Mango rotting in southern Senegal, a big phytosanitary challenge

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Key words: Anthracnose, mango, fruit flies, post harvest diseases, Sedhiou, Ziguinchor.

http://dx.doi.org/10.12692/ijb/5.5.183-188 Article published on September 10, 2014

Abstract

Shipments of Senegalese mango to Europe has a steady increase since 2002. This derives from greater efforts to comply with international standards rather than an increase of mango production. Within the country however, the southern regions (Ziguinchor and Sedhiou), with a much greater production potential are currently weakly exploited due mainly to fruit rotting after harvest. Mango fruit were sampled between May 10th and August 25th in 25 villages located along five main roads in the southern regions, departing from Ziguinchor to assess the extent of damages. The study showed a 100% rate of mangoes rotting for most of the villages during the rainy season. The damages were caused by anthracnose (90%) and fruit flies (74%). No infestation due to these pests and diseases was recorded before onset of rainfall. Samples taken on all road axis had 100% rotting rate except for villages in the Ziguinchor - Carrefour Ndiaye axis (Axis 4) for which 3% of fruits ripened free of infestation. The huge losses due to post harvest rot are leading to orchards and mango business abandonment upon onset of the rainy season.

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Introduction
In Senegal, horticulture is one of the sectors considered to represent the main pillars for economic growth through agriculture. Production and trade of fruits and vegetables has become in recent years one of the main objectives of developing countries (FIDA, 1998). In Senegal, the horticultural industry has grown considerably with respect to the importance of land dedicated to this production and quantities produced. Mango production has reached 150 000 tons of yearly production (FAO 2008). In Senegal, mangoes ripen from April to November with a peak between July and September depending on the varieties and the production sites. Production areas are mainly represented by the regions of Dakar, Thies, Kolda, Ziguinchor and Sedhiou. For the last three regions, the potential is enormous given the favorable climatic conditions for the development of fruit crops and efforts to promote fruit growing (Coleacp 2007).

This investment, if combined with appropriate measures to ensure good production, should have positive impact economic growth for the country. The expected outcome of a better contribution of the mango sector to economic growth of the country is becoming less important due to phytosanitary constraints with respect to the international markets. Mango quality depreciation by fruit rotting after harvest poses a serious problem. Post-harvest rotting affects more than 40% of mangoes produced in the rainy season in northern Senegal (Mbaye, 2006, Diedhiou et al., 2007). In the southern regions, however, the rainy season lasts longer and rainfall is 3 times greater than in the Niayes area in the north. Mango anthracnose due to Colletotrichum gloeosporioides, the major agent of post harvest rots is highly favored by high humidity (Fitzell et Peak, 1984, Jeffries et al., 1990, Dodd et al., 1992). The fungus attacks the young leaves, and panicles. It initiates quiescent infections in early stages of fruit development that will remain dormant until maturity, and quickly develops and rotten the mango at onset of ripening (Muirhead et Gratridge, 1986, Dodd et al., 1989).

Beside anthracnose, damages due to fruit flies have become more severe, mainly since the invasion of West Africa by Bactrocera invadens (Ndiaye, 2008). Losses due to Tephritid flies on mango have varied between 30% in the Niayes and 60% in Casamance (USAID-CE, 2006). The economic situation of mango in the southern region has become so compromised through phytosanitary constraints that it has become necessary to perform a situation analysis. Therefore the objective of this work was to identify the causing agents of mango rottng after harvest and assess their importance.

Materials and methods
Fruit sampling
Mango fruits were sampled between May 10th and August 25th throughout the regions of Ziguinchor and Sedhiou in the south of Senegal. Five main roads starting from Ziguinchor were selected and sampled twice as transects (fig. 1). On each transect, five villages separated by at least 10 km were identified after consultation with the regional agricultural services and farmers organizations. In each of these villages, 5 orchards were sampled, in which 10 mangoes were randomly picked from different trees. The sampled transects were:

• Road axis 1: it links Ziguinchor to Oussouye. As sampling sites the villages of Enampore, Mlomp Oukout, Nyassia and Djibelor (fig 1) were targeted;
• Road axis 2: it links Ziguinchor to Bignona and Thionk-Essyl. Sampling took place in the villages of Tobor, Teubi, Tendouck, Boutégol and Thionk-Essyl;
• In the road axis 3, linking Ziguinchor to Diouloulou, samples were taken in Kataba 1, Kataba 2, Karongue, Mahmouda Cherif and Nema;
• On the road axis 4 that links Ziguinchor to Carrefour Ndiaye, sampling started after Bignona in the villages of Oulampane, Silinkine, Mampalago, Django and Tangori.
• On the road axis 5, going from Ziguinchor to Sédiou and Kolda, sampling took place in Boutoute, Niaguis, Fanda, Sindone and Koundioundou.

Fruit rotting and identification of causing agents
Green mature mangoes were sampled. In each orchard, ten mangoes situated at mid-height of the trees were randomly picked. The fruits were labeled and put in clean bags, placed in cardboards for the transportation to the laboratory. The fruits were washed one by one under the tap, and placed in expedition boxes in a way to prevent contact between them and avoid contaminations. They were let to ripen at the room temperature (27 - 33 °C) for 15 days. The boxes were examined every 2 days for rotting mangoes. Fruits showing rotting symptoms were sorted out for the isolation of the causal agents. The symptoms observed were first described and classified. The isolation and identification of the causal agents were performed for every single rotting fruit.

Fungal pathogens responsible for mango rotting were isolated from the flesh beneath the peel. Therefore the mangoes were first soaked in a 1% NaOCl solution for 15 minutes and two crossed incisions in the form of V were made at the front of progression of the rotting process with a sterile scalpel. A piece of flesh under the peel was taken and put in a Petri dish containing Potato Dextrose Agar amended with 100 ppm of chloramphenicol and incubated at 30 °C in the dark. One day later, the mycelium growing out of the mango flesh was transferred into new Petri dishes to obtain pure culture of the fungi (Diedhiou et al., 2007).

To assess for fruit flies, mangoes were inspected upon arrival for oviposition marks as well holes or other signs presence of larvae. At ripening, mangoes were cut by a knife and the flesh examined for maggot of fruit flies and mines due to their feeding activity as well as entry or exit holes.

Data were analyzed with the XLSTAT 2008 software. Comparison of means was made using the Student-Newman-Keuls and separation through analysis of variance (ANOVA) at the 5%.
incidence in the region (=prevalence) of 98% was recorded (fig 2). The greater contributor to mango rotting was anthracnose with 90%, whereby in most cases, a combined infection with fruit flies was noticed (68%). Fruit flies occurred alone in fruits in 6% of cases. The third rotting causing agents was Botryodiplodia theobromae, with stem end rot occurring for 2% cases.

Table 1. Incidence of post harvest rotting of mango (cv Keitt) in different villages in the regions of Ziguinchor and Sédhiou (5 orchards per village and 10 fruits sampled per orchard).

<table>
<thead>
<tr>
<th>Road axis</th>
<th>Incidence of fruit rotting per road axis (%)</th>
<th>Village</th>
<th>Incidence of fruit rotting per village (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ziguinchor – Oussouye</td>
<td>99.6±0.9</td>
<td>Enampore</td>
<td>100 ± 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mlomp</td>
<td>100 ± 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Oukout</td>
<td>100 ± 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nyassia</td>
<td>98 ± 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Djibelar</td>
<td>100 ± 0</td>
</tr>
<tr>
<td>Ziguinchor – Bignona -</td>
<td>100±0</td>
<td>Tendouck</td>
<td>100 ± 0</td>
</tr>
<tr>
<td>Thionck Essyl</td>
<td></td>
<td>Bouguer</td>
<td>100 ± 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thionk-Essyl</td>
<td>100 ± 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Teubi</td>
<td>100 ± 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tobor</td>
<td>100 ± 0</td>
</tr>
<tr>
<td>Ziguinchor – Diouloulou</td>
<td>99.4±1.3</td>
<td>Kataba1</td>
<td>100 ± 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kataba2</td>
<td>100 ± 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Karongue</td>
<td>100 ± 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M-Cherif</td>
<td>100 ± 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Néma</td>
<td>97 ± 6</td>
</tr>
<tr>
<td>Ziguinchor – Bignona –</td>
<td>88.7±8.7</td>
<td>Oulampané</td>
<td>99 ± 3</td>
</tr>
<tr>
<td>Carrefour Ndiaye</td>
<td></td>
<td>Silinkine</td>
<td>87 ± 18</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Django</td>
<td>91 ± 11</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tangori</td>
<td>78 ± 39</td>
</tr>
<tr>
<td>Ziguinchor-Sedhiou</td>
<td>100±0</td>
<td>Boutoute</td>
<td>100 ± 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Niaguise</td>
<td>100 ± 0</td>
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<td></td>
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<td>Fanda</td>
<td>100 ± 0</td>
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<td></td>
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<td>Sindone</td>
<td>100 ± 0</td>
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<td></td>
<td></td>
<td>Koundioundou</td>
<td>100 ± 0</td>
</tr>
</tbody>
</table>

Incidence of fruit rotting in villages along the road axis

For most cases, 100% of fruits sampled in the villages along the main roads departing from Ziguinchor were rotten (Table 1). Samples from road axis 4 registered lower rotting rate that is still however always very high (88.7%).

All fruits from villages on the road axis Ziguinchor to Thionek-Essyl and Ziguinchor - Sedhiou got rotten before ripening. On the road axis Ziguinchor - Oussouye some fruits from Oukout, ripened healthy (98%), for the 4 other villages the rotting incidence was 100%. The same observation applies to the road axis Ziguinchor - Diouloulou where fruits from Nema presented 97% rotting while all fruits from other villages were infected. For fruits from the villages on the road axis 4 (Ziguinchor – Carrefour Ndiaye) the incidence of rotting varied between 78% and 99%.

Incidence of anthracnose

Anthracnose was the main cause of mango rotting in most villages (Fig. 3) like Djibeler, Enampore, Mlomp and Oukout on road axis 1; Bouguer, Thionek-Essyl on road axis 2; Kataba1, Kataba2 and Mahmouda Cherif on road axis 3 as well as all villages of the road axis 5. In the villages on the road axis 4, however, the average incidence ranged from 52% in Oulampané to 63% in Tangori.
Incidence of fruit flies

A lot of the sampled mangoes were prone to infestation by fruit flies. The lowest infection rate was around 40% in Teubi and Mampalago (fig 4). The highest infection rates were recorded for samples from Oukout and Thionck-Essyl with 90% fruit punctured.

Discussion

This study provides the first data representative of the phytosanitary situation related to the production of mango in the natural region of Casamance. It shows damage affecting almost 100% of production in the rainy season and the absence of adequate control measures. Anthracnose and fruit flies are the main causes of post-harvest rotting of mangoes. Anthracnose is a major problem with an incidence averaging 90%. Fruit flies were the second most important pest of mangoes during the rainy season with 74% fruit infection. The high incidence of the 2 agents with over 50% fruit rotting implies combined infection of both fruit flies and C. gloeosporioides on the same fruit. This was the case for 68% of sampled fruits.

Anthracnose caused by C. gloeosporioides is the main pre and post-harvest disease of mango in all areas of production. It is always associated and high humidity subsequent of regular rainfall, dew or mist (Fitzell and Peak, 1984, Jeffries et al., 1990, Dodd et al., 1992, Mbaye, 2006, Diedhiou et al., 2007). In this study, the high prevalence of anthracnose in the regions of Ziguinchor and Sedhiou could be explained by the heavy rainfall of about 1500 mm distributed over five months from June to mid-October. In other parts of Senegal, particularly in the Niayes zone with less than 400 mm rain per year, anthracnose affected up to 42% of mangoes (Mbaye, 2006, Diedhiou et al., 2007).

The combined infection by C. gloeosporioides and fruit flies could be due by the opportunism of tephritid flies during oviposition. In fact, it was showed that Ceratitis capitata preferred injured fruits for oviposition Papaj et al., (1989). The function of injury could be played in this context by the lesions caused through infection by C. gloeosporioides on fruits.

In all villages all fruits got rotten before ripening except for those of the road axis 4. This lower incidence of fruit rotting could be explained by a pilot control program that started against fruit flies. In fact, in these villages pheromone traps using methyl eugenol were distributed to producers. The lack of sanitation in general was another important factor.
that favors infection by both anthracnose and fruit flies. It is known that debris may harbor spores of many fungi which, when environmental conditions are favorable may be the cause of epidemics. The general hygiene of the orchard is very important for the control of mango anthracnose (Arauz 2000). It is also very important when implementing control methods against fruit flies, to tap on sanitation. Collecting and destroying fallen fruits are recommended among other measures to reduce fruit flies populations (Verghese et al., 2004).

Acknowledgement: This work was supported by the National Fund for Agricultural and Food Research (FNRAA) in Senegal.

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