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EVALUATION OF SOME CONTROL METHODS AGAINST THE JACKFRUIT TRUNK BORER, *BATOCERA RUFOMACULATA* DE GEER (CERAMBYCIDAE: COLEOPTERA)

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Abstract: The study was conducted on effectiveness of different management practices of the trunk borer infestation in farmers' jackfruit orchards at Kapasia upazila under Gazipur district of Bangladesh during 2009-2010. Among the ten treatments, the T_5 (placing aluminium phosphide + sealed hole with bordeaux paste) ensured the highest (83.33 %) control of infestation and the highest increase in yield (51.30%) over the control. The cost: benefit of T_6 (placing aluminium phosphide into the hole + sealing the hole with cow dung) (1:10.21) was higher than T_5 (1: 7.75) but in terms of infestation control and total yield T_5 was higher than T_6.

Key words: Jackfruit, trunk borer, management.

NTRODUCTION

Jackfruit (*Artocarpus heterophyllus* Lam.) is one of the most popular and important fruits in Bangladesh. It is a multipurpose tree crop with great importance to the farmers for fruit, timber, fodder and also fuel. It is often called poor man's fruit and has been given the status of the National fruit of Bangladesh. Jackfruit trees are attacked by thirty five species of insect pests, among which the jackfruit trunk borer, *Batocera rufomaculata* De Geer is one the most destructive pests. (Alam 1974, Maniruzzaman 1981, Butani 1979, Hill 1983, Singh 1969, Beeson 1941, Haq 2006, Azad 2000, Soepadmo 1992, Rasel 2004). This pest, being an internal feeder, is difficult to control. The desired level of control is seldom achieved by insecticides due to unpredictable translocation of insecticides within trees (Poland *et al.* 2006) and asynchronous larval development, both of which allow insects to evade treatment. Pruning of affected stem/branches and fumigation on main stem was recommended for controlling the pest (Chatterjee *et al.* 1969, Singh and Prasad 1985, Singh and Singh 1987).

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Removal and destruction of affected branches, killing the grubs with a stiff wire or closing hole with mud are some measures suggested for the control of the pest (Nayar *et al.* 1989). But in Bangladesh no effective management practice against the trunk borer has so far been developed or recommended. Keeping this in view, the present study was undertaken and designed to evaluate the effectiveness of some non-chemical and chemical control methods and identify the best method in terms of effectiveness and economic analysis for the management of the jackfruit trunk borer.

MATERIAL AND METHODS

The field experiment was conducted at farmer's jackfruit orchard in Kapasia Upazila under Gazipur district of Bangladesh during 2009-2010. The experiment was laid in Randomized Block Design (RBD), with six replications and ten treatments. One jackfruit tree was considered as one replication of a treatment. Around 20 to 30 -year old infested trees were used. The treatments were: T_1= injection of petrol into the hole by using syringe + sealing of the hole with Bordeaux paste; T_2= injection of petrol into the hole + sealing of the hole with cow dung; T_3= injection of kerosene into the hole + sealing of the hole with bordeaux paste; T_4= injection of kerosene into the hole + sealing of the hole with cow dung; T_5= placing aluminium phosphide into the hole + sealing of the hole with Bordeaux paste; T_6= placing aluminium phosphide into the hole + sealing the hole with cow dung; T_7= injection of dursban 20 EC @ 2ml/ litre water into the hole; T_8= injection of cypermethrin (Ripcord 10 EC) @ 1ml/ liter water into the hole; T_9= inspection of orchard at 15 days interval + cutting open the tunnel with help of chisel and sharp haft knife + hooking the hole by sharp iron rod; and T_{10}= untreated control. Each treatment was applied twice in a year. The following observations were made: external features of the holes, the frass on the ground, the fresh bleeding sap around the holes and the number of fresh holes. The hole was counted at 2m height of each trunk from the soil level. The performance of each treatment was explained in terms of healing hole and recovery of the damage of infested trees, increase of yield over control and the Benefit-Cost Ratio (BCR). The efficacy of different treatments were grouped into four classes (I, II, III and IV) to represent the state of larval activity, with corresponding values (v) of 3, 2, 1 and 0 to calculate the degree of control (Sheng-ying *et al.,* 2009).

Grading standard of efficacy of different treatments (Sheng-ying *et al.,* 2009):

External features of the defecator holes	Class	Value	Larval activity
No new holes and old holes had healed, trees which recover damage gradually	I	3	The larvae had died
No new holes, no saw dust on the ground, no fresh bleeding sap and frass	II	2	The larvae were in a comatose state
No new holes, no saw dust on the ground but little bit bleeding sap, fresh frass	III	1	The larvae became weak and caused light damage
New holes, fresh bleeding sap, fresh frass, saw dust on the ground	IV	0	The larvae were active and caused serious damage

Calculation was done by using the following formula:

$$\text{Degree of control (\%)} = \frac{v}{3} \times 100.$$

$$\text{Reduction of infestation over control} = \frac{\text{Mean value of the control} - \text{Mean value of the treatment}}{\text{Mean value of the control}} \times 100$$

$$\text{Benefit-Cost Ratio (BCR)} = \frac{\text{Net return}}{\text{Total management cost}}$$

The data were analyzed through MSTAT-C software in single factor Randomized Complete Block Design (RCBD), and Duncan's Multiple Range Test (DMRT) was used to separate means.

RESULTS AND DISCUSSION

Efficacy of different management practices on healing hole: Table 1 shows the efficacy of different management treatments on trunk borer infestation. The number of healed hole per tree significantly ($P<0.01$) varied with the highest healed hole per tree (4.33) recorded in T_5. The poorest performance shown by failure to healing hole/tree was in T_2 (3.50). T_5 ensured the larval death showing 100 % healing of oozing hole. A similar result has been reported using aluminum phosphide into the hole followed by putting stuff into the hole with wet mud that rendered 100 % control of infestation (CABI 2007, Yang 2005).

Percent degree of control of different management practices on trunk borer infestation: The state of larvae changed constantly from the active state (IV) to death (I) under different treatments. Table 2 shows clearly the degree of control (M) of different treatments based on analysis of variance and DMRT comparisons. The statistically highest ($p < 0.01$) degree of control (M) was 83.33 % in T_5 followed by T_6 ,T_8 , T_9 , T_2 & T_7 , T_1 & T_3 , T_4 and T_{10} . The test results revealed that aluminium phosphide had significant ($p < 0.01$) effect in controlling the trunk borer larvae in jackfruit trees.

Therefore, it may be concluded that aluminium phosphide can be applied as a suitable chemical to achieve a better control of the trunk borer larvae compared to other treatments in jackfruit trees.

Table 1. Effect of different treatments against the trunk borer infestation on jackfruit trees

Treatment	Mean healed hole/tree	Mean unhealed hole/Tree	Mean oozing hole /tree
T_1	1.83 cd	2.50 bc	1.00 ab
T_2	1.83 cd	3.50 ab	1.17 a
T_3	1.33 de	3.17 bc	0.83 ab
T_4	1.33 de	2.67 bc	0.83 ab
T_5	4.33 a	0.33 e	0.00 c
T_6	3.33 abc	0.83 de	0.33 bc
T_7	2.33 bcd	1.66 cde	0.33 bc
T_8	2.83 abcd	2.17 bcd	0.50 abc
T_9	3.66 ab	0.67 de	0.33 bc
T_{10}	0.00 e	4.83 a	1.17 a
P<(ANOVA)	P<0.01	P<0.01	P<0.01
LSD (0.01)	1.525	1.514	0.6979

Note: Means followed by common letter(s) in a column are not significantly different at 1% level by DMRT. Values are the averages of six replications.

Table 2. Grading of control effect of different treatments against the jackfruit trunk borer

Treatment	Treated trees with control effects						Degree % of control (M)
	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	
T_1	IV (0)	II (2)	IV (0)	III (1)	IV (0)	III (1)	22.22 bc (3.283)
T_2	III (1)	IV (0)	II (2)	III (1)	III (1)	IV (0)	27.78 bc (4.245)
T_3	III (1)	III (1)	III (1)	IV (0)	III (1)	IV (0)	22.22 bc (3.847)
T_4	III (1)	IV (0)	IV (0)	III (1)	III (1)	IV (0)	16.67 bc (2.885)
T_5	I (3)	I (3)	III (1)	II (2)	I (3)	I (3)	83.33 a (8.988)
T_6	III (1)	I (3)	I (3)	II (2)	I (3)	II (2)	77.78 a (8.682)
T_7	IV (0)	III (1)	II (2)	III (1)	IV (0)	III (1)	27.78 bc (4.245)
T_8	III (1)	II (2)	II (2)	II (2)	III (1)	II (2)	55.56 ab (7.363)
T_9	II (2)	III (1)	III (1)	II (2)	IV (0)	I (3)	50.00 ab (6.310)
T_{10}	IV (0)	IV (0)	IV (0)	IV (0)	IV (0)	IV (0)	0.0 c (0.00)
Prob. (p)	-	-	-	-	-	-	P<0.01
LSD (0.01)	-	-	-	-	-	-	38.39

Note: Means followed by common letter(s) in a column are not significantly different at 1% level by DMRT. Values are the averages of six replications. Figures in parentheses indicate data based on square root transformation.

Similar studies were made on *Apriona germari* (Hope) by Sheng-ying *et al.* (2009), Liu *et al.* (1996) and Wang *et al.* (2004) who reached a conclusion that it was a slow process from the time of treatment applied to the death of the larvae. The treated larvae can change from the intermediate state II and III to their death or resume their activity and continue to do serious damage. Two scenarios to explain these findings are conceivable: either, the large volume of the tunnel leads to a low concentration of the hypertoxic phosphine, which means that the larvae do not die in a short period, but at the end all of the holes of the treated larval tunnels became blocked with Bordeaux paste or cow dung and the poisonous environment caused the death of the treated larvae. Aluminium

Table 3. Effect of treatments on yield of jackfruit during 2009-2010

Treatment	Before treatment (Previous year's yield) Fruit /Tree	After treatment (Current year's yield) Fruit /Tree	% yield increase/ decrease over previous year (%)	Percent yield increase over control (%)
T_1	9.00	10.67 ab	18.55	42.17
T_2	7.16	8.66 abc	20.95	28.75
T_3	6.50	7.50 bc	15.38	17.73
T_4	7.17	8.16 bc	13.81	24.39
T_5	9.50	12.67 a	33.36	51.30
T_6	8.16	10.50 ab	28.68	41.24
T_7	7.50	9.50 abc	26.67	35.05
T_8	7.83	9.50 abc	21.33	35.05
T_9	7.33	9.66 abc	31.79	36.13
T_{10}	8.50	6.17 c	-27.41	-
P<(ANOVA)	Ns	P<0.01		
LSD (0.01)	-	3.809		

Note: Means followed by common letter(s) in a column are not significantly different at 1% level by DMRT. Values are the averages of six replications.

Table 4. Economics of different treatments on jackfruit trunk borer management (2009-2010)

Treatment	Mean yield (Fruits/ha)	Increased yield over control (Fruits/ha)	*Value of increased yield (Tk/ha)	Cost of treatment (Tk/ha)	Net benefit due to treatment (Tk/ha)	Cost : Benefit
T_1	1504	635	31750	5610	26140	1 : 4.66
T_2	1221	352	17600	3100	14500	1 : 4.68
T_3	1058	189	9450	5040	4410	1 : 0.88
T_4	1151	282	14100	2530	11570	1 : 4.57
T_5	1786	917	45850	5240	40610	1 : 7.75
T_6	1481	612	30600	2730	27870	1 : 10.21
T_7	1340	471	23550	3270	20280	1 : 6.20
T_8	1339	470	23500	3325	20175	1 : 6.07
T_9	1362	493	24650	4250	20400	1 : 4.80
T_{10}	869	-	-	-	-	-

*Average sale price of jackfruit in the wholesale market was Tk 50 per fruit.

phosphide provides a convenient and economically feasible method to control trunk borer larvae. In order to protect trees and reduce losses, physical and cultural control methods should be carried out before the emergence of larvae (Dickmann *et al.* 2001).

Effect of different management practices on the yield of jackfruit: Different management practices caused significant (P<0.01) increase in yield (fruits/tree) of jackfruit over the untreated control and over the previous year (Table 3). The highest yield was recorded in T_5 .

Economic analysis of different management practices applied against the trunk borer infestation: Economic analysis of different management practices applied against trunk borer infestation on jackfruit trees is presented in Table 4. The highest cost: benefit ratio (1: 10.21) was obtained in T_6 and the lowest (1: 0.88) in T_3. According to economic analysis, the order of the best management practices is: $T_6 > T_5 > T_7 > T_8 > T_9 > T_2 > T_1 > T_4 > T_3$.

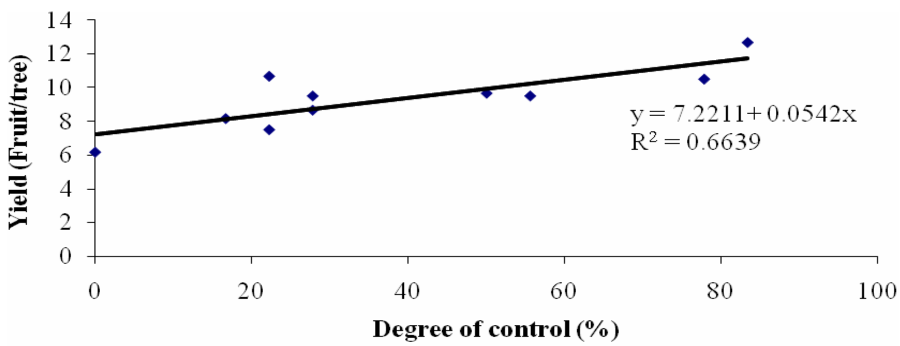

Fig. 1. Relationship between degree of control and yield

Relationship between degree of control (%) and yield: The relationship between the percent degree of control and increase in yield is presented in Fig. 1. A linear regression was fitted which indicated a positive linear trend between percent degree of control and increased yield. The regression equation was y = a + bX, where y = yield, a = 7.2211, b = 0.0542 and X = degree of control. The contribution of the regression (R^2 = 0.6639) was 66 %.

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