

FIELD TESTS OF FUNGICIDES AGAINST POST HARVEST ROT OF MANGOES IN SENEGAL

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Abstract: Mango production in Senegal suffers from diseases caused by latent infection of fungi during pre harvest stage resulting in fruit rotting upon onset of ripening. These diseases reduce fruit quality and cause severe losses. The efficacy of three fungicides (azoxystrobin, myclobutanyl and mancozeb) was tested in the field for the control of post harvest diseases of mango. These tests showed that pre harvest treatment with azoxystrobin and myclobutanyl reduced significantly the incidence of incidence post harvest diseases. A single foliar treatment of mango trees with myclobutanyl or two treatments with azoxystrobin combined with a cover spray with copper chloride decreased mango rotting rate from 100% to 30%. The treatment with mancozeb showed no protective effect against fungal diseases of mango.
Keywords: Post harvest diseases, fungicide treatments, mango, Senegal.

INTRODUCTION

Production and trade of fruits and vegetables have become in recent years one of the most important pillars for economic growth in developing countries. This is linked with the expanding markets for this sector in international trade (IFAD, 1998). Senegalese horticultural sector has grown considerably in acreage as well as tonnage for fruits and vegetables. Fruit production has increased from 95,075 tons in 1986 to 121,990 tons in 1998 (DH, 2003). Mango alone represents 60% of this production. Mango producing areas are mainly represented by the regions of Dakar, Thies, Kaolack, Saint-Louis, Fatick, Kolda, Ziguinchor and Sedhiou. However, the Niayes, which alone accounts for 80% of export volumes, is the main production site of mangoes for export. Postharvest diseases resulting from latent infection from the field by a variety of fungal agents, reduce fruit quality and cause significant losses (Arauz, 2000, Diedhiou et al., 2007). Infected fruit develop rots during ripening and thus do not meet quality standards in most export markets (Cappellini et

al., 1988). Among the post-harvest diseases of mango, anthracnose is the most important in wet conditions, where its incidence can reach 100% (Arauz, 2000). Other important diseases after harvest are stem end rot due to *Lasiodiplodia theobromae* (Pat.) Griffon and Maubl. (Arauz et al., 1994) and Petrak, *Dothiorella* spp. and Cif. (Johnson, 1994), *Aspergillus niger* (v. Tieghem). The latest fungal species as well as black spots caused by *Alternaria* spp. are more prevalent in dry conditions (Diedhiou et al., 2007, Dodd et al., 1997 Droby et al., 1987). These fungi, as well as *Phoma mangiferae* have all been reported in the Niayes (Mbaye, 2006; Diedhiou et al., 2007). Effective control of these diseases in the field requires the establishment of a treatment calendar considering both climatic conditions and the diversity of pathogenic agents. In the Philippines, the treatment calendar required six treatments before bloom and fruit setting and two more with different systemic as well as contact fungicides (Estrada et al., 1996). The complex interactions between pathogens and the climatic conditions often lead to the application of many treatments (up to 25) to achieve a good post-harvest disease control (Thompson, 1987). In several cases, prediction models combining complex research in climatology, biology and mathematics were developed for the control of postharvest diseases (Peak et al., 1986, Estrada et al., 1996). In Senegal beside the absence of a treatment calendar, information on effective fungicides against mango diseases are also lacking. This study was therefore carried out to provide information for an effective control of mango diseases.

MATERIALS AND METHODS

Study sites

The experiments were conducted in two orchards located in the Niayes agro-climate in Senegal. The Niayes zone is a coastal strip between Dakar and Saint Louis, extending over 180 km in length and a width of between 5 and 30 Km inland. Field testing took place in orchard 1 located in the village one Keur Sega planted with 15 years old trees of the varieties Kent and Keitt. Sanitation consisted with pruning trees, collecting and burying debris, plowing, etc. No fungicide treatment is usually carried out in the orchard.

Orchard 2 was located in the village of Notto. Mango trees of the varieties Kent and Keitt (between 7 and 9 years of age) were planted. Pruning, collecting and burying debris and fallen mangoes and plowing were performed. In addition, monthly applications of Mancozeb and Fosethyl aluminum were made to control fungal diseases.

Fungicide tests

Three fungicides azoxystrobin, myclobutanil and mancozeb were tested for the control of post harvest fruit rot. The tests were performed on the mango variety Keitt. Azoxystrobin (class of strobilurins) in the formulation name Ortiva® (250 g / L azoxystrobin) was used at the dose of 1L/ha. The treatment was applied twice at 15 days interval during fruit growth. Treatment with mancozeb at the concentration of 2.5 g / L was carried out twice with an interval of 15 days. Myclobutanil in the EC formulation with 240 g / L active ingredient was used once at 1L/ha, as recommended by the manufacturer. Treated mango trees were selected randomly in a way to be surrounded by untreated trees. Untreated mango trees separated from treated tree blocs by two tree rows were used as control. Each treatment was applied on 10 trees, representing 10 replicates.

For each treatment, 80 mangoes (8 per tree) were harvested at the mature green stage. After harvesting, they were incubated under the following conditions: Four sets of 10 mangoes per treatment were incubated at 10 °C for 6 days and then alternately at 10 °C and at room temperature (≈ 28 °C), to mimic the transit time to Europe (6 days shipping) and sales display at destination markets (day / night), - Another four sets of 10 mangoes per treatment were incubated at room temperature. Those mangoes were harvested at a stage close to full ripeness for fresh consumption, normally requiring a rapid delivery to the market in Europe by airplane for a transit time of 6 hours.

Fruits were observed every 2 days and sorted. For each mango showing symptoms of rotting, the disease agent was identified. When necessary, isolation for identification was performed as described by Diedhiou et al. (2007). The experiment was stopped after all mangoes reached ripeness.

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.

RESULTS

Test in orchard 1

The tests in the orchard 1 gave the results in Figure 1. When the fruits were kept for 6 days at 10 °C and then subjected to alternating temperatures of 10 °C at night and 25 °C during the day to mimic the conditions during transit by Ship and display in shelves for sale in Europe and storage at the cold, the first disease symptoms were observed after 3 weeks of incubation,

when mangoes reached the ripe stage (i.e. 4 weeks after harvest). Field treatments with fungicides, before harvest, reduced post-harvest disease incidence. After 6 weeks of incubation, 98% of mangoes from the untreated control trees were infected by the diseases and got rotten. The disease was also noticed on 78% of mangoes from azoxystrobin treated trees, 62.5% of mangoes from Mancozeb treated trees and only 40% mangoes from trees treated with myclobutanil.

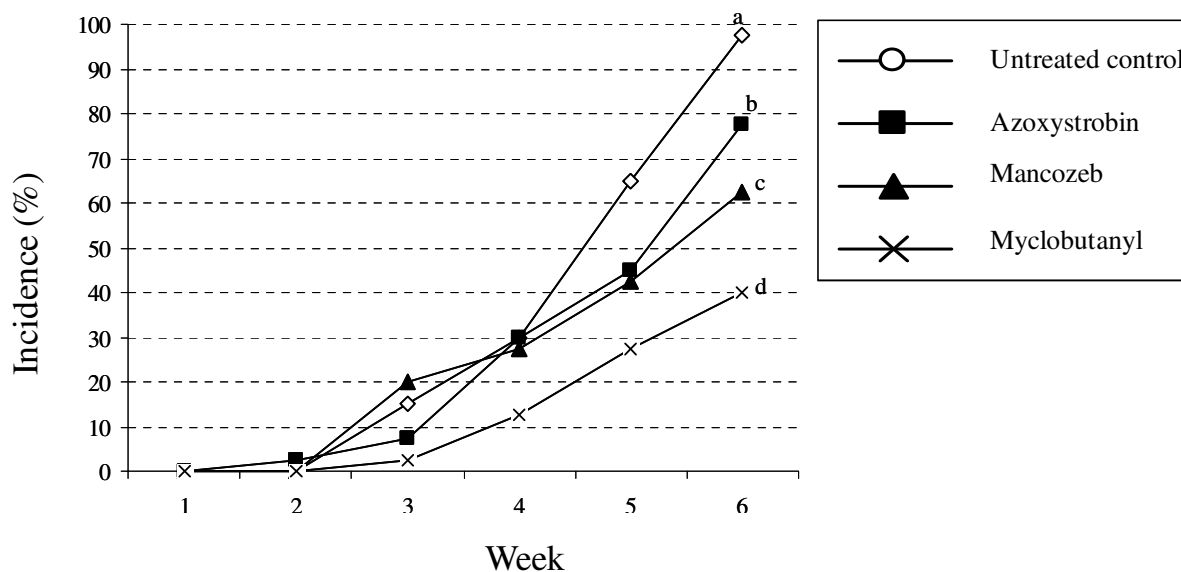


Figure 1. influence of field treatments with different fungicides in orchard 1 on post harvest rotting of mango cv Keitt stored under alternating temperatures of 10 and 28 °C (night/day) after a previous cooling (10 °C for 6 days). Curves with different letters represent significative differences to the control at 95% confidence interval.

For fruits incubated at room temperature ($\approx 28^{\circ}\text{C}$), 80% of mangoes respectively from treatments with azoxystrobin and 55% of fruits from myclobutanil treated trees were diseased while fruits from untreated control and those from trees treated with mancozeb were infected at 100% (Figure 2).

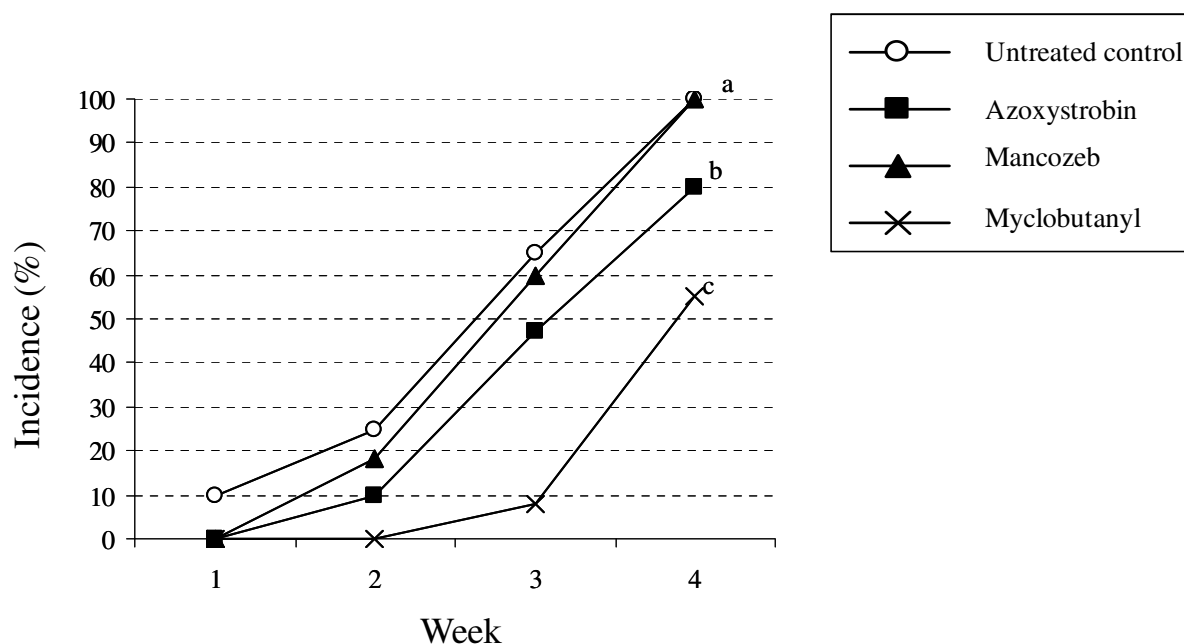


Figure 2: influence of field treatments with different fungicides in orchard 1 on post harvest rotting of mango cv Keitt stored at room temperatures. Curves with different letters represent significant differences to the control at 95% confidence interval.

Test in orchard 2

For mangoes incubated at room temperature, the disease was detected after 7 days of incubation in all treatments (Figure 3). Three weeks later, the disease incidence reached 79% for the control, 50% for the treatment with mancozeb, 35% for mangoes from myclobutanil treatment and 30% for fruits from azoxystrobin treated trees. The differences observed between the control group and the treated groups with azoxystrobin and myclobutanil are statistically significant.

For fruits incubated at 10 °C for 6 days and then subjected to alternating temperatures of 10°C at night and 28 °C during day time, first diseased fruits were observed after 3 weeks of incubation in all groups (Figure 4). After 6 weeks, the disease incidence reached 98% for the control group, 62.5% for mangoes from trees treated with mancozeb, 40% for treatment with azoxystrobin and myclobutanil 32%. The values obtained for the non treated control were significantly higher.

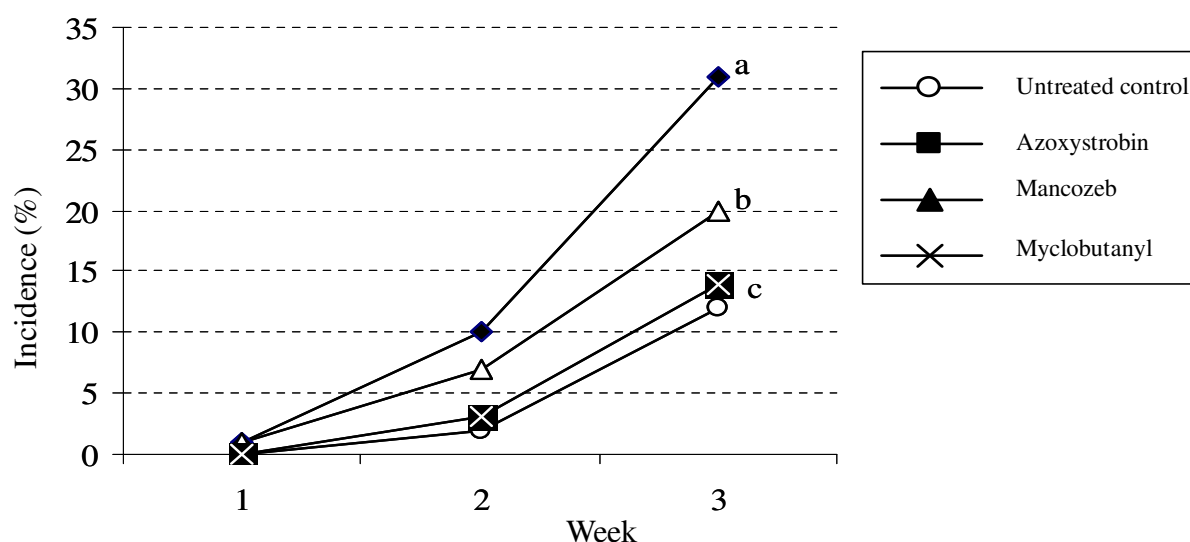


Figure 3. influence of field treatments with different fungicides in orchard 2 on post harvest rotting of mango cv Keitt stored under alternating temperatures of 10 and 28 °C (night/day) after a previous cooling (10 °C for 6 days). Curves with different letters represent significant differences to the control at 95% confidence interval.

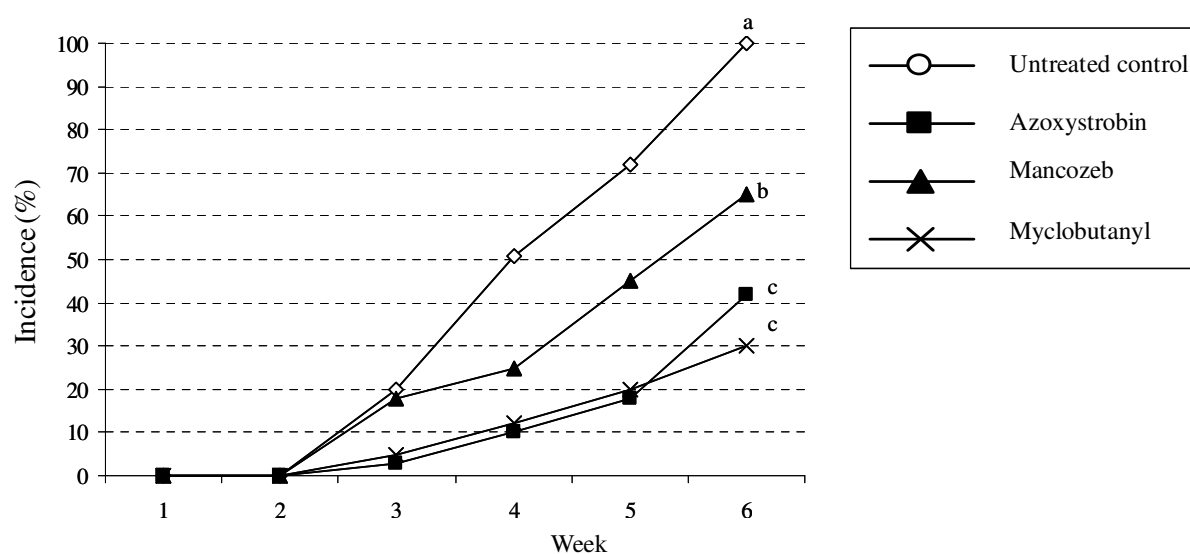


Figure 4. influence of field treatments with different fungicides in orchard 2 on post harvest rotting of mango cv Keitt stored under alternating temperatures of 10 and 28 °C (night/day) after a previous cooling (10°C for 6 days). Curves with different letters represent significant differences to the control at 95% confidence interval.

DISCUSSION

Field testing shows that myclobutanil and azoxystrobin are the most effective fungicides to control anthracnose and extend shelf life of mangoes. By improving the shelf life and quality

of the fruits, this control method will allow to increase competitiveness in the market. Mancozeb in contrasts showed little effectiveness. Similar results were reported for the control of anthracnose caused by *Euonymus fortunei* (Cole et al, 2005).

In fruit stored at 10 °C, the disease appeared after 4 weeks of incubation, whereas on those stored at room temperature, it was noticed after 2 weeks of incubation. The effect of storage temperature on the development of fruit rot is well known. According to Bezuidenhout (1983) temperatures are the main determinant of the start of active development for latent infections of anthracnose fungi. Fitzell and Muirhead (1983) as well as White et al (1998) found a significant reduction in post harvest losses due to anthracnose and stem end rot, when the storage temperature were reduced from 24 °C down to 17 °C. Reduced losses related to low storage temperatures were also reported by Spalding and Reeder (1975) on avocado.

This reduction in disease incidence at low temperatures should be rather linked to both inhibition of fungal growth as well as a slowdown of fruit ripening process. In fact, Oosthuysen (1991) reported that storing mangoes at 8 to 10 °C, delayed maturity but also the appearance of diseases. In climacteric fruits such as mango, a correlation was established between the end of the quiescent phase of the fungi responsible for latent infections and the reduction of the concentration of anti-fungal substances in fruits (Prusky, 1996; Prusky and Goldman, 1987). Ethylene production during fruit ripening, acting directly and indirectly as a trigger for fungal revival, is also well documented (Flaishman and Kolattukudy, 1994). In mango orchards, pathogens diversity and conditions favorable for their growth, often require a large number of fungicide applications to reduce post-harvest losses. According to Thompson (1987), more than 25 benomyl applications per season in Florida were sometimes necessary to achieve adequate control of anthracnose when conditions are favorable for the development of *C. gloesporioides*. Similarly, in Australia, a weekly treatment with mancozeb during flowering and a monthly spraying thereafter until harvest were recommended (Johnson and Muirhead, 1988). In this work, a single treatment with myclobutanil and 2 treatments with azoxystrobin allowed a reduction of disease incidence from 100% to 30% for fruits stored for over 7 weeks.

The high disease incidence for treatment with mancozeb could be speculated as a result from latent infections, installed before the spraying took place, as this product is known to be a contact fungicide. Myclobutanil is a systemic fungicide that belongs to the group of sterol biosynthesis inhibitors (IBS). These are effective in preventing mycelial growth with some effectiveness spore germination. Being systemic could have allowed reaching the fungi both

explain the efficacy of in latent infections and those from *de novo* infections. The same argument could be used to azoxystrobin - copper oxychloride. Strobilurins inhibit the mitochondrial respiration by binding to the *qo* site (outer quinone oxidising pocket in complex III) at cytochrome *b*, which has the structure of a saddle (Esser *et al.*, 2004). The increased use of IBS and strobilurins could be explained beyond their systemicity, by their wide range of target fungi belonging to Ascomycetes, Basidiomycetes and Deuteromycetes (Lepoivre, 2003).

CONCLUSION

Fungicide treatments performed in the field before harvest with azoxystrobin or myclobutanil showed good effectiveness on post-harvest rot of mangoes. However, fungicide tests should be extended to provide a wide range of active ingredients for producers to protect their crops while minimizing the risk of fungal resistance.

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