Biological Control Potentials of *Fusarium* sp. Against *Aphis gossypii* in Pepper

Andi Nasruddin

Department of Plant Protection, Faculty of Agriculture, Hasanuddin University, Makassar 90245, Indonesia

ABSTRACT

The study was conducted to determine the potentials of *Fusarium* sp as a biocontrol agent for *Aphis gossypii*, a key pest on chilly pepper in South Sulawesi. In this study several trials were performed to determine the following specific goals: 1) the values of LC*50* and LT*50* of the fungus on *A. gossypii* nymphs, 2) the effect of the fungus application on the population of the aphid, and 3) the effect of fungicide application on the growth of *Fusarium* sp. culture. The study results showed that the LC*50* and LT*50* of the pathogen were 1.6 x 10^4 conidia/ml and 3.8 days, respectively. There was a tendency that the larger the population of aphid, the more aphids were infected. Therefore, the fungus is very promising to be developed as a biopesticide against *A. gossypii*. However, fungicide (mancozeb) applied at the recom-mended rate showed a detrimental effect on the growth of the *Fusarium* sp. culture; hence it is necessary to conduct further studies to find a fungisicides which are safe to the entomopathogen.

INTRODUCTION

One of the most important limiting factors of pepper (*Capsicum annum* L) cultivation in South Sulawesi, Indonesia is the cotton aphid (*Aphis gossypii* Glover). The insect can directly damage crops by sucking their sap, resulting in leaf distortion and curling. The upper leaf surface is sticky due to honey dew excreted by the aphid which is suitable for sooty mold to grow. Besides that, the cotton aphid can also damage plants indirectly by acting as a vector of PVY on pepper (Soedarto 1985).

Growers rely heavily on insecticides to control the aphid; hence there is an increasing concern of detrimental effects of excessive use of the insecticides on pepper. Therefore, alternative effective control methods yet safe must be developed. The use of entomopathogenic fungi to control the cotton aphid is an alternative measures to achieve these goals.

A field survey conducted in farmers' pepper fields in the Districts of Gowa and Makassar, South Sulawesi Province, Indonesia to assess the cotton aphid population in pepper showed that the aphid populations were very low. Many aphid cadavers, covered with fungal myselia, were found in those fields. Laboratory observation results indicated that the aphids were killed by *Fusarium* sp. (Nasruddin 2007, unpublished data).

Therefore, the main purpose of this study was to determine the potentials of *Fusarium* sp as a biocontrol agent against *A. gossypii* on pepper. The specific goals were to determine: 1) the virulence of *Fusarium* sp. against *A. gossypii*; 2) the effect of *Fusarium* sp. application on the aphid population; and 3) the effects of fungicide (mancozeb), the most commonly used fungicide by pepper growers, on *Fusarium* sp.

MATERIALS AND METHODS

Fusarium sp. isolate. Entomopathogen was isolated from field-collected *A. gossypii* and then cultured on potato dextrose agar medium.

Virulence of Fusarium sp. against A. gossypii nymphs. To estimate LC_{50} of *Fusarium* sp., conidia were suspended in distilled water containing 0.01% Silwet with various concen-trations: 0 (control), 10^4, 10^5, 10^6, 10^7, and 10^8 conidia per ml. Ten adult aphids were transferred to a 2-week old pepper seedling confined in a small cage (20x-20x40 cm). Forty eight hours later, the aphids were removed from the cage but 20 nymphs were left on the plant. After the nymphs became instar two or three (three days after being deposited), the conidial treatments were applied to the plant until run off (5 ml per plant) using a perfume sprayer. Each treatment had five replications; and each replication consisted of one plant. Mortality values were recorded every 24 h for seven days. Mortality percentage was corrected using Abbott's formula (Abbott 1925). Estimate of LC_{50} for mortality at seven days post treatment and LT_{50} for concentration of 10^6 per ml were made using Probit analysis (Finney, 1971).

Effect of Fusarium sp. application on aphid population.

Eight 3-week old pepper plants were placed inside a cage (40x40x80cm) (Fig. 4). Ten adult aphids were transferred onto each of those plants. Two weeks later the plant were sprayed with conidia suspension with a concentration of 10^6 conidia per ml. The spray volume used was 20 ml per plant. The treatment had three replications; and each replication consisted of one cage. Plants in three other cages were sprayed with 0.01 Silwet only as controls. The cages were placed in a greenhouse with the temperature of 29 ± 2°C. The number of alive and dead aphids were recorded weekly for three weeks, starting one week post treatment.

Effect of fungicide on growth of mycelia. Treatments consisted of six concentrations of mancozeb (a.i): 0 ppm, 0.024 ppm, 0.24 ppm, 2.4 ppm, 24 ppm (recommended concentration for pepper), and 240 ppm. Ten ml of liquid potato dextrose agar was poured into a Petri dish and 1 ml of the fungicide solution was added at concentration equivalent to the concentration treatments. Once the agar solidified a 5 mm plug was cut from the center point of each plate and replaced with plugs from actively growing laboratory *Fusarium* culture (Lagnoui and Radcliffe 1998). Each treatment had five replications of plates. The plates were incubated in room temperature (28 ± 2). Diameter of the colony in each plate was recorded daily for seven days.

RESULTS

Virulence of Fusarium sp. against A. gossypii nymphs. Bioassay results showed that LC_{50} and LT_{50} of *Fusarium* sp. on *A. gossypii* were 1.6 x 10^4 conidia per ml and 3.8 days, respectively. These values indicated that the entomopathogen was highly virulent against the cotton aphid and potential for biopesticide development.

Effect of Fusarium sp. application on aphid population. There was a tendency that as the aphid population increased , the number of aphids killed by the entomopathogen also increased (Fig. 1). One week post Fusarium treatment, about 33% of the aphid population was killed and the number of alive aphids found on the treated plants was significantly lower than those in the control ($P < 0.05$). Approximately 40% of the treated aphids was killed two weeks after Fusarium application; and the number of alive aphids on the treated plants was significantly lower than those found in the control ($P < 0.05$). In the last observation 61% mortality was recorded for the aphids treated with Fusarium and the number of alive aphids was significantly lower than those in the control ($P < 0.01$).

Effect of fungicide on growth of mycelia. Growth of mycelia was strongly inhibited by mancozeb at the concentration 24 ppm, equivalent to the recommended rate (Table 1). The level of inhibition at that concentration was about 26% (Table 2) dan (Fig. 2). This is probably the reason why mycosis incidence was low in the field during 2009 planting season when growers more intensively used mancozeb in controlling blight disease on peppers.

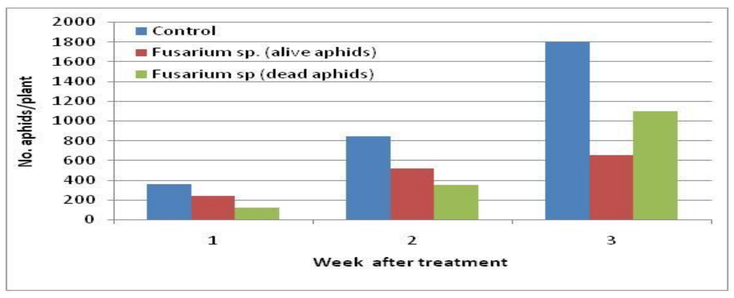

Fig. 1. Number of aphids per plant 1,2, and 3 weeks after Fusarium application.

Table 1. Effect of fungicide mancozeb on the growth of Fusarium mycelia

	Colony Diameter (cm)					
Treatment	**24 h**	**48 h**	**72 h**	**96 h**	**120 h**	**144 h**
0.000 ppm	**1.40a**	**2.30a**	**3.18a**	**4.00a**	**4.84a**	**5.54a**
0.024 ppm	**1.58a**	**2.10a**	**2.94a**	**3.88a**	**4.56a**	**5.18a**
0.240 ppm	**1.52a**	**2.24a**	**2.86a**	**3.88a**	**4.46a**	**5.20a**
2.400 ppm	**1.54a**	**2.14a**	**2.74a**	**3.78a**	**4.58a**	**5.20a**
24.000 ppm	**0.88ab**	**1.04b**	**1.90b**	**2.58b**	**3.32b**	**4.08b**

Means marked with the same letter are not significantly different (*P=0.05*)

Table 2. Inhibition by mancozeb of mycelial growth of *Fusarium* sp. after seven days of incubation

Treatment	Inhibition rate of mycelia growth (%)
0,024 ppm	**6.50a**
0,240 ppm	**6.14a**
2,400 ppm	**6.40a**
24,000 ppm	**26.35b**
240,000 ppm	**90.97c**

Means marked with the same letter are not significantly different (*P=0.05*)

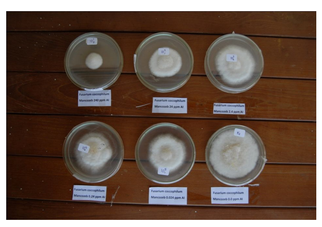

Fig. 2. Fusarium colonies after 7 days of incubation

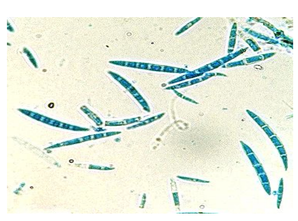

Fig. 3. Conidia of *Fusarium* sp

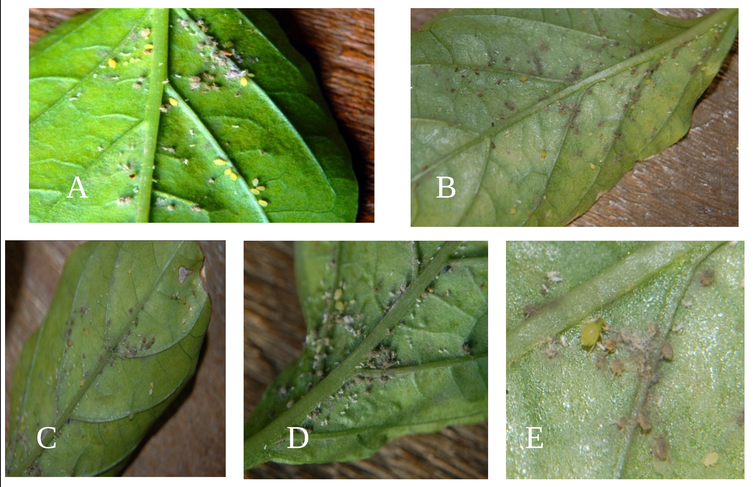

Fig. 4. Fusarium mycosis on *A. gossypii*: a week (A), two weeks (B), and 3 weeks © after Fusarium application. Diseased aphid (E).

DISCUSSION

Entomopathogen *Fusarium* sp. is highly virulent against *A. gossypii*, refelected by its relatively low LC_{50} and LT_{50} values obtained in this current study, 1.6 x 10^4 conidia per ml and 3.8 days, respectively. This agrees with the results of the survey conducted in pepper growers field in 2007 showing low aphid density; and many naturally infected cadavers were found on the lower surface of the leaves.

Three days after conidia suspension was spray to pepper plants, a few aphids were already killed by the fungus. About 33%of the aphid population was killed seven days after treatment, this number increased for the successive observations. The increase of the percent of the killed aphids paralleled to the increase of aphid density in the control plants. Therefore, the more aphids were available, the higher the percent of mycosis was.

Fungicide mancozeb, commonly used fungicide to control fungal diseases on pepper, detrimentally affected the entomopathogen's mycelia growth in vitro. This is probably one of the reasons why during 2009 planting season, mycosis incidence in the field was very low. During that time the rain fall was unusually high and the rainy season was also unusually long, so the growers protected their crops from fungal infections by applying more fungicide.

CONCLUSION

Because it is relatively highly virulent against *A. gossypii*, *Fusarium* sp. is potential to be used as biocontrol agent against the aphid. However, fungicide use to control fungal diseases on pepper can also affect to the entomopathogen. Therefore, further studies should be conducted to explore the development of a biopesticide with *Fusarium* sp. as its active ingredient.

REFERENCES

Abbott, W. S. 1925. A method of computing the effectiveness of an insecticide. J. Econ. Entomol. 18: 265-267.

Finney, D. J. 1971. Probit Analysis, third Ed. Cambridge University Press, Cambridge. 333 pp.

Lagnoui, Abdelaziz and E. B. Radcliffe. 1998. Potato fungicides interfere with entomopathiogenic fungi impacting population dynamics of green peach aphid. Amer. Pot. Res. 75: 19-25.

Soedarto, E. 1985. Biologi Aphis **gossypii Glov** (Homoptera : Aphididae) Asal Tanaman Cabai pada Tanaman Cabai, Terung, Tomat, dan Tembakau. Thesis Master, Fakultas Pertanian, Institut Pertanian Bogor.