BAFOG-1(S): FOGGING FORMULATION OF *Bacillus thuringiensis* FOR CONTROLLING BAGWORM

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MPOB INFORMATION SERIES • ISSN 1511-7871 • JUNE 2009 MPOB TT No. 421

Bacillus thuringiensis (Bt) is a gram-positive bacterium that upon sporulation produces protein crystal toxic to insects in Lepidoptera, Diptera, Coleoptera and other orders. The insecticidal protein of Bt which is target-specific are produced aerobically during the lag phase of its growth cycle (NPTN, 2004). The proteins are easily harvested and formulated. The δ-endotoxins when ingested by susceptible insect larvae were activated by gut proteases (Ghribi *et al.*, 2006) which causes osmotic lyses and death of larvae. Several Cry proteins or δ-endotoxins have receptor proteins in gut lining of the bagworm, *Metisa plana* (Siti Ramlah, 2000; Siti Ramlah *et al.*, 2003; 2005; 2007).

Bafog-1(S) is the local *B. thuringiensis* isolate, MPOB BT1 formulated solution for controlling bagworm via fogging. The name Bafog-1(S) was derived from *Bacillus sp.* for fogging in solution form (S). Bafog-1(S) is specially formulated for bottom-up application in peat and soggy areas where the use of tractor-mounted turbomist is not possible.

Bafog-1(S) is produced by vacuum evaporating of fermented liquid culture at 33ºC to produce concentrated culture and further process by mixing with inert ingredients. The product is mainly used for fogging application using a fogging machine (*Figure 1*).

OBJECTIVES

Members of the industry are invited to manufacture Bafog-1(S) with the following objectives:

- to produce Bafog-1(S), from MPOB Bt1, a formulation that can be used for immediate control of bagworm outbreaks via fogging.
- to reduce reliance on chemical pesticides for bagworms control.

Figure 1. Fogging machine, model Z-FOG for Bafog-1(S) application.

PROCESS DESCRIPTION

Mass propagation of MPOB Bt1 using laboratory prepared Agro-Nat 7 medium was conducted at MPOB Microbial Technology & Engineering Centre (MICROTEC), Bangi. The fermented Bt was concentrated using a vacuum evaporator (*Figure 2*) at 33ºC and -820 to -850 mbar. The concentrated culture was further concentrated by sendimentation technique. Inert ingredients were added into the concentrated culture.

Figure 2. MPOB pilot plant vacuum evaporator.

ISSN 1511-7871
9 771511 787001

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LABORATORY BIOASSAY

Bafog-1(S) was mixed (*Figure 3*) and fogged (*Figure 4*) for laboratory bioassay against early larval instar of the bagworm, *Pteroma pendula*. Treatments used are indicated in *Table 1*.

Figure 3. Bafog-1(S) solution was mixed and poured into 7 litres solution tank.

Figure 4. Fogging of Bafog-1(S) for laboratory bioassay.

TABLE 1. DIFFERENT TREATMENTS USED FOR LABORATORY ASSAY

Samples tested	Treatments preparation
Bafog-1(S) mixed with diesel	At ratio 1:1 (v/v)
Bafog-1(S) mixed with diesel	At ratio 1:3 (v/v)
Powdered Bafog mixed with diesel	5 g of Bafog mixed well in 1 litre diesel
Commercial Bt	5 g of commercial Bt mixed well in 1 litre diesel
Untreated (diesel only)	1 litre diesel

Bafog-1(S) at dose of C5, 2.36 x 1012 cfu ml^{-1}, in the ratio of Bafog-1(S): diesel;1:1 (v/v) resulted in 78.6% corrected mortality of *P. pendula* at seven days after treatment (DAT) (*Figure 5*). Eventually, the highest corrected mortality of 100% of *P. pendula* was recorded at 13 DAT.

FIELD EFFICACY

Bafog-1(S) was tested at an estate in Hutan Melintang in August 2008 and February 2009 (*Figure 6*). The total area covered was 8 ha. A fogging machine was used at four blocks of 2 ha each. Liquid Bafog-1(S) was mixed with diesel at 1:1 ratio and poured into the solution tank of the fogger machine. Bafog-1(S) was applied at a rate of 1.6 x 1012 cfu ml^{-1}.

Bafog-1(S) led to significant reduction of *Pteroma pendula* larval population (average of Block 1 and 2) from 451.4 larvae per frond (LPF) at 0 DAT to 40.4 LPF at 30 DAT, implying that Bafog-1(S) was effective for controlling the bagworm via fogging (*Figure 7*).

ECONOMIC ANALYSIS

The fixed cost for MICROTEC building, equipments and raw materials is RM 10 million. The payback period is seven years with an internal rate of return (IRR) of 16%. The net present value (NPV) at 10% discount rate is RM 4.73 million, with a benefit cost ratio (B:C) of 1.38.

BENEFITS

Bafog-1(S) is environmental-friendly, easily mixed with diesel for convenient delivery to palm canopy for the control of bagworms. Bafog-1(S) activity persists sufficiently long (one week) on the foliage for good bagworm control. The cost is less than using chemicals.

CONCLUSION

Bafog-1(S) is recommended for use to reduce the reliance on chemicals. It can be added with diesel and applied using fogging machine to effectively control large bagworm outbreaks in oil palm plantations.

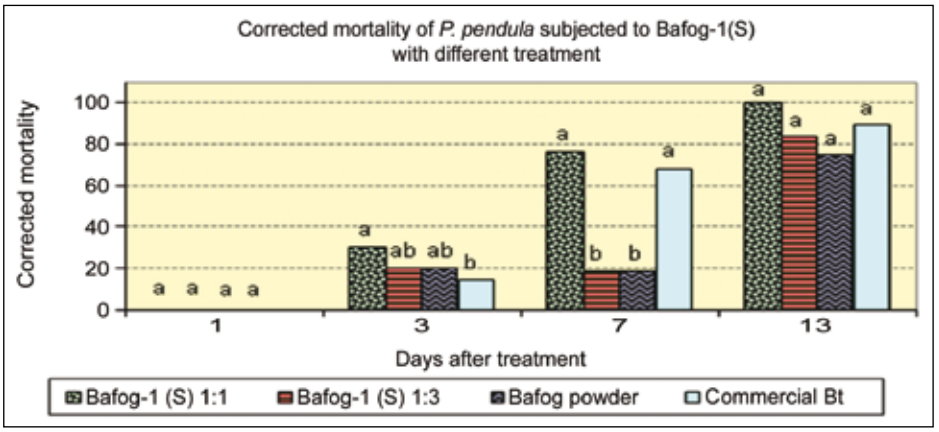

Figure 5. Corrected mortality of Pteroma pendula *treated with different rates of Bafog-1(S).*

Note: Treatments were Bafog-1 (S):diesel; 1:1, Bafog-1 (S):diesel; 1:3 and Bafog powder 12.5 g litre^{-1} diesel, commercial Bt and untreated control. Bafog-1(S) 1:1 = C5 = 2.36 x 10^{12} cfu ml^{-1}, Bafog-1 (S) 1:3 = C5 = 1.2x10^{11} cfu ml^{-1} and Bafog powder = C5 = 3.36 x 10^{12} cfu g^{-1}. Bars in a group with the same letters are not significantly different (P>0.05) in one-way ANOVA using LSD analysis. Corrected mortality = $\left(\frac{\%\text{Treatment} - \%\text{Control}}{100 - \%\text{Control}} \right) \text{x}100\%$

Figure 6. The fogging of Bafog-1(S) carried out at FELCRA Sg Manila, Hutan Melintang (a) and distribution of Bafog-1(S)/Bt fog on the palm canopy (b).

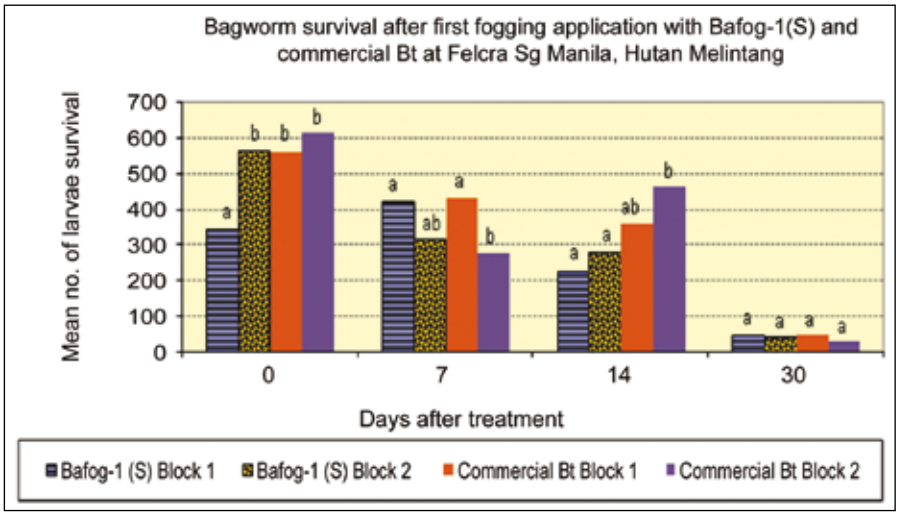

Figure 7. Bagworm survival after first fogging application using Bafog-1(S) and commercial Bt at FELCRA Sg. Manila.

Note: Bars in the same groups with same letters are not significantly different at (P>0.05) in one-way ANOVA using LSD analysis.

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