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Effect of Plant Extracts, Bio-insecticides, Petroleum Oil and Insecticides for Controlling Rose beetle (*Adoretus compressus*, Coleoptera: Scarabaeidae: Rutelinae) in Immature Oil Palm

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Absract The adult of rose beetles feed on the leaves of oil palm (*Elaeis guineensis* jacq.) that cause to be decreasing of growth rate. The outbreak of these beetles is usually found in new planting area. It is necessary for farmers to use insecticides for controlling. The effect of pesticides to control rose beetle in 2-year-old oil palm plantation was conducted in Thungsong district, Nakhon Si Thammarat province, Thailand from July, 2015 to January, 2016. Result showed that the effectiveness of treatment after the last spraying was carbaryl 85% WP followed by carbosulfan 20 % EC, petroleum oil 83.9% EC, bactospeine FC, tobacco 3% , Thai neem extract (azadirachtin 0.05%), which were 85.93 80.71 79.97 63.86 60.00 and 56.37 %, respectively, compared with non-treated control. The integrated pest management (IPM) program to control rose beetle was resulted after treated with M1 (tobacco 3%), M2(petroleum oil 83.9% EC 40 ml/20 L.of water), M3 (carbaryl 85% WP 60 g./ 20 L.of water, M4 (tobacco 3% (3%)+ carbosulfan 5 % G 200 g./ tree), M5 (petroleum oil 83.9% EC 40 ml/ 20 L. of water+carbosulfan 5 % G 200 g./ tree), M6 (carbaryl 85% WP 60 g./ 20 L. of water+carbosulfan 5 % G 200 g./ tree), M7 (carbosulfan 5 % G 200 g./ tree and M8 (non-treated control). The highest effectiveness methods were M6 (100 %), followed by M3, M7, M4, M5, M2 and M1 which were affected to control as at 86.62 74.98 73.86 70.59 66.54 and 62.82 %, respectively, which compared to M8.

Keywords: carbaryl, carbosulfan, azadirachtin, bactospeine, petroleum oil

Introduction

The rose beetle (RB), *Adoretus compressus*, (Coleoptera: Scarabaeidae: Rutelinae) is the economically important pest of young oil palm (*Elaeis guineensis* jacq.) plantation. The adult of rose beetles feed on the leaves that cause decreasing of growth rate. It is necessary for farmers to use insecticides to control. The distribution area of rose beetle has been found in South Africa, India, Sri Lanka, Myanmar, Malaysia, Thailand, Indonesia, Philippines and Papua New Guinea. Host plants often show characteristic lace-like leaf damage (Muniappan, 2012). The beetles severely damage the

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economically important plants such as some ornamental plants, shrubs, garden plants and field crops; including lychee (*Litchi chinensis*), rambutan (*Nephelium lappaceum*), rice (*Oryza* spp.), corn (*Zea mays*), oil palm (*Elaeis guineensis*), banana (*Musa* spp.), rose (*Rosa* spp.), grape (*Vitis* spp.), okra (*Abelmoschus esculentus*), cotton (*Gossypium* spp.), sweet potato (*Ipomoea batatas*), coffee (*Coffea* spp.), cocoa (*Theobroma cacao*), and tea (*Camellia sinensis*) (McQuate and Jameson, 2011). The adults feed on leaves only at night and hide under the ground in the day-time. Eggs are laid in soil, often around plant roots. The larvae feed also on roots, rotten wood decaying organic matter and roots of forage plants, pastures and on other crops, with five larval instars is likely erroneous (Pena *et al.,* 2002). After pupation in the soil, the adult emerge, the adult body; head, pronotum and elytra was reddish-brown, rather densely clothed with short scale-like whitish-gray setae above, body elongate oval and the body length was 0.50–1.0 cm **(**Oil Palm Research Center, 2016).

Oil palm is the one important widely grown crops in Southeast Asia. The planted areas in Thailand has been constantly increasing, with an average annual growth rate of 11% from 1981 to 2000, 9% from 2001 to 2010 and with the average annual growth rate of 9.7% between 1998 and 2008. Oil palm can be used as raw material in the process of palm oil production as a form of safe edible vegetable oil used for many food and non-food products (DOA, 2011). The rose beetles is the important pest of young oil palm plantation. Their severely feeding can lead to defoliation and even death of young tree. Many control methods for RBs have been investigated, the using of light traps such as black light or ordinary fluorescent light by placed (~ 5-10 cm.) over a plastic basin , which contained water mixed with a detergent, between 6:00 -7:00 pm., can reduce RB adults population or the use the insecticide such as carbaryI (Sevin 85% WP) 40 gm. per 20 liters of water, sprayed every 7 to 10 days when the leaf is destroyed more than 25 percent in the evening at the leaves and the base of trunk can reduce the infestation (Agriculture office, 2016). In the study, six commercially available pest management products with the active ingredients of nicotin, azadirachtin, *Bacillus thuringiensis*, petroleum oil, carbosulfan and carbaryl were evaluated for their effectiveness of reducing feeding damage from adult beetles in a young oil palm stage. The appropriate management to prevent rose beetles aimed to find appropriate method is conducted to find out the available carefully, reduce pests, avoid harmful to human, natural enemies, environment and less interfere with the agricultural ecosystem.

Materials and methods

Effectiveness of pesticides to control rose beetle in oil palm plantation

1) The study was conducted on 2-year oil palm plantation in Thungsong district, Nakhon Si Thammarat, Thailand. Randomly sampled from 35 oil palm trees which the regular size and integrity. The experimental design was using Randomized Complete Block Design (RCBD) with 5 replications (1 tree per replicate) and 7 treatments (T) as follows:-T1: tobacco (3%) 600 g./ 20 L. of water, T2: Thai neem extract (aza. 0.5%) 40 ml./ 20 L.of water, T3: bactospeine 5% WP 80 g/ 20 L. of water, T4: petroleum oil 83.9% EC 40 ml./ 20 L.of water, T5: carbosulfan 20 % EC 40 ml./ 20 L. of water, T6: carbaryl 85% WP 60 g./ 20 L. of water and T7: non-treated control.

2) When the young leaves were damaged, the chewing irregular shaped as small holes in the leaves, more than 25%, then the insecticides had been treated. The damage level of leaf considered as the assesment percentage of leaf damage base on visually as follows:-

Assesment level of leaf damage percentage
Fully chewing irregular shaped small holes in the leaves =100 %
3 out of 4 chewing irregular shaped, small holes in the leaves = 75 %
1 out of 2 chewing irregular shaped, small holes in the leaves = 50%
1 out of 4 chewing irregular shaped, small holes in the leaves = 25 %
No damaged = 0

3) Sprayed once a week for 3 times, recorded the percentage of leaf damage before the first spraying and 7 days after the spraying, mean comparisons of the leaf damage before and after spraying.

4) Analysis of variance (ANOVA) and means were compared by using the Duncan's Multiple Range Test (DMRT). The efficacies of insecticides at the last spraying compared with the non-treated control were calculated.

Effectiveness treatment (%)= $\frac{C_2 T_1 - C_1 T_2}{C_2 T_1} \times 100$ (adapted from Handerson and Tilton, 1995)

C_1 and C_2 : Percentage of leaf damage before and after spraying in non-treated control
T_1 and T_2 : Percentage of leaf damage before and after spraying in each treatment

Effectiveness of integrated pest management (IPM) for controlling rose beetle in oil palm plantation

1) The experiment was conducted on 2-year oil palm plantation in Thungsong district, Nakhon Si Thammarat, Thailand. The 40 oil palm trees were randomly selected for experiment. The experimental design was using RCBD with 5 replications (1 tree per replicate) and 8 method (M) as follows:- M1: tobacco (3%) 600 g./ 20 L. of water, M2: petroleum oil 83.9% EC 40 ml/ 20 L.of water, M3: carbaryl 85% WP 60 g./ 20 L. of water, M4: tobacco (3%) 600 g./ 20 L. of water + carbosulfan 5 % G 200 g. / tree, M5: petroleum oil 83.9% EC 40 ml/ 20 L.of water+ carbosulfan 5 % G 200 g./ tree, M6: carbaryl 85% WP 60 g./ 20 L. of water+ carbosulfan 5 % G 200 g. / tree, M7: carbosulfan 5 % G 200 g. / tree and M8: non-treated control.

2) Insecticides were treated when the young leaves damaged more than 25%. Leaf damage assesment percentage based on visually was considered as as Experiment 1.

3) Insecticide was sprayed in each treatment once a week for 3 times. The percentage of leaf damage before the first spraying and 7 days after spraying were recorded. Means were compared between the leaf damage before and after spraying.

4) Analysis of variance (ANOVA) and means were compared by using DMRT. The efficacies of insecticides at the last spraying was compared with the non-treated control.

Effectiveness method (%)= $\frac{C_2 T_1 - C_1 T_2}{C_2 T_1}$ X 100 (adapted from Handerson and Tilton, 1995)

C_1 and C_2 : Percentage of leaf damage before and after spraying in non-treated control

T_1 and T_2 : Percentage of leaf damage before and after spraying in each method

Results

Effectiveness of pesticides to control rose beetle in oil palm plantation

The assesment of leaf damage before and after treated, the result revealed that the percentage of leaf damage before insecticides application were not significantly different ($p>0.05$) from the non-treated control, the average damage of all treatment were 37.51-62.81%. After the first spraying, the average of the leaf damage was found that the control (non-treated) was

the highest damage percentage with 50 %, followed by tobacco , neem extracts, bactospeine(Bt) , petroleum oil were 45.31, 43.57, 40.62 and 35.31%, respectively, not significantly different from the control(non-treated). For carbosulfan 20 % EC and carbaryl 85% WP, the average of the leaf damage were 32.38 and 20.31 %, respectively, significantly different from non-treated control (Table 1).

After the second spraying, the average of the leaf damage was found that the non-treated control had the highest damage percentage with 36.70 %, followed by tobacco , neem extracts, bactospeine, petroleum oil, carbosulfan and carbaryl were 28.43, 27.30, 21.98, 8.55, 8.23 and 6.25 %, respectively, significantly different from the non-treated control (Table 1).

After the third spraying, the average of the leaf damage of non-treated control was the highest damage percentage at 34.36 %, followed by tobacco and neem extracts were 15.68 and 13.25 %, respectively, not significantly different from control (non-treated) and bactospeine, petroleum oil, carbosulfan and carbaryl were 11.06, 7.31, 5.50 and 2.62%, respectively, significantly different from non-treated control (Table 1).

Table 1. Average percentage (%) of leaf damage and the effectiveness methods (%) before and after spraying Plant Extracts, Bio-insecticides , Petroleum Oil and Insecticides for Controlling Rose beetle in oil palm plantation compared with non treated control on farmer‘s orchard from during July 2015 to August 2015

Treatment	Percentage of leaf damage from rose beetle(%) [1/]				effectiveness after last spraying [3/]
	before spraying	after spraying [2/]			
		1	2	3	(%)
T1: tobacco (3%) 600 g./ 20 L. of water	62.81	45.31^{ab}	28.43^{b}	15.68^{ab}	60.00
T2: Thai neem extract (aza. 0.5%) 40 ml/ 20 L.of water	55.00	43.75^{ab}	27.30^{b}	13.25^{ab}	56.37
T3: bactospeine) 5% WP 80 g/ 20 L. of water	53.46	40.62^{ab}	21.98^{b}	11.06^{bc}	63.86
T4: petroleum oil 83.9% EC 40 ml/ 20 L.of water	37.53	35.31^{ab}	8.55^{c}	7.31^{cd}	79.97
T5: carbosulfan 20 % EC 40 ml/ 20 L. of water	37.51	32.81^{bc}	8.23^{c}	5.50^{cd}	80.71
T6: carbaryl 85% WP 60 g./ 20 L. of water	39.06	20.31^{c}	6.25^{c}	2.62^{d}	85.93
T7: non treated control	38.46	50.00^{a}	36.70^{a}	34.36^{a}	-
F-test	ns	**	**	**	
C.V.(%)	37.90	23.35	33.95	35.77	

[1/] average from 5 replications, ns non-significantly (p>0.05) ** significantly different (P<0.01)

[2/] number in the column with same letters not significantly different (p>0.05)

[3/] Effectiveness of methods(%) = $\frac{C_2 T_1 - C_1 T_2}{C_2 T_1}$ X100 (adapted from Handerson and Tilton, 1995)

C_1 and C_2 : Percentage of leaf damage before and after spraying in non treated control

T_1 and T_2 : Percentage of leaf damage before and after spraying in each methods

The effectiveness treatment after the last spraying were carbaryl, carbosulfan, petroleum oil, bactospeine, tobacco and neem extracts were 80.71 79.97 63.86 60.00 and 56.37 %, respectively , compared with non-treated control (Table 1).

Effectiveness of integrated pest management (IPM) for controlling rose beetle in oil palm plantation

The seven methods were used for controlling rose beetle with 3 times spraying. Before sprayed, the result showed that all treatments were not significantly different ($p>0.05$) from the non-treated control, the average damage of all treatment were 27.50-40.00 %. After the first spraying, the average of the leaf damage was found that the non-treated control was the highest damage percentage with 40 %, followed by carbaryl 85% WP 60 g./ 20 L. of water+ carbosulfan 5 % G 200 g./ tree, average damage was 35%, not significantly different ($p>0.05$) from the non-treated control, followed by tobacco (3%)600 g, carbosulfan 20 % EC 40 ml, petroleum oil 83.9% EC 40 ml, carbaryl 85% WP 60 g , carbaryl 85% WP 60 g + carbosulfan 5 % G 200 g, tobacco (3%) 600 g + carbosulfan 5 % G 200 g had an average damage percentage of 29.50, 28.75, 27.50, 26.25, 25.00 and 23.75 %, respectively, significantly difference from non-treated control (Table 2).

After the second spraying, the average of the leaf damage was found that the non-treated control had the highest damage percentage with 37.50 %, followed by tobacco (3%) 600 g , petroleum oil 83.9% EC 40 ml+ carbosulfan 5 % G 200 g , petroleum oil 83.9% EC 40 ml, carbosulfan 5 % G 200 g, tobacco (3%) 600 g. + carbosulfan 5 % G 200 g and carbaryl 85% WP 60 g./ 20 L. of water+ carbosulfan 5 % G 200 g were 25.00 23.75 21.25 20.00 17.50 8.75 and 6.25 % , significantly difference from non-treated control (Table 2).

After the third spraying, the average of the leaf damage was found that the non-treated control had the highest damage percentage with 32.27 %, followed by tobacco (3%)600 g , petroleum oil 83.9% EC 40 ml , petroleum oil 83.9% EC 40 ml+ carbosulfan 5 % G 200 g , carbosulfan 5 % G 200 g, tobacco (3%)600 g. + carbosulfan 5 % G 200 g , carbaryl 85% WP 60 g and carbaryl 85% WP 60 g./ 20 L. of water+ carbosulfan 5 % G 200 g were12.50, 11.25, 11.25, 8.75, 8.70, 4.32 and 0.00 % , significantly difference from non-treated control (Table 2).

The effectiveness of integrated pest management (IPM) method after the last spraying, the highest effectively were carbaryl 85% WP 60 g./ 20 L. of water+ carbosulfan 5 % G 200 g,with 100 % ,followed by carbaryl 85% WP 60 g, carbosulfan 5 % G 200 g, petroleum oil 83.9% EC 40 ml+ carbosulfan 5 % G 200 g, tobacco (3%)600 g. + carbosulfan 5 % G 200 g, petroleum oil 83.9% EC 40 ml and tobacco (3%)600 g were 86.62 74.98

73.86 70.59 66.54 and 62.82 %, respectively , compared with non-treated control (Table 2).

Table 2. Average percentage (%) of leaf damage before and after spraying plant extracts, bio-insecticides , petroleum oil and insecticides and the effectiveness of integrated pest management (IPM) for controlling rose beetle (%) in oil palm plantation compared with non treated control on farmer's orchard during 1-30 January 2015

Treatment	Percentage of leaf damage from rose beetle(%) [1/]				effectiveness after the last spraying [3/] (%)
	before spraying	after spraying [2/] 1	2	3	
M1: tobacco 3% 600 g./ 20 L. of water	31.25	29.50^{bc}	25.00^{b}	12.50^{b}	62.82
M2: petroleum oil 83.9% EC 40 ml/ 20 L.of water	31.25	27.50^{bc}	21.25^{b}	11.25^{b}	66.54
M3: carbaryl 85% WP 60 g./ 20 L. of water	30.00	26.25^{bc}	8.75^{cd}	4.32^{c}	86.62
M4: tobacco (3%) 600 g./ 20 L. of water + carbosulfan 5 % G 200 g/ tree	27.50	23.75^{c}	17.50^{cb}	8.70^{b}	70.59
M5: petroleum oil 83.9% EC 40 ml/ 20 L.of water+ carbosulfan 5 % G 200 g/tree	40.00	35.00^{ab}	23.75^{b}	11.25^{b}	73.86
M6: carbaryl 85% WP 60 g./ 20 L. of water+ carbosulfan 5 % G 200 g/ tree	38.75	25.00^{c}	6.25^{d}	0.00^{d}	100.00
M7: carbosulfan 5 % G 200 g/ tree	32.50	28.75^{bc}	20.00^{b}	8.75^{b}	74.98
M8: non treated control	36.25	40.00^{a}	37.50^{a}	32.27^{a}	-
F-test	ns	*	**	**	
C.V.(%)	21.55	19.74	30.49	32.27	

[1/] average from 5 replications
[ns] non-significantly (p>0.05) * significantly different)P<0.05) ** significantly different)P<0.01)
[2/] number in the column with same letters not significantly different (p>0.05)
[3/] Effectiveness of methods (%) = $\frac{C_2 T_1 - C_1 T_2}{C_2 T_1}$ X100 (adapted from Handerson and Tilton, 1995)
C_1 and C_2 : Percentage of leaf damage before and after spraying in non treated control
T_1 and T_2 : Percentage of leaf damage before and after spraying in each methods

Discussion

The effect of pesticides for controlling rose beetle in young oil palm plantation was conducted, the method that used synthetic insecticidal spraying was the highest effectiveness treament such as carbaryl 85% WP or carbosulfan 20 % EC with the rapidly control and decreased the

infestation from insect. We can use when there have been severe damage and carbosulfan 5 % G, the granul formula is a systemic insecticide and can be applied by soil application. It was safer for honey bee and the natural enemies than the spraying formula, but for a long time, the groups of synthetics insecticides, usually have been found the happening of insect resistance, the insecticidal contaminated in fruit production and ecosystem. The used of many synthetics insecticides also side effect to the predatory and parasitoid insects in farmers'orchard. The reserch finding was similar to the worked of Sahaya (2017) which recommned carbaryl 85% WP controlling rose beetle in soybean and mungbean when the leaves were damaged 50 %. Sintusatepalmoil (2017) recommned carbaryl 85% WP and carbosulfan 20 % EC in young oil palm. While Spafford *et al*. (2016) reported that the foliar application of imidacloprid, azadirachtin, pyrethrin and *Beuveria basi*ana were the most effectiveness at protecting leaves on young cocoa plant.

The group of oil and plant extracts that integrated with synthetics insecticides are decreased chemical application, effectively control, safe for farmer, natural enemies, environment and agricultural ecosystem. Plant extracts and bio-insecticides are recommended to apply. The application time should be applied in the evening (Agriculture office, 2016) , otherwise there were not stable, break down in the environment, and it is not considered persistent and easily decomposed when exposed to sunlight (DOA, 2016). The activity is often deteriorates of high leaching conditions. Therefore, an appropriate timing of spraying in order to achieve maximum efficiency would be considered. The alternative way, the farmers could be decreased synthetic insecticides with the used of oil and plant extracts, which are safer for users and environment.

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