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Tree Gummosis a Thread for Mango Production in Northern Senegal

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ABSTRACT

In Senegal mango is one of the most important fruit crops. Mango trees are planted in a large part of the territory and produced in different cropping systems. Setting up mango orchards represents a great contribution to the national production effort. However, infestations of the vegetative organs of the trees by diseases, in addition to fruits infestations, are a major constraint to the development of mango plantations. The identification of the causal agents for any disease is a prerequisite for corrective actions. In the Lampsar orchard, an outbreak of gummosis was observed in almost all plots of mango trees, with greater intensity in the lower parts of the field. However a variety of symptoms was recorded. Some plants showed cracking of the stem bark and gum exudation (gummosis), while others, exhibited only the cracking of the stem bark. The symptoms were most frequently located below the grafting point and/or on the junction point of the graft and the rootstock. The incidence of the disease varied from a plot to the other, ranging from 0.59% to 8.5%. The diagnosis, made for 30 fungal isolates obtained from samples collected in the field, allowed identifying *Lasiodiplodia* sp as a causal agent, thanks to the presence of its characteristic pycnidia and pycniospores. Recommendations were made for the control of this fungus in the orchard.

Keywords: *Lasiodiplodia* sp, *Mangifera Indica*, Sénégal, Tree Gummosis.

I. INTRODUCTION

The mango (*Mangifera indica* L.) is one of the major fruit crops of tropical and subtropical regions. According to FAO (2011), the production of tropical fruits was estimated at over 82.2 million tons in 2009. The mango presents one of the main crops with 39% of world production of tropical fruits. In Senegal, mango production is experiencing a big growth with an increase of acreages allocated to this crop and a modernization of mango orchards as well. Mango represents 60% of fruit production in the country with an annual production of 150,000 tons harvested on a land surface of about 41,000 ha (ASEPEX, 2012). Although the soil and climatic conditions of the country offer a great potential for the expansion of mango production (USAID, 2006), this value chain is facing a lot of constraints related to phytosanitary quality of both tree and fruit stages. Postharvest rotting of fruits due mainly to anthracnose and fruit fly cause important losses. In addition, the appearance of a disease causing gum exudation from the trunk of the trees in the north of the country accentuates the pest pressure on the plant and thus affects the entire value chain. This disease has been reported in mango orchards from different parts of the world sometimes in relation to mango decline (Malick *et al*., 2005). The most specific symptom of the disease, one that earned him his name, is the flow of brown gum, along the trunk and branches (Vanderweyen, 1974). Several fungi are associated with tree gummosis, among them, are listed : *Phytophthora palmivora* (N'diaye *et al*, 2011), *Lasiodiplodia theobromae*, *Ceratocystis fimbriata*, *F. solani*, *Phoma sp*, *Ceratocystis omanensis* (Khanzada *et al*., 2004b; Al Adawi *et al*., 2006; Iqbal *et al*., 2007; Saeed *et al*., 2011; Haougui, 2013). The objective of this study was to identify the causing agent of the disease and assess its incidence in order to better target an adequate control method.

II. METHODS AND MATERIAL

1. Study Site

The mango orchard where the disease broke out, is located in the zone of Lampsar, 30 km east of the main city of Saint-Louis (16°06'N latitude, 16°20'W longitude and 29 m altitude). The climate is of Salelian type and characterized by low rainfall (less than 300 mm in the year). The soil is sandy but the proximity of the river Senegal has impacted deeply on the landscape and provides fresh water for irrigation.

The studied orchard covers 50 hectares of land, of which about 40 ha are cultivated, the remaining 10 hectares are represented by driveways and various facilities. It is divided into 20 plots of 2 ha each. Almost all mango trees were planted in 2013 on rows with 7 m interval. In each row trees are planted in lines with 5 m spacing. Plot 10 and 19 were set up 2 years later, in 2015. The plantation design resulted in a population of 572 trees per plot populated with only mango trees of the variety Kent. Planting was performed by first sowing mango kernels let to grow in the nursery. The seedlings, used as rootstock were thereafter grafted with scions from mature mango trees of the variety kent only. The orchard is equipped with drip irrigation system. This is set in a way to feed each mango tree with twenty drippers emitting 5L per hour each around each around the tree. Each plot is irrigated every 2 days for 50 minutes. Fertilization is performed through the irrigation system allowing the supply of nutrients in soluble form in the irrigation water. The nutrients are delivered to the trees with the drippers on the basis of fertilization program. A mechanical weed control with an offset is performed on the driveways and between the rows as necessary. It is done manually under the canopy of the trees. Several phytosanitary treatments were carried out in the orchard, likewise, an insecticide was sprayed in May 2015 and lime paintings were applied to the trunk of the mango trees to control fungi.

2. Collection of data

A questionnaire was submitted to the head of the orchard. Thereafter, an assessment of the diseases was carried out in the orchard and covered systematically all plants of the plots. Parameters like the presence of cracking or gumming were recorded. Disease severity was scored on a scale of 0 to 3, and the location of the symptoms with respect to the grafting point was also recorded. The topography of the different plots in the orchard was taken into account in terms location on upland or lowland areas in the orchard.

3. Sampling

Thirty samples were collected from diseased plants by pealing the bark on parts of the trunk showing disease symptoms. Twenty other samples were taken from the trunk of symptomless plants. The fragments were then taken to the laboratory for isolation of pathogens.

4. Isolation of Fungi

The isolation of pathogenic fungi responsible for the disease was performed at the front of progression of developing disease symptoms according to the methodology described by Diédhiou *et al*. (2007). The samples were first soaked in a 2% solution of sodium hypochrorite for 1 minute. A sterilized scalpel incision is made in order to cut a small fragment of bark at the front progression of disease. The fragment is placed in a petri dish containing PDA (Potato Dextrose Agar) supplemented with 100 ppm of chloramphenicol. The petri dishes are incubated at room temperature in the dark. After 48 h, the mycelium growing out of the fragment is transplanted into fresh petri dishes. When the pure cultures are obtained, petri dishes are incubated for 3 to 6 weeks to allow sporulation. Features of fruiting bodies like spores and pycnidia were used for the identification of fungi.

5. Statistical analysis

The data were submitted to an analysis of variance (ANOVA) using the SigmaStat ® software with a confidence interval of 95%. Mean values was separated through Tukey's tests pairwise comparisons.

III. RESULT AND DISCUSSION

1. Incidence of disease

Gum exudation from the trunk of mango trees was observed in all plots except for plots 10 and 19. The

incidence of the disease ranged from 0 in plot 10 to 8.5% in plot 4 (Figure 1). Some of the diseased plants exhibited cracking of the bark of the trunk accompanied by an exudation of gum (Figure 2a). The other type of symptoms was characterized by only the cracking of the bark on the trunk of trees (Figure 2b). The highest rate of cracking was observed at the plot 4 (8.5%). The younger trees in plots 10 and 19 were apparently healthy.

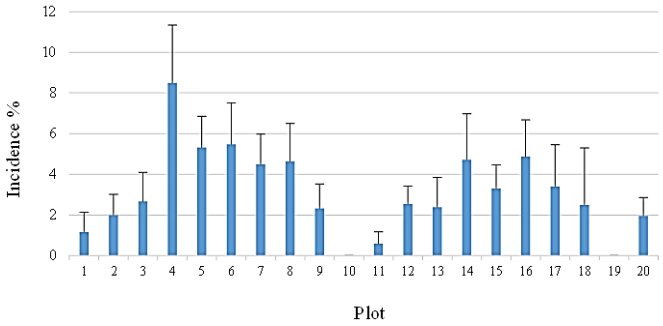

Figure 1: Incidence of gummosis in the plots of the orchard (n = 14, p≤ 5%) (in the plot, there are 14 rows representing each a replication)

a b

Figure 2: Trunk of mango trees showing cracking and exudation of gum (a) and cracking of the bark (b)

Either gum exudation and/or cracking of the bark of the trunk of the trees were mainly located either below the grafting point (figure 3a), or at the grafting point (figure 3b).

For most of the cases, cracking of the bark and/or gum exudation were often located on the grafting point and below the graft point (figure 4). The proportion of plants with symptoms above the grafting point was low. The incidence per plot was variable but reached a maximum of 5.33% in plot 4 for symptoms on the grafting point. The highest incidence for symptoms appearing below the grafting point was also recorded in the same plot 4.

a b

Figure 3: Plants with symptoms of gummosis at the grafting point (b) and below the graft point (a)

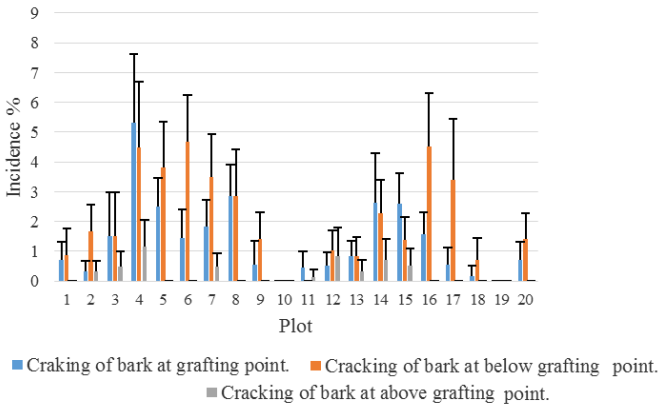

Figure 4: frequency of gummosis symptoms with respect to the grafting point

The incidence of gum exudation and cracking of the bark was significatively higher in plots located in the lowland portions of the field 3.7 % and 4.3% respectively against 1.5% and 2.4% for plants in the upland areas (figure 5).

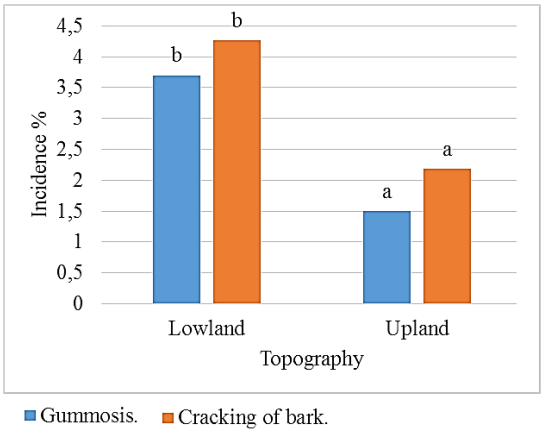

Figure 5: incidence of gummosis and cracking of the bark in the lowland and upland areas of the orchard.

2. Pathogenic agents

All fungal isolates from the samples collected in the field were initially white to smoky gray with a soft aerial mycelium on PDA. This mycelium color turned thereafter black on both sides of the Petri dishes. On the upper side, shiny black fruiting bodies that match the pycnidia were gradually visible. The conidia from the pycnidia were initially hyaline, unicellular and subovoïde to ellipsoid, with granular content. At maturity, the conidia become dark brown and cinnamon, with a thick wall and presented a central septum (figure 6). These features are specific for fungi of the genus Lasiodiplodia.

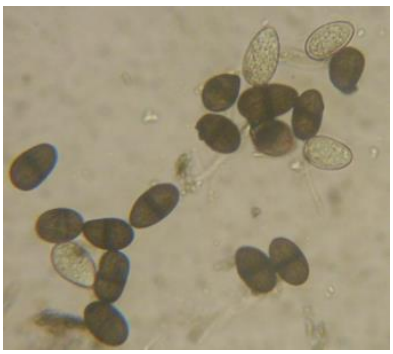

Figure 6 : conidia (pycniospores) of *Lasiodiplodia* sp under compound microscope

DISCUSSION

Lasiodiplodia sp was found as the causal agent causing gum exudation as well as cracking of the bark of the mango trees in the orchard. All macroscopic and microscopic features of colonies, pycnidia, and conidia were characteristic for the genus *Lasiodiplodia*. However among all species of Lasiodiplodia, *L. theobromae* is the one always associated with diseases of mango. It is descried as a cosmopolitan fungus that causes various diseases on about 500 plant species (Pedraza *et al*., 2013). *L. theobromae* is found mainly in tropical and subtropical regions in mango production area. It was reported as a pathogen of mango worldwide and is associated with several diseases such as mango decline, canker and dieback (Ismail *et al.,* 2012). According Khanzada *et al.,* (2005) *L. theobromae* is a soil-borne fungus that causes both diseases on standing trees and on mango fruits during storage. *L. theobromae* was identified as causal agent for mango gummosis back in 1992 (Narasimhudu & Reddy, 1992). Khanzada *et al*., (2004a) reported that mango decline and gummosis in Sindh (Pakistan), were also caused by *L. theobromae*. The same fungus was found associated with all symptoms of dieback of the mango tree (Iqbal *et al*., 2007; Khanzada *et al.,* (2004b). The disease is characterized by burning twigs, gum bleeding and splitting of the bark. Diedhiou *et al.,* (2007) and Haggag *et al.,* (2010) also identified *L. theobromae* as the causal agent of stem end rot of mango fruits after harvesting.
Lasiodiplodia sp was also isolated from several samples from apparently healthy mango trees in the orchard. A similar case was reported by Muniz *et al.,* (2011) who found *L. theobromae* in tissues of asymptomatic cashew plants. This could explain the absence of symptoms in plants used as controls. According to Muniz *et al.,* (2011), *L. theobromae* is able to live in plant tissues without causing apparent symptoms. Following external signals due to biotic or abiotic stress, symptoms begin to appear and the disease is established. In the case of the orchard studied, water and fertilizers were provided to individual trees abundantly. In addition, smaller younger trees were still symptomless.

The incidence of gummosis varied across the different plots in the orchard. This variability could also be related to the topography. In fact, a higher infestation rates were observed for plots in the low areas of the orchard. This could be explained by the presence of a moist microclimate favorable for the development of pathogens. Harsh climatic conditions and high humidity are favorable for the development of mango gummosis (N'diaye *et al.,* 2011). Such conditions were found zone where the orchard is located.

Gum exudation from trees may be observed alone or in combination with other symptoms in mango orchards (Iqbal *et al.,* 2007; Shahbaz *et al.,* 2009; Malik *et al.,* 2005). In the present study, mango gummosis was combined with cracking of the bark on the trunk for some of the infected plants. This combination was observed for other plant species like neem tree (Khalil, 2012) and citrus (Graham and Timmer, 2003). In other cases, gum exudation is associated with dieback (Iqbal *et al.,* 2007; Shahbaz *et al.,* 2009; Malik *et al.,* 2005).

The combination of gum exudation with other disorders on the mango tree could be an indication that they share

a common causal agent (Iqbal *et al.*, 2007). In the present study, the symptoms were mainly observed on the rootstock. It is known that *L. theobromae* is a soil-borne fungus (Khanzada *et al.*, 2005), which is preserved in the soil, on plants debris, etc. The rootstock is therefore more exposed to the pathogen and should be more susceptible to develop the disease in a conducive environment. The genotype of the rootstock could then play an important role in plant susceptibility to the disease. If resistant rootstocks could be found, this may help reduce the importance of the potential damage of the disease. The questionnaire conducted with the orchard manager revealed however, that any mango varieties were used as rootstock making any further investigation in this direction, not relevant. Surveys conducted in the region showed no other mango orchard with gummosis. It is important to mention that the variety kent is not common in the region. In addition, all other orchards are of traditional type, with trees planted and left without further care until harvest period.

IV. CONCLUSION

Gummosis disease was observed in almost all plots of this single orchard, with widely varying incidences between plots and higher levels infestation in the lower parts. Results of the present study would suggest that *Lasiodiplodia sp* is the causal agent of gummosis diseases of mango in Senegal. Isolation of the pathogen from asymptomatic plants, confirms its endophyte character. Further studies would be necessary to identify not only the species of Lasiodiplodia associated of the gummosis of mango in Senegal, but also the sensitivity of different mango.

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