



## A long-term evaluation of fungicides to manage the Black spot disease of papaya

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### Introduction

Black spot disease is caused by the fungus *Asperisporium caricae* and is a major foliar disease affecting papaya (*Carica papaya*) in Hawaii (Ogata and Heu, 2001). The initial symptoms of Black spot disease are small water-soaked spots which develop on the upper surface of leaves and later become greyish white in color. On the lower surface, symptoms include irregular brown to black spots measuring 2-6 mm in diameter on older papaya leaves. The number of black spots increases and coalesce with each other to become larger lesions. Affected leaves curl and become necrotic, brittle and subsequently die under severe disease pressure, which result in extensive defoliation (Figure 1). Lesions on fruit begin as small black spots that can enlarge to 2-6 mm in diameter. The tissue beneath these lesions remains firm, but the value of harvested fruit with these symptoms is reduced (Vawdrey et al., 2008). A suite of best management practices includes proper site selection, reducing initial fungal inoculum and application of appropriate fungicides (Sugano et al., [Link](#)). However, the disease is not notable until growers observe the black spots on fruits, when any management methods applied is found to be not effective. Thus, a timely application of appropriate fungicides in a regular manner is needed to effectively suppress the Black spot disease of papaya.



**Figure 1:** Defoliation of older leaves under high Black spot disease pressure.

## Methods

A superimposed trial was conducted to evaluate the effectiveness of fungicides for the Black spot disease management in Wirat's Farm at Lihue, Kaua'i. In this farm, papaya variety 'Sunrise' was planted in an approximately 4 Acre area with the row and plant spacings of 7 ft. x 10 ft. in 2019 summer. At the flowering stage (4 months after planting), one best hermaphrodite papaya plant was retained by removing two others (could be unisexual or less vigorous plants) in a hole. This operation is normally done to ensure successful papaya production.

Various classes of fungicides are available for the management of Black spot disease of papaya. Three fungicides with active ingredients Copper hydroxide, Mancozeb, and Chlorothalonil were evaluated (Table 1) and compared with the farmer's practice. All three fungicides used in this trial are contact fungicides. The farmer's practice followed the same spray schedule as other treatments, but it consists the mixture of all three fungicides. Soon after selecting one best hermaphrodite plant, the fungicide treatments were applied at monthly intervals until the beginning of harvest (August 2019 - May 2020). A total of 9 fungicidal sprays were applied (Table 2).

**Table 1:** Trade names and active ingredients of fungicides with the dosage used in the trial 2019/20

Active Ingredient	Trade name	Dosage per Acre
Copper hydroxide	Kocide 3000	1.75 lbs
Mancozeb	Manzate ProStick	2.0 lbs
Chlorothalonil	Initiate 720	1.5 Pint

Fungicide solutions were prepared estimating 100 gallons of spray volume is needed to spray one Acre area of Papaya stands.

**Table 2:** A monthly fungicide spray and the black spot severity inspection dates in the trial 2019/20

Spray#	Fungicide application date	Disease inspection date
1	August 9, 2019	August 27, 2019
2	September 7, 2019	-
3	October 6, 2019	October 14, 2019
4	November 14, 2019	December 5, 2019
5	January 21, 2020	January 28, 2020
6	March 15, 2020	-
7	March 30, 2020	April 7, 2020
8	April 24, 2020	May 1, 2020*
9	May 4, 2020	May 12, 2020*

\* indicates disease inspected on the papaya fruit.

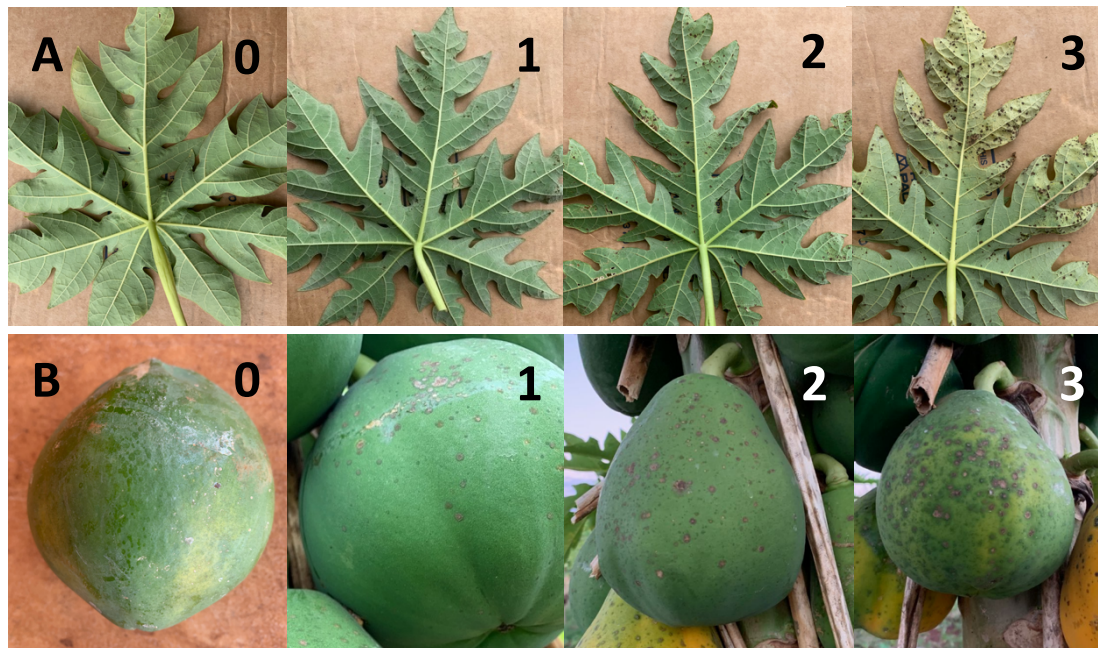
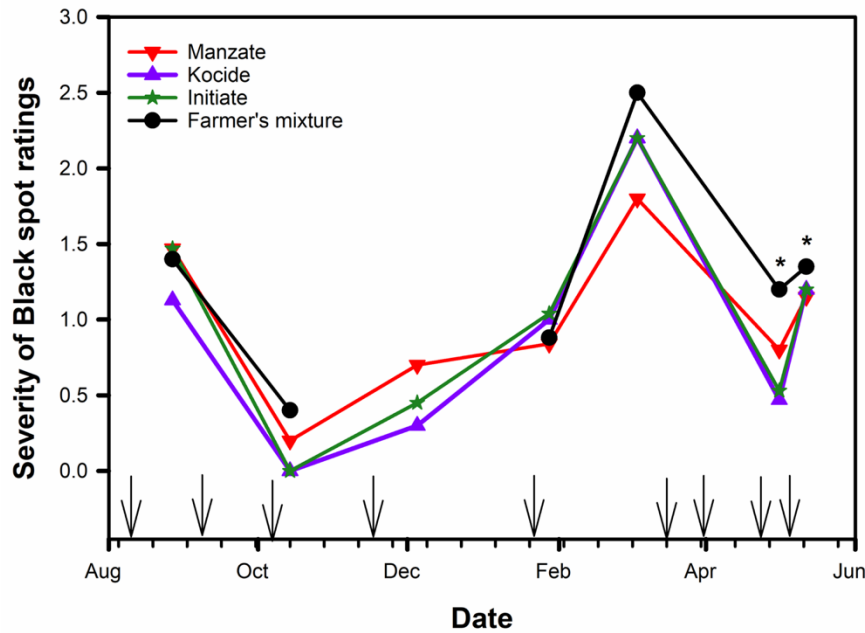


Figure 2: (A) Severity of black spot ratings on the leaf, 0 – 3, and (B) Severity of black spot ratings on the fruit 0 – 3, in both cases 0 indicated absence of black spots and 3 indicated densely distributed black spots

Each fungicide treatment was applied to three rows of papaya, in which each row measured 300 ft long. The blocks of each treatment (3 rows of papaya) were located adjacent to one another. The farmer's practice, a mixture of fungicides was applied to the rest of the papaya area. A total of 15-20 papaya plants (at least 5 plants/row) were selected for the severity of disease inspection. The severity of black spot disease was measured by inspecting the 2<sup>nd</sup> lower most green leaf of the plant. The leaves were rated on the scale of 0-3, where 0 indicated absence of black spots, 1 indicated sparsely distributed black spots, 2 moderately distributed black spots, 3 indicated densely distributed black spots on the lower surface (Figure 2A). The severity of black spots on the leaf was inspected once in two months in variable days after the fungicide spray (Table 2). The final two severity of black spots were inspected on a mature papaya fruit, in a similar manner as in the leaf inspection (Figure 2B).

## **Results and Discussion**

The effectiveness of fungicide treatments, including farmer's mixture was similar without any significant differences during the trial period. The severity of disease reduced to the lowest (= 0) initially after first two sprays (October 2019). Among the treatments, no black spots were observed on the leaves in Kocide and Initiate treatments (Figure 3). The severity of black spots was suppressed until January 2020, after which it gradually increased and was the highest during April 2020. This might be due to missed sprays once in December 2019 and another in February 2020 and that coincided with the most wet weather period on this island. To counterbalance this, an additional spray was applied in the months March and April 2020, just before the harvesting stage. Although the fruits were not spot less, the treatments, Kocide and Initiate had substantially lowered the severity of black spots. Overall result suggests that Kocide and Initiate treatments were effective to suppressed black spots on leaves initially and then on fruits at harvesting stage (Figure 3).



**Figure 3:** Severity of black spot ratings in papaya in four different fungicide treatment blocks during August 2019 through May 2020. \* indicates black spots inspected on the fruits, and others were on the leaves. ↓ indicates the date of fungicide spray.

In general, initial preventative sprays can be applied before the onset of disease, then in cases of disease incidence periodic curative sprays are needed. In this trial, although the fungicide sprays initiated early and applied periodically, the disease severity on the leaves increased with the papaya developmental time. Although the favorable weather might have played a role, the repeated application of the same class of fungicide for the long time could be the reason of increased disease severity. It is recommended that fungicides should be rotated among different mode of action groups for greater effectiveness (Sugano et al., [Link](#)). In addition, a rotation of preventative sprays (contact fungicides) followed by a curative spray of systemic fungicides (e.g., Azoxystrobin, Trifloxystrobin, Triflumizole) may offer a better option than the rotating contact fungicides. Further field trials are necessary to validate the results and recommend to the Kaua'i growers for the management of Black spot of papaya.

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