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Control of leaf-miners and other leaf-feeders infesting angsana and pongamia trees of Malaysia via trunk injection

(Mengawal ulat pelombong daun dan ulat lain yang makan daun pokok angsana dan mempari di Malaysia melalui suntikan batang)

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Key words: trunk injection, leaf-miners, leaf-feeders, angsana, pongamia

Abstrak

Tiga ujian telah dijalankan untuk menentukan insektisid, dos dan teknik suntikan batang pokok yang paling berkesan untuk mengawal serangga perosak pokok hiasan teduhan angsana dan mempari. Monokrotofos, metamidofos dan asifat didapati berkesan sebagai insektisid suntikan batang untuk mengawal pelombong daun angsana, 'psyllid' dan kumbang *Buprestid* pada mempari masing-masing pada dos 6 mL (3.30 g a.i.), 6 mL (2.90 g a.i.) dan 6 g (4.50 g a.i.) sepokok. Tiada perbezaan yang ketara antara monokrotofos dos 3 mL (1.65 g a.i.), 6 mL (3.30 g a.i.) dan 9 mL (4.95 g a.i.) bagi sepokok dalam mengurangkan serangan perosak ini terhadap kedua-dua pokok angsana dan mempari. Suntikan batang di satu lubang dan tiga lubang pada 30 cm di bawah silara pertama serta suntikan di tiga lubang pada 30 cm dari permukaan tanah didapati lebih berkesan daripada teknik suntikan lain dalam mengurangkan serangan kumbang Buprestid. Bagi kawalan 'psyllid' pula, tiada perbezaan yang ketara antara keenam-enam teknik suntikan yang diuji. Kadar kerja yang diperoleh dengan teknik suntikan tiga lubang ialah 320 pokok sehari tenaga.

Abstract

Three experiments were conducted to determine the most effective insecticides, dosage and technique of injecting the insecticides into the tree trunk for the control of insect pests on angsana and pongamia ornamental shade trees. Monocrotophos, methamidophos and acephate were effective as trunk injection insecticides in controlling the leaf-miners on angsana, psyllid and Buprestid beetles on pongamia at doses of 6 mL (3.30 g a.i.), 6 mL (2.90 g a.i.) and 6 g (4.50 g a.i.) per tree respectively. No significant difference was recorded between three dosages of monocrotophos, i.e. 3 mL (1.65 g a.i.), 6 mL (3.30 g a.i.) and 9 mL (4.95 g a.i.) per tree, in reducing insect pest infestations on both angsana and pongamia trees. The one-point and three-point injection at 30 cm below the first crown as well as the three-point injection at 30 cm above the ground were more effective than the other trunk injection techniques in reducing Buprestid beetle infestations. For psyllid control, there was no significant difference between the six injection techniques tested. The work rate obtained with the three-point injection technique was 320 trees/man-day.

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Introduction

Of late, Malaysia witnessed a tremendous boost in the beautification and landscaping programs, especially in the cities, new highways, numerous golf courses and the Kuala Lumpur International Airport at Sepang. One of the major activities of these beautification and landscaping programs is the planting of ornamental shade trees along the roadsides, road dividers and little pockets of empty spaces. Among the commonly used tree species, angsana *(Pterocarpus indicus)* and pongamia *(Pongamia pinata)* are very prone to insect pest attacks. The most common insect pest on angsana is the leaf-miner (*Phyllonorycter pentadesma* Meyrick), whereas psyllid (*Epipsylla albolineata/venusta* complex) and Buprestid leaf scarers (*Trachys* spp.) commonly infest pongamia. These pests can cause severe aesthetic damage to the trees, premature yellowing and defoliation of the infested leaves, thus rendering the trees to lose their aesthetic value and 'shade-provider' function. Insecticide spraying or fogging is not feasible during the daytime or even up to midnight hours because of the possible discomfort and hazards to the public due to spray droplet contamination, especially in very busy business areas. As these trees are widely planted, trunk injection of insecticides may be the most appropriate method of pest control because the insecticide applied to the trees is not in direct contact with the public and the other non-target organisms.

Trunk injection is an old technique of applying pesticide into plants or trees (Ripper 1955). A review by Khoo et al. (1983) showed that in Malaysia, trunk injection is being used mainly against insect pests attacking coconut (Ooi et al. 1975, 1979) and oil palms (Wood et al. 1974; Singh 1976; Badsun and Prathapan 1978; Prathapan and Badsun 1979; Ng and Chong 1982). Recently, the technique was used successfully to control *Phytophthora* black pod of cocoa (Tey and Lee 1994) and *Phytophthora* patch canker of durian (Lee 1994). However, there is no record of the technique being used on ornamental shade trees, although Khoo et al. (1983) suggested that the technique could also be useful for other tree crops.

Materials and methods

To determine the most effective insecticides, dosage and technique of injecting the insecticides into the tree trunk for the control of insect pests on angsana and pongamia ornamental shade trees, three experiments were conducted in Serdang. The first experiment compared the effectiveness of monocrotophos (Azodrin® 55% a.i. WSC), methamidophos (Tamaron Special® 48.4% a.i. WSC), acephate (Orthene® 75% a.i. SP) and dimethoate (Rogor® 38.4% a.i. EC) as trunk injection insecticides. Each insecticide was applied at 6 mL (monocrotophos 3.30 g a.i., methamidophos 2.90 g a.i. and dimethoate 2.30 g a.i.) or 6 g (acephate 4.5 g a.i.) per tree via the three trunk injection points at midway between the first crown and the ground *(Plate 1)* using three 20 mL Chem-Jet syringes. Each insecticide, either 6 mL or 6 g, was mixed with 54 mL of distilled water to make 60

Plate 1. Three-point injection technique at the main trunk midway between the soil line and the first crown (the third syringe is at the back portion of the trunk). Each syringe contains 20 mL of diluted monocrotophos

mL of insecticide solution. Each solution, 20 mL, was then drawn into three syringes. Using a Bosch cordless drill with 0.8 cm diameter drill bit, a hole of 2.5 cm deep was made at three points of equidistant along the circumference of the tree trunk. The syringe containing 20 mL of the insecticide solution was screwed into the hole. Then, the locked plunger was released, thus slowly pressuring the insecticide solution into the tree trunk. It took 30 min to completely pressure the insecticide solution into the tree trunk. The syringe was then removed and the hole was plugged with plastercine. Each insecticide treatment was replicated on five pongamia trees just after flushing, i.e. when the new leaves are about 1 week old. Fifty leaves were randomly sampled from each tree where the number of psyllids was counted at 1 day before treatment (DBT) and 3 days after treatment (DAT). Another 50 leaves were sampled at 1 DBT, and 1, 4, 8 and 12 weeks after treatment (WAT) for the assessment of the percentage of leaves with at least 10% of the surface area damaged by *Buprestid* beetles' feeding activities.

The second experiment determined the effects of three dosages of monocrotophos in reducing the damage of *P. pentadesma* on angsana, and psyllid and *Buprestid* beetle infestations on pongamia trees. Monocrotophos dosages of 3 mL (1.65% a.i.), 6 mL (3.30% a.i.) and 9 mL (4.95% a.i.) per tree were applied via three injection points at midway between the first crown and the ground in the same manner as in the first experiment. Each treatment was replicated on five angsana and five pongamia trees. Psyllid counts were made only on pongamia where 50 leaves/tree were randomly taken at 1 DBT, and 1, 3 and 28 DAT. For the assessment of damage due to either leaf-miners (angsana) or Buprestid beetles (pongamia), another 50 leaves/tree were randomly sampled at 1 DBT and 1, 12 and 24 WAT from both angsana and pongamia trees.

The third experiment determined the effects of six trunk injection techniques using monocrotophos in reducing the psyllid infestations and the percentage of *Buprestid* beetle damaged leaves on pongamia trees. The treatments were: 3-point and 1-point injection at 30 cm below the first crown, 3-point and 1-point injection at 30 cm above the first crown, and 3-point and 1-point injection at 30 cm above the ground. Monocrotophos at 6 mL (3.30 g a.i.) per tree diluted with distilled water to make up 60 mL (3-point injection) or 20 mL (1-point injection) solution was injected into the pongamia trees according to each of the above treatments. Psyllid counts were made on 50 leaves/tree randomly sampled at 1 DBT and 3 DAT. Feeding damage assessments were made on another 50 leaves/tree randomly sampled at 1 DBT, and 1, 4 and 12 WAT.

Results

Comparison of the four insecticides *(Table 1)* showed that monocrotophos and methamidophos were most effective as they reduced the psyllid population completely just within 3 DAT. Acephate was found to be less effective than monocrotophos or methamidophos but dimethoate was not at all effective compared with the untreated control. Against the Buprestid beetles, monocrotophos, methamidophos and acephate were found to be equally effective for up to 4 WAT. However at 8 WAT, monocrotophos gave significantly better control than methamidophos or acephate. These results indicate that the control of psyllid and Buprestid beetle infestations remains effective for up to 8 WAT with monocrotophos, methamidophos or acephate.

In the second experiment, the use of monocrotophos at three dosages on angsana recorded no significant difference in reducing the percentage of new leaves with at least 10% leaf-miner feeding damage for up to 12 WAT *(Table 2)*. Similar results were obtained on pongamia with regard to reduction in the percentage of new leaves with at least 10% *Buprestid* beetle feeding

Table 1. Effectiveness of four insecticides in reducing the number of psyllids and feeding damage of *Buprestid* beetles on pongamia trees

Insecticide	No. psyllids/50 leaves		% leaves with >10% *Buprestid* beetle feeding damage				
	1 DBT	3 DAT	1 DBT	1 WAT	4 WAT	8 WAT	12 WAT
Monocrotophos	66.2a	0a (100)	6.2a	0a	4.0a	6.7a	44.0a
Methamidophos	57.0a	0a (100)	5.3a	4.0a	9.3a	37.3b	61.3a
Acephate	73.8a	13.4ab (79.8)	4.8a	6.0a	11.2a	26.7b	53.3a
Dimethoate	68.2a	36.0bc (41.2)	6.9a	14.7b	18.7ab	62.3c	61.7a
Untreated (control)	68.7a	61.6c	7.2a	18.7b	22.0b	63.7c	65.5a

Mean values with different letters are significantly different (p <0.05) according to DMRT
Values in brackets are percentage reduction of psyllid using Abbott's formula
DBT = days before treatment DAT = days after treatment WAT = weeks after treatment

Table 2. Effects of three dosages of monocrotophos applied via trunk injection technique on leaf-miner infestations on angsana trees

Dosage (mL/tree)	% of new leaves with at least 10% feeding damage			
	1 DBT	1 WAT	12 WAT	24 WAT
3 (1.65 g a.i.)	53.8a	16.8a	3.8a	16.4a
6 (3.30 g a.i.)	42.8a	16.2a	2.2a	17.0a
9 (4.95 g a.i.)	57.8a	13.6a	1.8a	15.8a
Untreated (control)	49.6a	84.8b	81.6b	17.6a

Mean values with different letters are significantly different (p <0.05) according to DMRT

Table 3. Effects of three dosages of monocrotophos applied via trunk injection technique on psyllid and *Buprestid* beetle infestations on pongamia trees

Dosage (mL/tree)	No. of psyllids/50 leaves				% new leaves with at least 10% *Buprestid* beetle feeding damage			
	1 DBT	1 DAT	3 DAT	28 DAT	1 DBT	1 WAT	12 WAT	24 WAT
3 (1.65 g a.i.)	157.8a	17.6a	0.6a	0a	48.2a	32.4a	8.4a	12.0a
6 (3.30 g a.i.)	159.8a	18.6a	0a	0a	42.4a	28.4a	9.8a	11.2a
9 (4.95 g a.i.)	165.6a	12.8a	0a	0a	42.4a	33.0a	11.8a	10.6a
Untreated (control)	185.8a	201.2b	191.6b	4.2a	46.2a	63.6b	82.2b	11.6a

Mean values with different letters are significantly different (p <0.05) according to DMRT

damage *(Table 3)*. However, these dosages gave 100% kill of psyllids in just 3 DAT *(Table 3)*.

Results of the third experiment showed no significant difference between the six techniques of trunk injecting monocrotophos in their effectiveness of reducing the psyllid infestations on pongamia *(Table 4)*. However, against the *Buprestid* beetle infestations, the three-point injection at 30 cm below the first crown and 30 cm above the ground as well as the one-point injection at 30 cm below the first crown techniques gave superior results than the others *(Table 4)*. The results also indicated that effective control only lasted for about one month in contrast with the results of the first experiment *(Table 1)* where the treatment remained effective for up to 3 months.

Discussion

In the 1970s, several insecticides were used for trunk injection mainly for the control of bagworms and nettle caterpillars on oil

Table 4. Effects of six techniques of trunk injecting monocrotophos in reducing psyllids and *Buprestid* beetle infestations on pongamia trees

Treatment technique	No. of psyllids/ 50 leaves		% leaves with at least 10% *Buprestid* beetle feeding damage			
	1 DBT	3 DAT	1 DBT	1 WAT	4 WAT	12 WAT
3-point injection						
At 30 cm below the first crown	49.7a	0a (100)	0.7a	4.0a	22.0a	48.0a
At 30 cm above the first crown	56.3a	2.7a (95.6)	0a	12.0abc	34.7bc	64.0a
At 30 cm above the ground	43.3a	0a (100)	2.0a	8.7ab	23.7a	42.7a
1-point injection						
At 30 cm below the first crown	66.7a	1.7a (97.7)	1.3a	6.7a	26.7ab	51.3a
At 30 cm above the first crown	56.7a	2.7a (95.6)	0.7a	16.0bcd	42.0cd	60.7a
At 30 cm above the ground	59.0a	9.3a (85.6)	1.3a	18.7cd	49.3d	67.3a
Untreated (control)	59.3a	65.0b	1.3a	24.0d	50.7d	66.0a

Mean values with different letters are significantly different (p <0.05) according to DMRT
Values in brackets indicate percentage reduction of psyllid using Abbott's formula

palms and coconut leaf moth on coconut palms. These insecticides included monocrotophos, dichrotophos, acephate, phorate (Wood et al. 1974) and methamidophos (Prathapan and Badsun 1979). Although there was no significant difference in the percentage of dead caterpillars, Wood et al. (1974) singled out monocrotophos as the most promising of all for the control of bagworms and faster acting (Prathapan and Badsun 1979) than methamidophos. The result of present study *(Table 1)* concurs with those earlier findings and in addition it showed that persistency of monocrotophos is longer than that of methamidophos or acephate.

With regard to the dosages used in trunk injection, Wood et al. (1974) tested dosages of 2, 4, 6, 8 and 12 g a.i./palm (24 years old) and found that better kill was obtained at higher dosages. However, they were not clear which dosage was optimal. Prathapan and Badsun (1979) obtained similar findings when they used dosages of 1.5 and 3.0 g a.i. for monocrotophos, and 3.3 and 5.0 g a.i. for methamidophos. The finding of present study *(Table 2* and *Table 3)* also proved that there was no significant difference between treatments with monocrotophos at 3 mL (1.65% a.i.), 6 mL (3.30% a.i.) and 9 mL (4.95% a.i.) per tree. However, both Singh (1976) and Khoo et al. (1983) recommended 6 g a.i./tree as the minimum dosage for oil palms. Present study suggests a minimum monocrotophos dosage of 3 mL (1.65% a.i.) per tree for angsana and pongamia trees with trunk diameter not exceeding 80 cm.

The technique of trunk injection can differ in terms of number and height of injection holes or points. For oil palms (Wood et al. 1974) and coconut palms (Stelzer 1970), the two-point injection provided no better results than the one-point injection of equal insecticide dosage per tree. Similarly, differences in the height of injection point (30 cm versus 90 cm from the base of the palm) resulted in no significant difference (Prathapan and Badsun 1979). In contrast, this study with pongamia trees showed that the three-point injection at 30 cm below the first crown or above the ground and one-point injection at 30 cm below the first crown gave significantly better control of Buprestid beetle infestations than other techniques *(Table 4).* It also showed that the effective control period was 4–12 WAT *(Table 2* and *Table 4).* This is comparable with past results on oil palms and coconut palms which range from 72 DAT (Rai 1973) to 170 DAT (Prathapan and Badsun 1979). In this study, the diameter and depth of the injection holes were also reduced to 0.8 cm and 2.5 cm respectively compared with 1.3–1.9 cm in diameter and 10–15 cm deep (Khoo et al. 1983) practised previously on oil palms. This is very important because the smaller and shallower hole causes less injury to the trees. Thus plant nursery owners would be more willing to use trunk injection technique for the control of pests and diseases on ornamental shade or orchard trees.

The trunk injection technique apparently is very effective and safe with several advantages over the commonly used foliar spray technique. However, trunk injection is slow and less effective in most large-scale outbreak situations where large number of trees have to be treated quickly. The highest work rate achieved thus far was 360–500 oil palms/man-day (PNP-Marihat Research Station 1976) which was equivalent to 2.5–3.5 ha/man-day. In this study with angsana or pongamia trees using the three-point injection at 30 cm below the first crown technique, it takes only 0.5 min to drill the hole, 1 min to screw in the syringe and another 30 min to completely pressure the insecticide from the syringe into the tree trunk. This translates to a work rate of about 320 trees/man-day without recycling the used syringes. If only a limited number of syringes are available, then the work rate will be greatly reduced because a waiting time of at least 0.5 h is needed before those used syringes can be reused.

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