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Using Insect Monitoring and Economic Threshold as Decision Tools in Sweet Corn Pest Management

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ABSTRACT

Farmers must use insecticides when growing sweet corn to protect their crops from damage by insect pests. However, such practice has caused many serious consequences. One of the long term solutions is to implement insect monitoring for decision making and to apply insecticide only when the pest population reaches a certain threshold. The reduced application of insecticide will help to conserve predators and parasitoids. This research focused on the implementation of insect monitoring and the economic threshold in sweet corn pest management. The experiment was conducted at the National Corn and Sorghum Research Center (Suwan Farm), Pakchong, Nakhon Ratchasima province, Thailand during November 2010–February 2011 by comparing two treatments. The first treatment involved partial weed control with emphasis on maintaining some of the weed population to serve as the nectar source and habitat for the natural enemies of insect pests together with regular field monitoring to obtain information for decision making and applying insecticide only when the pest population reached the specified economic threshold. The second treatment was complete weed control and calendar spraying of insecticide. The results showed that plots with the first treatment produced an average benefit of USD 4,205 ha^{-1}while that of the second treatment was USD 3,845 ha^{-1}. Although the numbers of key pests and the level of crop damage from both treatments were significantly different, the levels were lower than the economic threshold. However, the numbers of natural enemies from the first treatment were much higher than those from the second treatment. The three major groups of natural enemies observed were Arachnids, Chelisochidae and Anthocoridae (*Orius* sp.). Therefore, regular field surveys before making a decision to apply insecticide should be promoted among sweet corn growers to reduce the amount of chemical applied which should achieve a reduction in the production costs and the hazards to farmers, consumers and the environment.

Keywords: sweet corn, insect pest management

INTRODUCTION

In Thailand, over 76 species of insect pests have been reported to attack corn (Areekul *et al*., 1966). However, only 8–9 species were considered as major pests (Kongkanjana and Choonhawong, 1997b). The important key pests of corn are: corn earworm (*Helicoverpa armigera* Hübner), corn stem borer (*Ostrinia furnacalis* Guenee), corn thrip (*Frankliniella williamsi* Hood) and corn aphid (*Rhopalosiphum maidis* Fitch). Corn thrip is considered an important pest at the seedling stage during the dry season (Nawanich *et al*., 2010). During the whorl stage, corn stem borer

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is an important pest with an economic threshold (ET) of 20% leaf damage (Kongkanjana and Choonhawong, 1992). For corn aphid, decision making for applying insecticide was recommended when 5–10% damage occurred at the pre-tasselling stage (Kongkanjana and Choonhawong, 1997a), while the economic threshold for corn earworm was 0.5–1 caterpillars per ear (Kongkanjana and Choonhawong, 1997b).The objective of this research was to test the implementation of insect monitoring and an economic threshold in a sweet corn pest management program to avoid unnecessary applications of insecticide.

MATERIALS AND METHODS

The experiment was conducted at the National Corn and Sorghum Research Center (Suwan Farm), Pakchong, Nakhon Ratchasima province, Thailand, during November 2010–February 2011. A randomized complete block design with two treatments and four replications was employed using the "Insee 2" sweet corn variety. Each individual plot consisted of 12 corn rows 22 m long (with an area of 198 m^2) and plant spacing of 0.75 × 0.25 m. Agronomic practices commonly implemented for sweet corn production including pre-emergence herbicide application were performed for the whole experiment except for the post-emergence herbicide and insect pest control which varied between treatments. Two treatments were tested. The first treatment involved partial weed control by applying herbicide on every other row of corn at 36 d after emergence (DAE) with emphasis on maintaining some weed population to serve as a nectar source and habitat for natural enemies of corn pests and also on regular field monitoring to obtain information for decision making and applying insecticide only when the pest population reached the specified economic threshold. In the case of thrip which has no available economic threshold, a seed treatment with imidacloprid at the rate of 5.0 $g.kg^{-1}$ seed was applied to avoid thrip damage. The second treatment involved complete weed control by applying herbicide to the whole plot at 36 DAE and calendar spraying of insecticides i.e. imidacloprid at the rate of 20 mL per 20 L was sprayed at 7 and 14 DAE; fipronil at the rate of 15 mL per 20 Lwas sprayed at 20 and 27 DAE to control corn stem borer; imidacloprid at the rate of 20 mL per 20 L was sprayed at 49 DAE to control sucking insect pests; and chlorfluazuron at the rate of 25 mL per 20 L was sprayed at 62 DAE to control corn earworm. Visual counts of insect pests and their natural enemies from 10 plants per plot were conducted before the pesticide application using systematic sampling for 11 sampling dates (7, 14, 20, 27, 35, 42, 49, 55, 62, 68 and 76 DAE). The numbers of each species were recorded. Yields were harvested at 83 DAE. Data were analyzed using a *t*-test and paired comparisons. The cost-benefit ratio and the Shannon-Wiener diversity index (Burikam, 2005) were also compared between the two treatments.

RESULTS AND DISCUSSION

Normally, the harvesting date of sweet corn variety Insee 2 is 68 DAE. However, due to cool weather, the harvest was delayed to 83 DAE in this study. Plots with the first treatment produced an average yield of 20,700 $kg.ha^{-1}$ while that of the second treatment was at 19,462 $kg.ha^{-1}$ ($P > 0.05$). The yield data are shown in Table 1.

The numbers of thrip, aphid, corn earworm and the percentage of plants damaged by corn stem borer in both treatments are shown in Table 2. The results indicated that plots in the first treatment where seed was treated with insecticide before planting had significantly lower numbers of thrip and aphid than plots in the second treatment that received insecticide sprays at 7 and 14 DAE. However, the number of thrip at 55 DAE in the second treatment was lower than that of the first treatment. In general, seed treatment with imidacloprid was effective against thrip up to about 30 DAE.

Table 1 Mean sweet corn yield for variety "Insee 2" at Suwan Farm during November 2010–February 2011.

Treatment	Yield of fresh ears (kg.ha^{-1})			
	Total	Total(de-husked)	Under grade size	Number of damaged ears
1	20,700	13,331	100	331
2	19,462	12,862	231	281
t–test	ns	ns	ns	ns
CV (%)	0.49	0.20	72.89	86.25

Treatment 1 = Partial weed control and economic threshold-based pest management program.
Treatment 2 = Complete weed control and calendar spray program.
ns = Non significant; CV = Coefficient of variation.

Table 2 Mean numbers of major insect pests (thrip, aphid and corn earworm) and percentage of corn plants damaged by corn stem borer on sweet corn variety "Insee 2" at Suwan Farm during November 2010–February 2011.

Treatment	Mean numbers of major insect pests per 10 plants								% Damage by CSB
	Thrip						Aphid	CEW	
	7 DAE	14 DAE	20 DAE	27 DAE	55 DAE	62 DAE	7 DAE	62 DAE	27 DAE
1	14.25	3.00	2.50	0.25	30.50	162.00	5.50	0.75	8.14
2	34.50	7.00	3.00	0.50	1.25	153.00	11.25	0.50	4.55
t–test	**	*	ns	ns	*	ns	*	ns	*
CV (%)	1.81	15.05	38.98	46.95	44.38	9.46	8.36	106.97	10.66

Treatment 1 = Partial weed control and economic threshold-based pest management program.
Treatment 2 = Complete weed control and calendar spray program.
ns = Non significance; CV = Coefficient of variation; * = Significant difference at the 0.05% level; ** = Significant difference at the 0.01% level.
DAE = Days after emergence; CEW = Corn earworm; CSB = Corn stem borer.

At the pre-tasselling stage, the first treatment had aphid damage below the specified threshold. Moreover, leaf damage by corn stem borer was only 8.14% which was also lower than the economic threshold while the damage due to corn earworm in both treatments was quite low. Hence, it was not necessary to apply insecticide in the first treatment.

The results from the economic analysis are shown in Table 3 and reveal that the first treatment had an average production cost of USD 1,315, an average yield of 20,700 kg.ha^{-1} and produced an average benefit of 4,205 USD ha^{-1} while the production cost of the second treatment was USD 1,346, the average yield was 19,462 kg.ha^{-1}and the average benefit was USD 3,845. Hence, the cost/ benefit ratio of each treatment was 1:3.19 and 1:2.85, respectively.

Analysis of the ecological information (Table 4) revealed that the species richness of arthropods from both treatments was relatively the same (27 and 26, respectively). However, the first treatment had a greater overall abundance (1,409 individuals) compared to the second treatment (1,230 individuals). In addition, on 7 out of the 11 sampling dates, the numbers of arthropod species

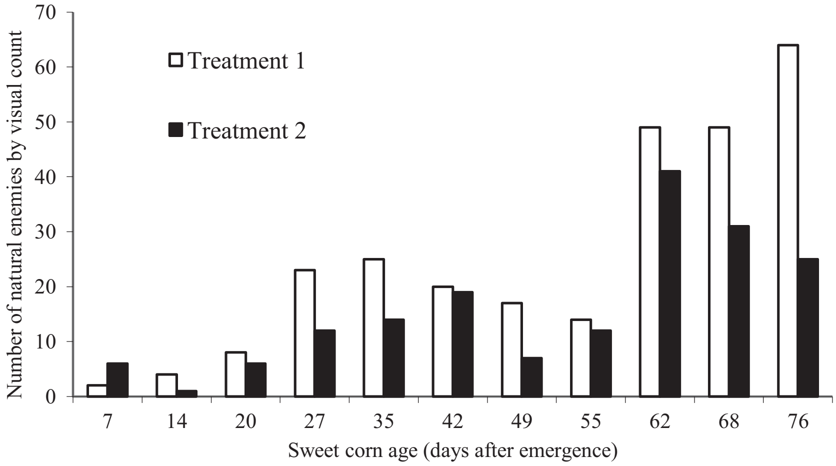

Figure 1 Total numbers of natural enemies by visual count in sweet corn fields with two different treatments (Treatment 1 = Partial weed control and economic threshold-based pest management program. Treatment 2 = Complete weed control and calendar spray program.)

Table 3 Economic analysis of sweet corn production.

Item	Treatment 1 (USD)	Treatment 2 (USD)
Common cost		
Soil tillage	375	375
Furrowing and row preparation	177	177
Seed cost (Insee 2, 9 kg.ha^{-1})	156	156
Basal dressing fertilizer15:15:15 of N:P:K at 156 kg. ha^{-1}	88	88
Top dressing fertilizer46 -0 - 0, at 156 kg. ha^{-1}	97	97
Pre emergence weed control	73	73
Labor cost for applying fertilizer	94	94
Total common cost	1,060	1,060
Treatment cost		
Seed treatment (fungicide & insecticide)	15	0.7
Insecticide cost (6 applications)	0	37
Herbicide cost(1 application)	10	19
Labor cost for insect scouting	168	0
Labor cost for applying herbicide & insecticide	62	229
Total treatment cost	255	285.7
Total cost	1,315	1,346
Income	5,520	5,191
Benefit	4,205	3,845
Cost/ benefit ratio	1:3.19	1:2.85

Table 4 Diversity and abundance of insects and other arthropods on sweet corn, variety “Insee 2” at Suwan Farm during November 2010–February 2011.

Treatment	Observation date (DAE)	Visual count				Pit fall trap			
		Richness[1]	Abundance[2]	Accumulative richness	Diversity indices (H')[3]	Richness[1]	Abundance[2]	Accumulative richness	Diversity indices (H')[3]
1	7	4	83	4	0.7895	7	25	7	1.7562
	14	8	38	8	1.7314	7	38	10	1.0890
	20	11	43	13	2.1494	10	51	14	1.6557
	27	12	45	18	2.0785	4	19	14	1.0156
	35	13	51	23	2.0860	-	-	-	-
	42	14	47	24	1.9627	5	31	15	1.1315
	49	12	41	24	2.1356	5	21	16	1.1677
	55	9	149	25	0.7910	4	9	16	1.2730
	62	15	748	26	0.6762	6	27	17	1.4859
	68	12	76	27	1.8526	6	29	17	1.4610
	76	7	88	27	1.7024	9	19	18	1.9959
	Overall season	27	1409	27	1.6629	18	269	18	1.9346
2	7	4	193	4	0.7675	5	22	5	1.5338
	14	6	46	7	1.1783	3	25	5	0.8333
	20	10	44	11	1.9447	6	31	8	1.0446
	27	9	40	14	1.8080	7	15	12	1.6217
	35	8	34	14	1.4861	-	-	-	-
	42	13	43	17	2.1956	5	19	12	1.3893
	49	8	15	19	1.8594	3	11	12	0.9949
	55	8	30	20	1.8675	3	3	12	1.0986
	62	16	688	25	0.5894	4	13	13	1.2659
	68	12	55	26	1.8526	6	16	13	1.4402
	76	7	42	26	1.7024	5	20	14	1.4964
	Overall season	26	1230	26	1.5281	14	157	14	1.8730

Treatment 1 = Partial weed control and economic threshold-based pest management program.
Treatment 2 = Complete weed control and calendar spray program.
DAE = Days after emergence.
[1] = Number of species or families or groups of Arthropods.
[2] = Number of individuals.
[3] = Shannon-Wiener diversity index (H').

per taxa in the first treatment were higher than in the second treatment. Similarly, the Shannon-Weiner diversity indices of the first treatment were higher than those of the second treatment on 7 out of 11 sampling dates for the indices as calculated from direct visual counts of arthropod on corn plants and on 8 out of 11 sampling dates for the indices calculated from the pitfall trap data. The diversity index for the whole season of the first treatment was also higher than for the second treatment.

Natural enemies (insect predators, insect parasitoids and spiders) play an important role in insect pest control. In this experiment, the numbers of natural enemies found in the first treatment were higher than those in the second treatment throughout the season except for the first sampling date (7 DAE) as shown in Figure1. The three dominant groups of natural enemies in descending order were: Arachnids, Chelisochidae and Anthocoridae (*Orius* sp.). On the other hand, the three dominant groups of insect pest in descending order were: Thripidae, Cicadellidae (*Cicadulina bipunctata*) and a secondary pest, Nitidulidae (*Carpophilus* sp., commonly known as the corn sap beetle).

In the first treatment, the distribution of both pests and their natural enemies was greater than in the second treatment. Species diversity, evenness and complexity of association among species are essential to the stability of the community (Khaing *et al.,* 2002) Thus, the results indicated that insect pests and their natural enemies in the first treatment were more balanced than in the second. In other words, the opportunity for a pest outbreak was less in the first treatment.

CONCLUSION

The first treatment (partial weed control and economic threshold-based pest management program) produced an average benefit of USD 4205 ha^{-1} while the second treatment (conventional and calendar spray program) produced USD 3,845 ha^{-1}. The cost benefit ratio of the first and second treatments was 1:3.19 and 1:2.85, respectively. The two majors groups of key pests observed were thrip and aphid. The numbers of and damage by key pests from both treatments were significantly different but were less than the economic thresholds. In addition, the numbers of natural enemies to pests in the first treatment were much higher than in the second treatment. The three major groups of natural enemies observed in descending order were: Arachnids, Chelisochidae and Anthocoridae (*Orius* sp.). The results of this study indicated that maintaining some weed population in the field could serve as habitat for natural enemies of pests while field monitoring and determining an economic threshold would be of benefit in pest management decision making.

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