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CHEMICAL CONTROL OF CBD

by

Raoul A. MULLER

Docteur ès Sciences

Directeur de Recherches de l'ORSTOM (*)

Chef du Service de Phytopathologie de l'IRCC (**)

I - INTRODUCTION

Chemical control of CBD, as well as control of all other fungal diseases, involves a series of elements :

- timing spray, the most important one, determined by epidemiology of the pathogen, which is depending on climatic conditions, sources of primary and secondary inoculum, efficiency of these sources, susceptibility of organs ;

- choice of fungicides according to their efficiency in field conditions, which depends on their type of activity, their polyvalence if it is necessary to fight, at the same moment, more than one disease, and their physiological secondary effects on the plant ;

- choice of spraying methods (low or high volume) which is depending on their efficiency in field conditions, and type of machine according to topography, dimensions of fields and plantation density ;

- prophylactic measures always when possible.

(*) ORSTOM : Office de la Recherche Scientifique et Technique Outre-Mer.

(**) IRCC : Institut de Recherche du Café et du Cacao, Centre GERDAT, B.P. 5035, 34032 Montpellier cédex, France.

II - TIMING SPRAY IN CAMEROON AND KENYA

1°) Date of first spray and limits of treatment period

Starting our studies in Cameroon in 1958 we learned in kenyan litterature that, according to Nutman and Roberts "inoculum potential" theory, the main source of primary infection would be bark of twigs, where the pathogen would be living without giving any damage but producing spores able to infect berries.

Counting the spores produced by the bark (number of spores per cm^2 per hour, in humid chamber in laboratory) these authors gave curves showing that the production of spores was the most important during dry season : consequently they advised the farmers to do chemical treatments during dry season, before flowerings.

According to climatic conditions and coffee phenology in Cameroon (see figure 2 in precedent paper : "Changes in susceptibility of berries") we tried to verify the efficiency of Nutman and Roberts timing spray in a trial comparing the six following treatments :

1 - 1rst spray on the 10th of january
2 - 1rst spray on the 10th of february
3 - 1rst spray on the 10th of march
4 - 1rst spray on the 10th of april

} associated with prophylactic measures by picking the overlapping berries at the end of the precedent campaig

5 - Prophylactic measures alone, by picking the overlapping berries at the end of precedent campaign
6 - No chemical treatment, no prophylactic measures.

Year 1959 was characterized exceptionnaly by 2 flowerings :

- the first one on the 16th of january following one unic rainfall in early january and giving a population of berries which will be named here "population A" ;

- the second one — the most important, corresponding to the real crop — on the 25th of march, following the first rain of the wet season starting on the 18th of march, and giving a population of berries which will be named here "population B".

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The first CBD symptoms were visible, on the population A only, on the 12th of april (at this date the population B was too young to be attacked by the fungus as it will be demonstrated later) : the results recorded in early may on 45 000 berries were as follows (% of infected berries) :

Table

Plots / Blocks	1rst spray on the 10th/1 (1)	1rst spray on the 10th/2 (2)	1rst spray on the 10th/3 (3)	1rst spray on the 10th/4 (4)	Prophylactic measures only (5)	Control plots (6)
A	0.1	0.4	0.5	8.3	9.4	21.0
B	0.8	0.2	1.3	2.7	3.0	25.8
means	0.5	0.3	0.9	5.5	6.2	23.4

These results which, one more, concerned population A of berries only, lead to the following conclusions :

- coffee treatments were efficient (high significant difference between control plots (6) and treatments 1-2-3) ;

- no significant difference appeared between treatments 4 and 5 : sprays beginning on the 10th of april were too late to protect berries against the first infection taking place after the first rainfalls (18th of march and following days) ;

- no significant differences appeared between treatments 1-2 and 3 ; it was obvious that the last one — starting on the 10th of march, that means 8 days before the 1rst rainfalls — was early enough to protect berries : during the period between the 10th of january and the 10th of march, treatments were not necessary, which was confirmed by the fact that the 1rst CBD symptoms were not seen before the 12th of april.

Late in july, a second series of observations taking in account berries of both flowering (populations A and B), gave the following results, recorded on 119 000 berries :

Table 2

Plots / Blocks	1rst spray on the 10th/1	1rst spray on the 10th/2	1rst spray on the 10th/3	1rst spray on the 10th/4	Prophylactic measures only	Control plots
A	0.7	0.4	1.3	2.2	55.0	60.0
B	0.6	0.5	1.2	0.5	31.5	53.2
C	7.2	0.9	1.6	4.8	40.5	33.5
D	0.6	0.2	0.1	0.3	32.0	30.8
means	2.3	0.5	1.1	1.9	39.8	44.5

From these datas, it was concluded that :

- copper treatments were very efficient (high significant differences between treatments 1-2-3-4 and 5-6) ;

- no significant differences appearing between treatments 1-2-3 and 4, that means that treatment 4 was as efficient as other ones to protect berries issued from the second flowering ; in other words treatment 4, starting 2 weeks after flowering was early enough to protect berries, showing that preflowering sprays treatments 1-2-3 applied during dry season were unnecessary ;

- on the other hand, treatment 4 which appeared previously (table 1) too late to protect population of berries A against the first CBD attaks, was shown to protect efficiently these berries against following CBD infections taking place after the 10th of april.

In conclusion of all these observations, it was concluded that, in the conditions of Cameroon :

- if there is, as in 1959, one early flowering, one or two months before the main one, it is usefull to do one first spray sometimes before the beginning of the rainy season to protect existing young berries coming from that early flowering ;

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- in the general case – one flowering only – the first spray is to be done just after that flowering, that means after the beginning of rains.

More generally, it was concluded that preflowering treatments done during the dry season, as recommended by Nutman and Roberts, would be completely unnecessary, the only way to protect the berries being in postflowering treatments starting 10 to 15 days after flowering and being done the whole rainy season long.

2. - Assessment of rythm and number of sprays

After having determined the period when chemical treatments had to be done and the date of the first spray, we try to determine the good rythm and the minimum sufficient number of sprays.

In a series of trials and observations it was shown that treatments had to be done only during the first 5 months following the flowering.

In fact, during this period, the main increase of infection occurs (see curve A in figure 3, in precedent paper : "Changes in susceptibility of berries") : this is explained by the coexistence of a wet period which allows the pathogen activity, and the expanding stage of the berries during which they are highly susceptible (curve C in figure 3 of precedent paper) ; this coïncidence of a wet period and the most susceptible stages of the berries give the disease its high severity, all the losses taking place during this period (curve B in figure 3 in precedent paper).

After 5 months, although humidity appears to be very favourable to the pathogen, treatments are not necessary because the berries have lost their own susceptibility.

Fongicides remanence being reduced by heavy rains, and according to the fact that rainy hours are every day more and more numerous from march to july, we assessed that intervals between treatments had to be shorter and shorter.

In summary, and resulting of all these considerations, and observations, we recommended in Cameroon, after having made experiences in the field to verify our ideas, the following timing spray for copper treatments :

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1rst spray : 2 weeks after flowering ;
2nd spray : 5 weeks after the 1rst one ;
3rd spray : 4 weeks after the 2nd one ;
4th spray : 3 weeks after the 3rd one ;
5th spray : 2 weeks after the 4th one ;
6th spray : 2 weeks after the 5th one ;
7th spray : 2 weeks after the 6th one.

These 7 sprays giving the same results as 8 or 9 spayrs during the same times appeared to be sufficient but necessary with copper fungicides.

This timing spray gives a quite complete protection shown in our trials where the production for 20 trees was 100 kg fresh berries in the untreated plots and near 200 kg fresh berries in the treated ones.

3. - The problem in Kenya

Studying the problem in Kenya in 1964 and 1967, we concluded that the same policy would be applied in that country, but two times a year to protect both early and late crops.

In fact, we explained in a paper (La lutte contre l'anthracnose des baies du caféier arabica au Kenya, Café-Cacao-Thé, n° 1, 1968) that Nutman and Roberts inoculum potential theory, after which preflowering treatments were recommended, was wrong :

- if we consider epidemiology, Nutman and Roberts :
  . confound all species of *Colletotrichum* living in bark with the CBD pathogen ;
  . measured the production of spores on the bark in humid chamber and not in field conditions leading to draw artificial curves ;
  . forgot the preminent production of spores by infected berries : in Kenya it is obvious that early crop is a very efficient source of infection for late crop and *vice versa* ; even if it is true that bark gives some spores the role of that spores, is a very little one compared with that of spores produced by infected berries ;

- if we consider the efficiency of preventive chemicals as copper or captafol, Nutman and Roberts said that preflowering treatments during dry season would stop the sporulation, while such treatments are efficient mainly by avoiding germination of spores.

In Kenya, due to the fact that each 2 rainy seasons are shorter than the unic one in Cameroon, treatments may be less numerous for both early, and late crops.

It is very surprising to read in Kenya litterature that preflowering treatments applied during dry season according to Nutman and Roberts theory were efficient until 1967 but lost their efficiency later on.

Obviously is not possible to accept the idea of a total change in climate, able to change the CBD epidemiology : there are no meteorological datas to assess this idea.

The truth is that preflowering treatments had never been efficient at all : the changes in official recommendations which, in 1968, were to do postflowering treatments, are only due to our study showing the failures of Nutman and Roberts theory (see H. Vermeulen "Coffee Berry Disease in Kenya", Thesis, University of Wageningen, Holland, 1979, p. 25 and p. 95) and to the results of studies carried out after our own recommendations.

As we already explained these studies confirm our points of view, leading to adopt the timing spray we recommended for Kenya according to our experiences in Cameroon.

III - PROPHYLACTIC MEASURES

In a precedent paper ("Epidemiology, etc..) we explained that in Cameroon, one main flowering only occurs giving one only annual crop. But it happens that some flowers open along the year giving fruits which will never be picked because they reach their maturity out of time and are not numerous enough to justify special pickings. Remaining on trees and being infected in a great proportion, they are a kind of bridge for the pathogen to survive from one campaign to the following one, and by the fact, they are a very efficient source of contamination for the new crop, as we demonstrated in some trials : if we compare the datas of treatments 5 and 6 in table 1, we see that the destruction of these overlapping berries reduces infection.

It is the reason why we consider that in Cameroon it is very good to remove these overlapping berries by picking all berries being on the trees (mature or not) during the last tour of harvest.

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If this measure is not able to control the disease, it is a good auxiliary for chemical treatments.

It is obvious that this prophylactic measure is impossible in Kenya where there are permanently two important crops on the trees.

IV - CHOICE OF FUNGICIDES

In Cameroon in the CBD area, coffee is heavily attacked by leaf rusts, mainly *Hemileia coffeicola* which is, in high altitude, more dangerous than *Hemileia vastatrix*, and can infect until 50 to 70 % of leaves. By the fact, treatments against leaf rusts are necessary.

This fungus develops during the same period as CBD : as a result, the fungicides used against CBD must be efficient against leaf rusts.

Among all the fungicides we tried in that country, only few are polyvalent enough to be adopted. It is the reason why it is recommended to use copper fungicides or captafol.

All copper fungicides may be used but it appeared that a range of efficiency could be assessed as follows :

- cuprous oxyde at the concentration of 0,5 % of commercial product containing 50 % of copper ;

- copper hydroxyde at the concentration of 0,5 % of commercial product containing 56 % of copper ;

- stabilized Bordeaux mixture at the concentration of 0,5 % of commercial product containing 24 % of copper ;

- copper oxychloride at the concentration of 0,5 % of commercial product containing 50 % of copper.

For all these copper fungicides, 7 sprays a year are needed, following the above timing.

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Captafol appeared the best of all fungicides against CBD, at the concentration of 0,4 % of commercial product containing 80 % of active material : with captafol at this concentration only 5 sprays are necessary in Cameroon, with the following timing spray :

1rst spray : 2 weeks after flowering ;
2nd spray : 5 weeks after the first one ;
3rd spray : 4 weeks after the second one ;
4th spray : 3 weeks after the third one ;
5th spray : 3 weeks after the fourth one.

But captafol is less efficient than copper against leaf rusts. Nevertheless, we recommend captafol because, if compared with copper, it has a stimulating effect on trees giving a better growth og twigs ; on the contrary copper, when applied at the concentration and frequency given above, appeared to be depressive for coffee.

Systemic fungicides as benomyl or thiophanates were not recommended in Cameroon against CBD because they had no efficiency against rusts.

In conclusion, it is necessary, in Cameroon, to find a polyvalent fungicide able to fight both CBD and leaf rusts. On the other hand our experiences lead us to recommend a great care on the secondary physiological effects of fungicides on the plant.

V - CHOICE OF A SPRAYING SYSTEM AND SPRAY MATERIAL

Until to now in Cameroon high volume spraying is very much better than low volume spraying.

According to the dimensions of farms, manual knapsack sprayers are considered as well adapted to CBD and leaf rust treatments in that country.

VI - CONCLUSION AND SOME PARTICULAR CONSIDERATIONS

1. - In conclusion we can say that CBD chemical control is efficient. But it is a very hard work for the farmer.

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It is obvious that it is necessary to improve the spraying technic to find new systems to facilitate the work of the farmer, combining new fungicides giving a good control and being easier to apply thanks to a different type of efficiency. We may envisage polyvalent systemic fungicides having a long life in the plant, put on the soil or on the plant by low volume or ultra low volume sprays.

2. - Early irrigation, insurance for a regular high yield, contributes to reduce the number of chemical treatments.

3. - All pathologist must expressed their results in terms of concentration of fungicide mixture, not in terms of weight by surface unit : it is obvious that it is quite impossible for a farmer to adjust his fungicide mixture if he is recommended in terms of weight/acre, because the weight by acre depends on a lot of factors as age of trees, size of the varieties, planting density.

The only way to be clear is to determine the minimum efficient concentration of a fungicide, and to give the farmer the possibility of measuring the necessary amount of product for his sprayer capacity (for example fungicides conditions in sachets for 10 litres, or calibrated spoons).