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Research Article

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Evaluation of Bio-efficacy of Applying Different Fungicides against Brown Spot Disease (*Neoscytalidium dimidiatum*) in Field Condition

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Abstract The field experiment was conducted to assess the effect of several fungicides against the brown spot disease (*Neoscytalidium dimidiatum*) on dragon fruit in Chau Thanh district, Long An province. The experiment was laid out in Randomized Complete Block Design with 5 treatments and 3 replications including T1 (Aviso 350 SC), T2 (Opus 75 EC + Kumulus 80 WG), T3 (Ridomil Gold 68 WG0, T4 (Control). The result showed that Opus 75 EC + Kumulus 80 WG (Epoxiconazole 750g/L + Sulfur 800 g/Kg), Aviso 350 SC (Azoxystrobin 200 g/L + Difenoconazole 150g/L) and Ridomil Gold 68 WG (Mancozeb 640 g/Kg + Metalaxyl-M 40 g/Kg). The results showed that by fungicides application, almost effectiveness to brown spot disease and achieved higher yield compared to control. Especially, the combination of Opus 75 EC + Kumulus 80 WG (Epoxiconazole 750g/L + Sulfur 800 g/Kg) achieved the highest efficacy against brown spot disease on dragon fruit.

Keywords Pesticides, brown spot disease on dragon fruit, efficacy against disease, yield

Introduction

Pitahaya (*Hylocereus undatus* L.) or commonly known as dragon fruit is genus *Helocereus* which belongs to family *Cactacea*. Pitahaya is one of the most common edible fruit and high economic value for farmers compares to the other fruits in Vietnam. Furthermore, pitahaya contains a variety of nutrients such as antioxidant vitamins like vitamin A and vitamin C, minerals: iron, magnesium, potassium etc [1]. In present, Vietnam has approximately 30,000ha total area grows pitahaya, mostly in some provinces in North, Vietnam, such as Binh Thuan which covers 20,000ha, Long An has 3,248ha, Tien Giang has 3,000ha and the rest belongs to other provinces [2]. However, in recent years, pitahaya in Vietnam has been damaged by the infestation of some different pests like fruit flies, antsor many diseases such as brown spot disease, anthracnose disease etc. Moreover, the brown spot disease which causes by the *Neoscytalidium dimidiatum* fungus has the most crucial damage to pitahaya. Brown spot disease occurs mostly in the rainy season (from May to November annually), suitable temperature for this fungus can develop around 30-35^{o}C with high humidity [3, 4]. This disease has a complicated speading cycles, easily spread in a wide area in the rainy season with disease ratio around 20 -50% which causes the reduction in productivity and the quality of fruit lead to the decline in both home consumption and export [2].

As finding the solution, many farmers have used chemical fungicides with higher dosage many times than the limitation of the product's recommendation, blends different kinds of chemical fungicides, spray periodically once per 5 – 7 days in a raining season which lead to the environmental pollution, increase in production cost

and causes the remaining chemical fungicides in pitahaya fruit. To solve this issue, the field experiment was conducted to assess the effect of several fungicides against the brown spot disease (*Neoscytalidium dimidiatum*) on pitahaya in Chau Thanh district, Long An province to find the highest efficiency of fungicide to treat brown spot disease on pitahaya.

Materials and Methods

Materials

A 7 years old white-flesh pitahaya was used in this study. While, the used fungicides was: Aviso 350 SC, Opus 75 EC, Kumulus 80 WG, Ridomil Gold 68 WG. Evaluating bio-efficacy of several fungicides to brown spot disease (*Neoscytalidium dimidiatum*) on pitahaya in Chau Thanh, Long An.

Field experiments

The experiment was conducted in Chau Thanh, Long An from 30th July 2017 to 19th August 2017, 7 years old white-flesh pitahaya, distance: 3m x 3m, density: 1,110 pillars/ha. The experiment was designed by using Randomized Complete Block Design – RCBD, single factor with 4 treatments, triple replications, 3 pillars per block. Each treatment component was shown in Table 1.

Table 1: Fungicide components used in this study

No	Treatment	Component	Dosage (L, Kg/ha)
1	Aviso 350 SC	Azoxystrobin 200 g/L + Difenoconazole 150g/L	1.8
2	Opus 75 EC + Kumulus 80 WG	Epoxiconazole 750g/L + Sulfur 800 g/Kg	1.2 + 1.5
3	Ridomil Gold 68 WG	Mancozeb 640 g/Kg + Metalaxyl-M 40 g/Kg	1.5
4	Control (water only)	-	-

Note: Water irrigate: 600liters/ha

Fungicide sprayed on both leaves and pitahaya fruit. The experiment had 2 periods of treatment: First spray period: when brown spot disease briefly promoted, disease ratio: 5-10% (30th July 2016; 10 days after the inflorescence and pollination). Second spray period: 7 days after the first spray period. All blocks had been provided similar fertilizers, pesticides during the time of the experiments. All experiments were performed following the standard basic: TCCS 162: 2014/ of Vietnam.Disease ratio and disease index collected before spraying; 5, 7 days after 1st treatment period and 5, 7, 10 days after 2nd treatment period. Each pillar chose 4 points in 4 directions to observe, each point observed 2 branches, each branch screened all fruits. And all screened fruits must be permanent. Disease ratio and disease index were calculated by the following equations:

$$\text{Disease ratio (\%)} = \frac{\text{The number of fruit affected disease}}{\text{Total fruits screened}} \times 100$$

$$\text{Disease index (\%)} = \frac{9n_9 + 7n_7 + 5n_5 + 3n_3 + n_1}{9N} \times 100$$

Where: $n_1 \rightarrow n_9$: The number of fruit with the correspondent level

N: Total fruits screened

The level of disease would be evaluated based on the following criteria:

Level 0: No infection of disease

Level 1: ≤ 5 % Pitahaya's acreage got disease.

Level 3: 5 – 10 % Pitahaya's acreage got disease.

Level 5: 11 – 15 % Pitahaya's acreage got disease.

Level 7: 16 – 20 % Pitahaya's acreage got disease.

Level 9: > 20 % Pitahaya's acreage got disease.

Productivity and compositions of pitahaya productivity were conducted as follow: the number of fruit/pillar: Count all fruits on the pillar while collecting; Weight (g/Fruit): Weight randomly 10 fruits in each block then calculate the average; Total productivity (kg/Pillar): Weigh all fruits in each a block; Commercial productivity (kg/Pillar): Weight all heathy fruits in a block. The toxicity of fungicides to pitahaya in 1, 3, 7 days after sprayed would be evaluated on a different levels:

Level	Symptom
1	Normal plant.
2	The development of the plant slightly decrease.
3	The development of the plant decrease but the symptoms (in color, shape, ...) are not clear.
4	Has poisoning symptoms but does not affect on productivity of the plant.
5	Plant changes color, affects on productivity.
6	Fungicide slightly reduce productivity of the plant.
7	Fungicide causes an extensive decrease in productivity
8	The symptoms become more clearly and cause the fatal of plant.
9	Dead plant.

Statistical Analyses

All data were statistically analysed by Excel version 2017, Duncan's test and IRRISTAT 5.0 software.

Results and Discussion

The affection of different dosages on brown spot disease ratio and index

As shown Table 2, the fluctuation was ranged from 5.8 – 9.2 % of disease ratio with no significantly different which meant the disease was equally in each treatment before the experiment. After 1st spray period (NSP1) 5 days, the ratio of disease in each treatment around 7.5 – 11.7%, significantly lower than control. Especially, disease ratio in Opus 75 EC + Kumulus 80 WG treatment significantly lower than Aviso 350 SC and Ridomil Gold 68 WG treatment which was the lowest value. As a result, Opus 75 EC + Kumulus 80 WG, Aviso 350 SC and Ridomil Gold 68 WG had high efficiency in restricting the expansion and development of brown spot disease 5 days after the 1st spray period in

Table 2: Influence of applying different dosages of fungicides in field condition

Treatment	Dosage (L,Kg/ha)	Disease ratio (%)					
		TP L1	5NSPL1	7NSPL1	5NSPL2	7NSPL2	10NSPL2
1. Aviso 350 SC	1.8	7.5	11.7 b	14.2 b	19.2 b	20.8 b	23.3 a
2. Opus 75 EC + Kumulus 80 WG	1.2 + 1.5	5.8	7.5 a	8.3 a	12.5 a	13.3 a	17.5 a
3. Ridomil Gold 68 WG	1.5	8.3	11.7 b	13.3 b	20.0 b	22.5 b	24.2 a
4. Control	-	9.2	25.8 c	33.3 c	43.3 c	50.0 c	69.2 b
Calculated F		ns	**	**	**	**	**
CV (%)		23.8	13.2	11.8	9.8	9.7	10.1

Note: TP L1,2: Before 1st,2nd spray period; NSP L2: After 2nd spray period.

*Before statistical analysis, values are converted into arcsine $\sqrt{p}$ (with p is disease ratio); different lowercase letters indicate no significant differences between treatments in the same column based on Duncan's test; **: has statistically significant; no statistically significant.*

Which the treatment with Opus 75 EC + Kumulus 80 WG had the highest effect (table 1). A similar result also occurred in 7 days after the 1st spray period and 7 days after the 2nd spray period. While 10 days after 2nd spray period, disease ratio in different treatments had result in the range 17.5 – 24.2%, significantly lower compared to the control (69.2%).

Table 3: The effectiveness of fungicides on disease index:

Treatment	LL (L, Kg/ha)	Disease index (%)					
		TP L1	5NSPL1	7NSPL1	5NSPL2	7NSPL2	10NSPL2
1. Aviso 350 SC	1.8	0.8	1.3 a	1.6 a	2.5 b	2.9 b	3.1 ab
2. Opus 75 EC + Kumulus 80 WG	1.2 + 1.5	0.8	1.0 a	1.1 a	1.6 a	1.7 a	2.1 a
3. Ridomil Gold 68 WG	1.5	1.1	1.5 a	1.7 a	3.0 b	3.2 b	3.6 b
4. Control	-	1.4	4.5 b	6.3 b	11.9 c	13.9 c	18.4 c
Calculated F		ns	**	**	**	**	**
CV (%)		36.3	21.2	17.3	9.5	9.2	8.1

Note: TP L1,2: Before 1st,2nd spray period; NSP L2: After 2nd spray period.

*Before statistical analysis, values are converted into arcsine $\sqrt{p}$ (with p is disease ratio); different lowercase letters indicate no significant differences between treatments in the same column based on Duncan's test; **: has statistically significant; no statistically significant.*

Before sprayed fungicides, the disease ratio around 0.8-1.4 % which showed in Table 3 had no significantly different. This result showed the similarity of disease ratio in different treatments. Disease index in 5 days after 1st spray period about 1.0 – 1.5% and significantly lower than the control treatment which indicated that Opus 75 EC + Kumulus 80 WG, Aviso 350 SC and Ridomil Gold 68 WG fungicide could limit the development and spreading of the disease.

In 5 days and 10 days after 2nd spray period, disease ratio in each treatment was significantly lower than the control. Exclusively, disease index in the combination of Opus 75 EC + Kumulus 80 WG treatment was the lowest and significantly lower than Aviso 350 SC and Ridomil Gold 68 WG fungicide. Hence, the treatment of Opus 75 EC + Kumulus 80 WG which was the highest efficiency and had a higher effect than Aviso 350 SC treatment and Ridomil Gold 68 WG treatment.

The influence of fungicides on productivity of pitahaya

Table 4: The influence of fungicides on compositions of pitahaya productivity and the yield of pitahaya

Treatment	Dosage (L, Kg/ha)	Fruit/pillar	Fruit weight (g/fruit)	Total prodcutivity (kg/pillar)	Commercial prodcutivity (kg/pillar)
1. Aviso 350 SC	1.8	15.3 a	496.3 a	7.23 a	6.56 b
2. Opus 75 EC + Kumulus 80 WG	1.2 + 1.5	17.7 a	495.0 a	8.22 a	7.72 b
3. Ridomil Gold 68 WG	1.5	15.7 a	473.0 a	7.34 a	6.81 b
4. Control	-	14.7 a	453.7 a	6.67 a	3.73 a
Calculated F		ns	ns	ns	*
CV (%)		8.6	10.2	8.0	11.3

*The difference between values which had a similar letter in the same column had no statistically significant based on Duncan's test; *: Has statistically significant, ns: No statistically significant.*

Fruit/pillar, fruit weight and total productivity of each treatment had no significantly different compared to control as presented in Table 4. So, fungicide had no affection for fruit formation and development of pitahaya. But the commercial productivity in Opus 75 EC + Kumulus 80 WG, Aviso 350 SC and Ridomil Gold 68 WG significantly higher than the control treatment because of fungicides prevented the spreading and growing of disease which fixed the number of damaged fruit caused by disease.

Toxicity of fungicide to pitahaya

Opus 75 EC + Kumulus 80 WG (dosage 1.2 L + 1.5 Kg/ha), Aviso 350 SC (dosage 1.8 L/ha) and Ridomil Gold 68 WG (dosage 1.5 Kg/ha) had no damage on the growth and development of pitahaya.

Table 5: Toxicity of fungicide to pitahaya

Treatment	Dosage (L, Kg/ha)	Damage level		
		1 NSP	3 NSP	7 NSP
1. Aviso 350 SC	1.8	1	1	1
2. Opus 75 EC + Kumulus 80 WG	1.2 + 1.5	1	1	1
3. Ridomil Gold 68 WG	1.5	1	1	1
4. Control	-	1	1	1

Note: NSP: Day after spray

Conclusions

In summary, the Opus 75 EC + Kumulus 80 WG (dosage 1.2 liters + 1.5 Kg/ha), Aviso 350 SC (dosage 1.8 liters/ha) and Ridomil Gold 68 WG (dosage 1.5 Kg/ha) had good results in treating Brown spot disease (*Neoscytalidium dimidiatum*) and increasing productivity of plant. Especially, Opus 75 EC and Kumulus 80 WG with the dosage (1.2 liters + 1.5 Kg/ha) showed the best result. The Opus 75 EC + Kumulus 80 WG (dosage 1.2

liters + 1.5 Kg/ha), Aviso 350 SC (dosage 1.8 L/ha) and Ridomil Gold 68 WG (dosage 1.5 Kg/ha) had no negative affection on the growth and the development of dragon fruit.

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