African Journal of Biotechnology Vol. 4 (1), pp. 109-112, January 2005
Available online at http://www.academicjournals.org/AJB
ISSN 1684–5315 © 2005 Academic Journals

Full Length Research Paper

Export papaya post-harvest protection by fungicides and the problems of the maximal limit of residues

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Accepted 28 September, 2004

The post-harvest maturity of papaya fruits is influenced by several environmental factors including temperature, light and ventilation of the surrounding wall. The maturity, presence and attacks or rots, and the accumulation of fungicide residues in the papaya was evaluated on papaya fruits treated with different fungicide. Thiabendazole-treated fruits did not rot 21 days after treatment and this fungicide was the most satisfactory with detected residues lower than the European Union's 2000/48/EC guideline.

Key words: Post-harvest, papaya, fungicides, phytotoxic, thiabendazole, residues maximal limit.

INTRODUCTION

Fruits and vegetables constitute a vital economic sector for most Africa Caribbean Pacific countries. In Côte d'Ivoire, the production of the papaya fruits was estimated at 1,000 tons in the year 2000, with half of this amount exported mostly to European countries (BID, 1999). There is a projected production of 3,000 tons in 2015. However, this sector is confronted with phytosanitary problems and the need to conform to the European Union pesticides residues (residues maximal limit) regulations.

We initiated this survey in the "Nembel Invest" farm located at 18 kilometres from Ferkéssédougou a town in the North of Côte d'Ivoire, on the soaking of the papaya fruits in the fungicides (Table1) for post-harvest conservation. The objective is to evaluate the maturity, the presence and attacks or rots, and the accumulation of fungicide residues in the papaya.

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MATERIALS AND METHODS

Plant material

The fruit of *Carica papaya* (Figure 1) is a bay of size and of variable shape according to the variety and the sexual type of the papaw tree. The male trees do not produce fruits. These fruits contain a yellow, orange and red pulp at maturity (Ministere de la Cooperation, 1993).

The papayas of every sample are packed in a cardboard boxes with an approximate net weight of 4.5 kg/12 papayas. Then the cardboards are arranged on the storage palettes and placed in a container and refrigerated at 10°C for 21 days (Figures 2 and 3).

Table 1 . Maturity State and Sanitary follow-up three (3) days after treatments.

Number of Samples	Fongicides (Active Ingredients)	Concentrations (g/l)	Maturity Stage	Ripeness	Rots	Complementary Observations
P_o	Reference sample	0	M_2	+ +	Nothing	Light withering
$P_{o'}$	Reference sample	0	M_2	+ +	Nothing	Light withering
P_1	Triadimefon	100	M_2	+ +	Nothing	General withering
P_2	Triadimefon	12, 5	M_2	+	Nothing	General withering
P_3	Bitertanol	0. 201	M_2	+ + +	Nothing	Nothing to report
P_4	Triadimefon + Bitertanol	50 + 0. 1	M_2	+	Nothing	General withering
P_5	Triadimefon + Bitertanol	25 + 0. 05	M_2	+	Nothing	General withering
P_6	Sulphate of Imazalil	0. 4	M_2	+ + +	Nothing	Nothing to report
P_7	Abamectine	5. 4	M_2	+ +	Nothing	Depression
P_8	Fongic plus	...	M_2	+ +	Nothing	Nothing to report
P_9	Maneb	2. 66	M_2	+ +	Nothing	Nothing to report
P_{10}	Thiabendazole	0. 22	M_2	+ +	Nothing	Nothing to report
P_{11}	Thiabendazole	0. 44	M_2	+ +		Nothing to report

- : Standstill + : Backward + + : normal + + + : More marked.

Figure 1 . Papaw – trees and papaya fruits.

Figure 2. Conditioning in a container of the cardboards of papaya (conservation surrounding wall).

Figure 3. The papaya samples are arranged in a fruit expedition cardboards

Observations take place inside the enclosed cold room (conservation surrounding wall), safe from the solar light and with the help of torchlight. There are four stages of maturity of the papaya:

M_1: 0 to 25% of the surface yellow.
M_2: 25 to 50% of the surface yellow.
M_3: 50 to 75% of the surface yellow.
M_4: 75 to100% of the surface yellow.

To ascertain for rots or attacks, the pedunculated scar and then the whole surface of the fruit is scrutinized to discover possible abnormal colorations. The different parts of the fruit are pushed very slightly to verify their firmness or to discover softenings.

Table 2. Maturity State and Sanitary follow-up 7 days after treatments.

Number of Samples	Fongicides (Active Ingredients)	Concentrations (g/l)	Maturity Stage	Ripeness	Rots	Complementary Observations
P_o	Reference sample	0	M_2 middle	+ +	Nothing	Light withering
$P_{o'}$	Reference sample	0	M_2 middle	+ +	Nothing	Light withering
P_1	Triadimefon	100	M_2 beginning	+	Nothing	Drying up
P_2	Triadimefon	12, 5	M_2 beginning	+	Nothing	Drying up
P_3	Bitertanol	0. 201	M_2 middle	+ +	Nothing	Nothing to report
P_4	Triadimefon + Bitertanol	50 + 0. 1	M_2 beginning	+	Nothing	Drying up
P_5	Triadimefon + Bitertanol	25 + 0. 05	M_2 beginning	+	Nothing	Drying up
P_6	Sulphate of Imazalil	0. 4	M_2 advanced	+ + +	Nothing	Nothing to report
P_7	Abamectine	5. 4	M_2 beginning	+	Nothing	Burn
P_8	Fongic plus	...	M_2 middle	+ +	Nothing	Nothing to report
P_9	Maneb	2. 66	M_2 middle	+ +	Nothing	Nothing to report
P_{10}	Thiabendazole	0. 22	M_2 middle	+ +	Nothing	Nothing to report
P_{11}	Thiabendazole	0. 44	M_2 middle	+ +	Nothing	Nothing to report

- : Standstill + : Backward + + : normal + + + : More marked.

With gloves, 2 papayas are appropriated from every cardboard following the Plan de Surveillance (1996) to extract the fungicides residues. The presence and amount of residues were determined by HPLC, UV, or fluorometric detector on RP 18 column. Gas chromatography with flame ionization detector (FID) on a compact column was sometimes applied.

RESULTS AND DISCUSSION

The post-harvest maturity of fruits and particularly the papaya is a phenomenon that is influenced by several environmental factors including temperature, light and ventilation of the conservation surrounding wall. The variations of the maturity state attributable to the applied fungicidal treatment are indicated in Table 2. Indeed some of the fungicides used such as the triadimefon or the triadimefon + Bitertanols mixture promotes the cellular and physiological modifications on the envelope of the fruits and cause their withering and drying up. Other fungicides like the Abamectine has proven to be phytoxic for the papaya by provoking some burns.

With the triadimefon, we have been able to prove by dilutions that the modifications of the papayas were not caused by high concentration. Nevertheless, increase in concentration intensifies this fungicide effects. But observed flakiness on the fruits are the results of the initial drying-up by the conditioning at 10°C which results in a light hardening of the fruits. Thus, the weakening of the fruits predisposes them to fungal attacks in spite of the fungicide treatments. Rots appear on the papaya surface about 18 days after fungicide treatment including the reference papaya samples making them unacceptable to consumers. However, fruits treated in Bitertanol, Fongic Plus and Maneb which did not show extensive withering and a drying-up, presented surface rots 18 to 21 days after treatment.

The Imazalil sulphate protects against rots 21 days after treatment which gives enough time for marketing. It, however, accelerates the maturity which is an unfavorable factor for the conservation of the fruits in middle and long enough term because it weakens them and leads to a decrease in quality. Only Thiabendazole treatment protected against rot 21 days after treatment while presenting a satisfying aspect of the maturity and sanitary state.

It is important to note that in the most of the cases the surface rots often develop on former injury scars and no peduncle rot was observed after treatment. Only the samples which were not treated presented some peduncular rot after 18 days of storage.

The treated, traded and consumed fruits are those which first present a maturity and a satisfying sanitary state. The verification of the harmlessness of fruits by evaluating the accumulated residues was carried out on the Thiabendazole-treated papayas. There is no meaningful variance difference between the quantities of measured residues for the two concentrations of the soaking environment (Figure 4). The concentration of0.22 g/l is as efficient as that of 0.44 g/l and it therefore more economic and suitable. This is much lower than the maximal limit of residues of Thiabendazole (10 mg/kg, Initiative pesticides ACP, 2000). The traces of this fungicide in the reference papaya samples (0.0029 mg/kg) are most probably due to contaminations.

The marketing network of papaya requires their continuous evaluation from the production until sale. A great number of the infestations occur in the plantation and a good fungicide protection at this level facilitates the post-harvest conservation. These fungicides must preserve the quality of the fruits until sale (Codex Alimentarus, 1998). The fungicides evaluated in this study are quickly biodegradable but there is always a

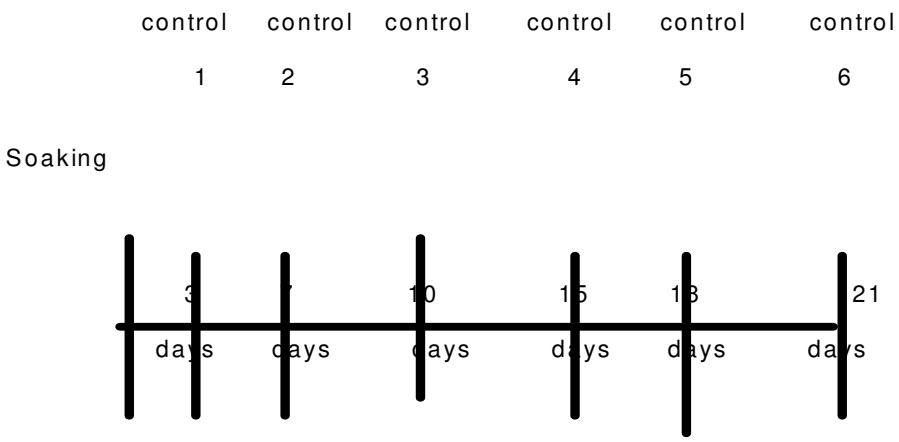

Figure 4. Sampling chronogram.

risk of poisoning due to a misuse. Maximum precaution is necessary in the application of pesticides (Fleischer et al., 1998). It is in this context that the biological fungicides constitute alternatives to chemicals because they are biodegradable thus protecting the environment.

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