releasing new varieties with a lower level of susceptibility to black pod disease than the one observed on the currently commercially released varieties.

40 additional on farm progeny trial plots have been set up since 2008, allowing the comparative assessment of 69 additional progenies

LITTERATURE

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