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Plant Physiology

Evolution of Oil Palm Fusariosis on the Descriptions of the Third Selection Cycle in Cote D'ivoire

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Abstract: Vascular Fusarium vascularization caused by the fungus Fusarium oxysporum f.sp. elaeidis, is a major pathological constraint for oil palm cultivation in Côte d'Ivoire where the disease is endemic. Research on integrated pest management was carried out on plots with a high density of Fusarium wilt. Therefore, our study aims to improve plant material in order to minimize the impact of Fusarium wilt on oil palms. We analyzed the evolution of Fusarium disease according to the progenies. The study focused on the observation of the symptoms of Fusarium wilt of oil palms planted from 2002 to 2016 on a cultural history of Fusarium palms. Thus, the percentage of Fusarium wilt expressed and accumulated and the rate of remission of the plants were calculated. Our results revealed that the progenies of the third cycle of recurrent reciprocal selection express high tolerance to Fusarium disease and only four of them showed remission rates. Huge progress has therefore been made on the plant material concerning the tolerance to Fusarium wilt from the 1st to the 3rd cycle.
Keywords: oïl palm, Fusarium, recurrent reciprocal selection, Côte d'Ivoire.

INTRODUCTION

The palm oil sector (*Elaeis guineensis*) occupies a prominent place in the Ivorian society and economy. Introduced in Côte d'Ivoire as part of the policy of diversification of annuity products initiated since independence, this sector produced 417,000 t of palm oil in 2016 [1]. The oil palm is subject to numerous attacks by pests and pathogens including *Fusarium oxysporum f.sp. Elaeidis*, the causal agent of vascular fusariosis of the oil palm.

Under favorable ecological conditions, yields of more than 6 t of oil/ha/year can be achieved [2], [3]. However, this production performance has so far been far from widespread, given the dispersal of the pathogen in the soil and the size of the contaminated crop areas. Conventional methods of control (chemical control) for the control of this tracheomycosis prove to be expensive and not economically feasible. Indeed, more than 50% of the palms in production can be reached if the plant material is susceptible to the disease in a replanting situation (Fig. 1 and 2). On the other hand, the previously adopted preventive control methods are mainly in the choice of plant material after an inoculation test of the pre-nursery stage pathogen [4, 5]. For a long time, there have been very clear differences in behavior related to crosses. This has led to the initiation of a program to improve plant material tolerance by recurrent reciprocal selection (RRS) Fusarium wilt that is currently in its third cycle. It is in this context that this study was conducted to reduce the incidence of Fusarium oil palm disease by producing more efficient and more tolerant planting material.

MATERIALS AND METHODS

Our work took place on the agro-industrial site of PALMICI in Ehania located in the department of Aboisso 140 km from Abidjan. This area benefits from a warm and rainy equatorial climate, rugged terrain and ferralitic soils with an average annual temperature of 25.7 ° C.

Plant material

The plant material was oil palm seedlings (*Elaeis guineensis*) consisting of 444 hybrid progenies. These were planted between 2002 and 2007, after old palm groves with fusariosis, on different plots in Ehania. These progenies are presumed to be tolerant to vascular fusariosis and from the third recurrent reciprocal selection cycle.

Methods

Experimental apparatus

The 3rd cycle planting plan is an incomplete block system consisting of 6 blocks and 14 plots with a total area of 375 ha. Each parcel contains 127 lines on which are arranged 27 palm trees a total of 3429 feet per parcel. The lines are oriented from south to north as well as the numbering of the feet. The interval between two rows of oil palms is 7.8 m and two consecutive palms are 9 m apart. The lines and numbers of the trees allow the identification and location of each palm tree.

Fig-1: Palm tree reaches by chronic Fusariosis

Fig-2: Palm tree reaches by acute fusariosis

Data collection method

A device of successive surveys of the palms tree of the trial was set up in order to follow the field behavior of the different progenies. The readings were made using sheets in the form of a grid. Which allowed in the progression, to note the presence or the absence of fusariated plants or any other attack. Observations were made from the bottom of the palm tree to the leaves of the bouquet. In case of suspicion, the symptoms (discoloration, brown fibers after a cross section) present on the leaves are observed.

Frequency of a report of Fusarium wilts

The expression of the disease can be accentuated by replanting at the level of young plants according to the behavior of the plant material. This suggests a higher frequency of readings which is as follows:

- From 0 to 4 years, once a quarter;
- From 5 to 10 years, once every 4 months.

Percentage of Fusarium exprimed and Cumulative

The observations of the symptoms made it possible to follow the evolution of Fusarium wilt since the setting up of 2002 to 2007 until in 2016 on the various plots and to regularly determine the rates of Fusarium wilt expressed and cumulated.

- The percentage of Fusarium wilt expressed includes all palm trees those have displayed symptoms of Fusarium wilt, including those who died of the disease.
- The percentage of cumulative Fusarium wilt includes all palm trees that have, at one time or another expressed the symptoms of the disease whether they are recovered, fusariated or dead.

Remission rate

It is by considering the cumulative number of Fusarium plants and the number of plants expressing the disease that it is possible to establish a remission rate, illustrating the capacity of the plant material to overcome parasitic aggression.

Statistical analysis

The collected data were analyzed using the STATISTICA 7.1 software where the Pearson χ^2 test was performed to detect significant differences in risk at 5%.

RESULTS

Evolution of fusariosis by progeny

Fusarium wild expressed

The percentages of Fusarium wilt expressed by progeny are shown in Figure 3. Out of a total of 444 progenies, 38 had Fusarium wilt symptoms, representing 8.56% of the progenies tested. The 38 progenies each expressed at least one case of Fusarium wilt since their establishment until 2016. The LM 26333 progeny showed no Fusarium wilt in 2016. In contrast, the others showed symptoms of Fusarium wilt. Fusarium wilt, with the highest rates being 0.23% and 0.26% corresponding to progenies LM 25640 and LM 24866, respectively. Differences in expressed Fusarium wilt expression were not significant (p = 0.22).

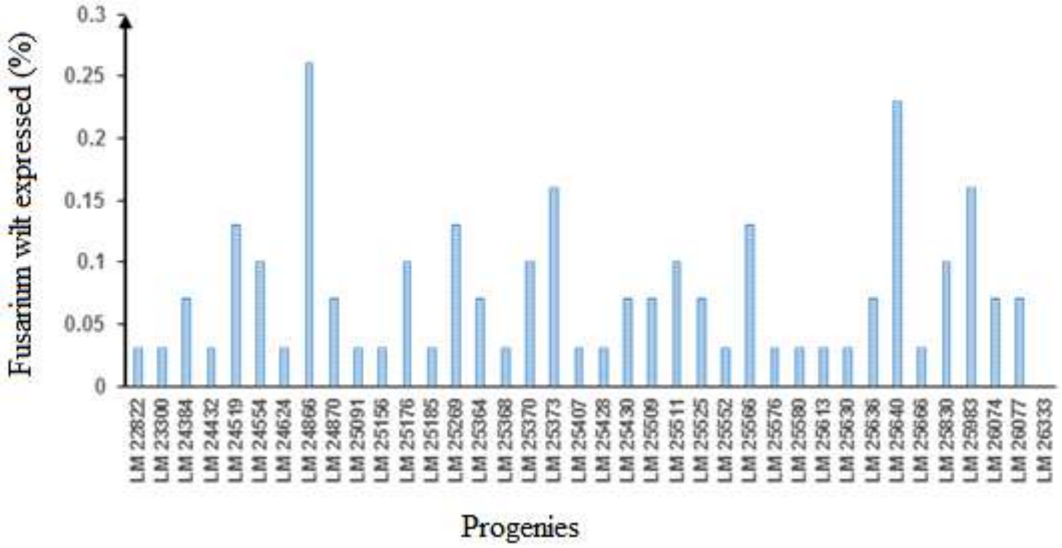

Fig-3: Evolution of Fusarium wilt expressed as a function of progeny

Cumulative Fusarium Wilt

The rate of cumulative fusariosis of the progenies in 2016 has fluctuated between 0.03 and 0.26% (Fig. 4). The LM26333 progeny accumulated a rate of 0.03% despite the absence of symptoms in 2016. The LM25373, LM 25640, LM24866, LM25511 and LM 25983 progenies had the highest cumulative fusariosis percentages. The differences observed between the values are not significant (p = 0.22).

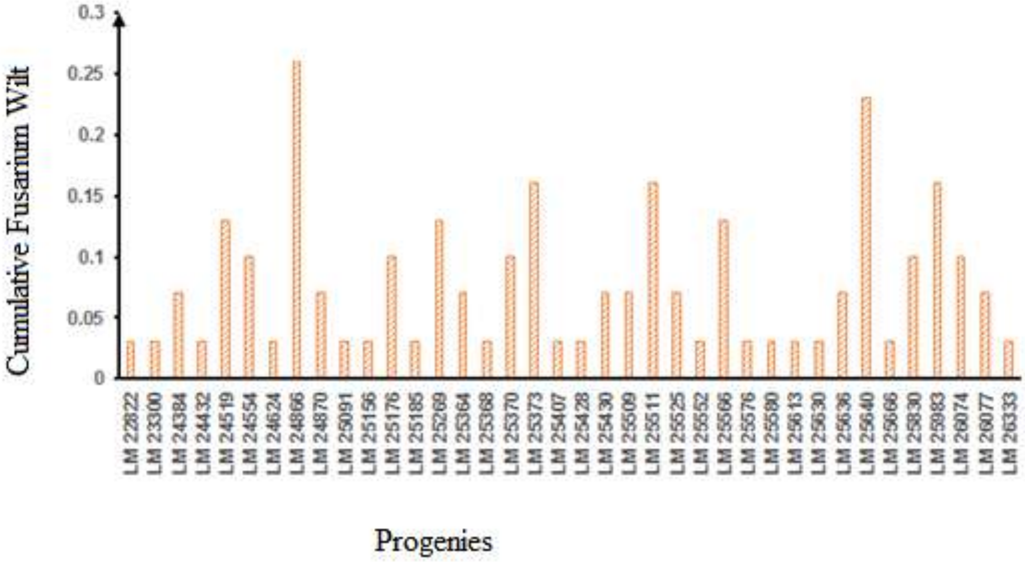

Fig-4: Evolution of cumulative Fusarium wilt by progeny

Remission rate

The remission rates of all progenies that showed the disease are shown in the table below. Of a total of 38 progenies, only 4 had remission rates. These are the progenies LM 25511, LM 25430, LM 26074 and LM 26333 with rates of 12.5% for the first and 6.5% for the others. The Pearson χ^2 test indicates that there is no significant difference between these values ($p = 0.93$).

Table-1: Rates of remission Fusarium wilt by progeny

Progenies	Rates of remission (%)	χ^2	P
LM 25511	12,5		
LM 25430	6,25	0,43	p>5 %
LM 26074	6,25		
LM 26333	6,25		

P : probability at the 5% threshold

DISCUSSION

The results presented in this study confirm the very high tolerance of plant material to Fusarium wilt. This tolerance is due to the fact that the plant material comes from the best tolerant crossing of the 2nd cycle. Our results are in agreement with those of [6] who noted that the production of diets of the 3rd cycle progeny is not affected despite the presence of symptoms of Fusarium wilt.

The variation in the expression of symptoms is related to the difference in allelic composition of the progenies. These results are consistent with those of [7] that show that the tolerance to fusariosis is a polygenic character essentially additive mode that is to say different allelic composition. It is probably this difference in allelic composition that explains the appearance of the symptoms of the disease in the 38 progenies. They have undoubtedly received from their ancestors more alleles sensitive to Fusarium. These variations in progenies may also result from the host-pathogen interaction. Indeed, in the face of aggression of the pathogen, the plant reacts by activating its defense system. This leads to the development of certain inhibitory substances preventing the action of the pathogen. The quality and quantity of these substances synthesized by the plant are related to the tolerance of the latter to the fungus. This analysis is similar to that of [8], who observed that the stems infected with *Fusarium oxysporum f.sp. vasinfectum* has vascular occlusions and a large accumulation of terpenic aldehydes that prevent the expression of Fusarium wilt symptoms.

The percentage of plants expressing Fusarium wilt is decreasing despite the replanting conditions confronting the plant material with a high risk of Fusarium wilt. The Fusarium wilt rate, which averaged 1% in replanting for some crosses of the second variety release of the 2nd round of breeding in 2000, decreased to 0.06% in 2016 in the progenies of the 3rd cycle. These low rates of Fusarium wilt expressed by the progenies of the 3rd cycle would be attributable to the reaction of defenses of the plant material with respect to the parasite aggression. In fact, these progenies underwent a selection test at pre-nursery stage. This test is based on the inoculation of *Fusarium oxysporum f. sp. elaeidis* to seedlings, allowed early identification of tolerant progenies prior to testing on heavily fusarious Ehania plots.

These results corroborate those of [9] who proved the validity of early life-size tests in plantations with very fusaried antecedents. The reduction in the rate of Fusarium wilt is also reflected in the evolution of the remission rate. Indeed, in replantation, on a previous Fusarium, the disease manifests itself in the first year to stabilize from the fourth year. It follows a phase of remission that results in total healing of the plant material. These results are similar to those of [10] who have shown that the remission rate evolves exponentially over time and then stabilizes thereafter.

CONCLUSION

This work evaluated the field behavior of tolerant progenies of the 3rd round of SRR with respect to Fusarium wilt in oil palm trees. These progenies showed very low and substantially equal expressed and cumulative Fusarium wilt rates. Out of 38 progenies that had the disease, the progenies LM 25511, LM 25364, LM 25983 and LM 263334 stood out from the others by presenting remission rates. These observations made in the field during this study thus revealed that enormous progress has been made on the plant material concerning the tolerance to Fusarium wilt from the 1st to the 3rd cycle.

Moreover, all the progenies that proved to be tolerant could be selected for future seed fields in the 3rd cycle. In addition to tolerance selection, otherwise research could be considered to:

- Evaluate the quality and quantity of the inhibitory substances produced by the progenies to control *Fusarium oxysporum f. sp elaeidis*;
- Put in place an integrated pest management strategy that takes into account the components of the environment.

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