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NOTES

THE EFFECTIVENESS OF TWO COMMERCIAL FORMULATIONS AND SN-2 STRAIN OF *BACILLUS THURINGIENSIS* AGAINST THE TEAK SKELETONISER, *PALIGA DAMASTESALIS*

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For several decades, products containing *Bacillus thuringiensis* Berliner (Bt) have been used in agriculture as they are commonly considered to be environmentally friendly. This opinion is primarily based on studies showing that Bt compounds used as foliar insecticides have little or no effect on beneficial insects (Flexner *et al.* 1986). For this reason as well, the use of Bt to control insect pests in forestry is expected to increase in the coming years. In most studies carried out on forest insect pests, evaluations in tropical forest plantations were often based on the use of commercial Bt products that were originally developed for agricultural pests (see Zanuncio *et al.* 1996, Tantichodok & Nanta 1998). Although these products may be effective in controlling some of the forest insect pests, it is also proper to remember that Bt strains are rather specific (Singleton & Sainsbury 1987). Hence using the right strain to control these forest pests is important.

In an attempt to find suitable control measures for controlling the teak skeletoniser, *Paliga damastesalis* (Lepidoptera: Pyraloidea: Crambidae), during serious outbreaks, Intachat *et al.* (2000) in their screening tests carried out on four Bt strains identified the strain SN-2 to be the most effective. SN-2 strain is a radiation-resistant mutant strain of a re-isolated strain from a commercial preparation (Bacillex, Shionogi, Japan) (Jangi & Ibrahim 1983). Subsequent to the previous finding, we now compare the effectiveness of this SN-2 strain and two Bt formulations widely available in Malaysia. The two commercial Bt formulations were the powder (Delfin, Sandoz, Switzerland) and aqueous (Foray 48B, Novo Nordisk, Denmark) formulations of Bt subspecies *krustaki* serotype 3a, 3b.

A total of 125 third instar teak skeletoniser larvae were tested for each of the five treatments, which also included two control treatments: distilled water and nutrient broth. Nutrient broth was included as one of the controls to ensure that any effect which arose from the treatment was not due to the nutrient broth which was used as the 'vehicle' for the Bt culture. The detailed protocols for this experiment and the data analysis carried out were as those described in Intachat *et al.* (2000).

Table 1 shows that the mean percentage mortality for SN-2 was approximately twice that for both Bt formulations at all time points. The mean percentage mortality values for both Bt formulations are approximately equal at all time points and are each larger than both control treatments.

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As in the previous study, stepwise logistical regression was also made to determine the relative importance of the crossed factors, exposure time, treatment and the nested factor of replicate. Only factors that significantly reduced the residual deviance (at the 5% level) were included in the model. Table 2 shows that treatment and time are the two most important factors but their interaction term is not significant. This means that over time, all the treatments increase mortality in a consistent manner. The insignificant dish factor shows that the experiment is repeatable.

Table 1. Cumulative mortality (%) for each treatment after 24, 48 and 72 h exposures. The fitted value for each treatment/time combination is shown in parenthesis.

Treatment code	Treatment	Time		
		24 h	48 h	72 h
T1	Control 1 (distilled water)	0 (0.0)	2.4 (2.4)	9.6 (9.2)
T2	Control 2 (nutrient broth)	1.6 (0.1)	4.0 (3.9)	13.6 (14.6)
T3	Bt powder	2.4 (1.8)	8.8 (10.1)	32.8 (32.1)
T4	Bt aqueous	1.6 (2.0)	12.0 (11.0)	33.6 (34.2)
T5	SN-2	4.0 (4.7)	23.2 (23.0)	56.0 (55.6)

Table 2. Analysis of deviance

Model	Deviance explained	df	Deviance difference	df difference	p value
Null	0	0			
Time	217.3	2	217.3	2	<0.001
Time + treatment	344.4	6	127.1	4	<0.001
Time + treatment + dish (nested in treatment)	393.8	150	49.4	144	>0.05
Time * treatment	347.5	14	3.1	8	>0.05

Combining the two control treatments gave no significant difference between the two whilst there was also no significant difference between the two Bt products. Further simplification of the model, however, produced a significantly worse model (Table 3). This together with the results in Table 1 shows that SN-2 produced significantly greater mortality to the teak skeletoniser larvae than the two Bt products which in turn had greater mortality than the control treatments.

The increased effectiveness, sustained over time, and quicker response of SN-2 over current Bt formulations make this an attractive approach to controlling the teak skeletoniser. However, before such a treatment can be recommended for commercial purposes, an evaluation on the performance of this strain in the field against this teak pest and other non-target lepidopterans must be established.

Table 3. Analysis of deviance to investigate differences among treatments

Model	Deviance explained	df	Deviance difference	df difference	p value
Time + treatment	344.4	6			
Time + treatment with (T1,T2) combined	342.1	5	2.3	1	>0.05
Time + treatment with (T1,T2) combined and (T3,T4) combined	339.5	4	2.6	1	>0.05
Time + treatment with (T1,T2,T3,T4) combined	295.2	3	44.3	2	<0.001
Time + treatment with (T1,T2,T5) combined and (T3,T4) combined	219.9	3	122.2	2	<0.001
Time + treatment with (T1,T2) combined and (T3, T4,T5) combined	312.7	3	26.8	2	<0.001

See Table 1 for treatment codes.

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