J. Hama dan Penyakit Tumbuhan Tropika
Vol. 2, No. 1: 8 -14 (2002). ISSN 1411-7525

INSECT PESTS IN AGROECOSYSTEM WHERE THREE CORN VARIETIES WERE GROWN UNDER CONSERVATION VERSUS FULL TILLAGE SYSTEM IN NATAR, SOUTH LAMPUNG IN 2001 GROWING SEASON

F.X. Susilo[1] and I Gede Swibawa [1]

ABSTRAK

Serangga hama pada pertanaman jagung yang dibudidayakan dengan olah tanah konservasi di Natar Lampung Selatan pada musim tanam 2001. Penelitian sebelumnya (musim penghujan 2000) menunjukkan bahwa serangga yang berpotensi menjadi hama tanaman jagung di Lampung Selatan adalah lalat bibit jagung (LBJ) (*Atherigona* sp.) yang tidak selalu dapat diatasi dengan perlakuan benih dan penggerek tongkol (*Helicoverpa armigera*) yang serangannya terbatas pada ujung tongkol. Penelitian pada tahun ini (musim kemarau 2001) dilakukan untuk menjawab beberapa pertanyan berikut: (1) Apakah ada serangga lain yang berpotensi menjadi hama pada tiga varietas jagung yang dibudidayakan dengan olah tanah konservasi (OTK) versus olah tanah penuh (OTP)? dan (2) Sejauh manakah serangan lalat bibit jagung dan *Helicoverpa* pada tahun ini? Informasi terkini yang diperoleh adalah sebagai berikut. Selain diserang oleh LBJ dan *Helicoverpa*, pertanaman jagung tahun ini diserang pula oleh wereng coklat (WCJ) (*Nilaparvata* sp.) dan penggerek batang (PBJ) (*Ostrinia* sp.) Serangan LBJ dapat menyebabkan berkurangnya populasi tanaman produktif sebesar ≤ 1% dan 4—12%, berturut-turut pada sistem OTK dan OTP. Dibandingkan dengan pemulsaan (kegiatan utama dalam OTK), perlakuan benih menggunakan insektisida imidacloprid kurang efektif untuk mengendalikan serangan LBJ. WCJ cenderung lebih menyerang pertanaman jagung (apa pun varietasnya) yang dibudidayakan dengan OTK. Belum nampak adanya kecenderungan serangan PBJ pada salah satu varietas jagung atau pada satu di antara dua sistem olah tanah yang diuji. Selain menyerang tongkol seperti pada tahun sebelumnya, *Helicoverpa* pada tahun ini juga menyerang daun. Pada tahun ini serangan pada tongkol berlanjut sehingga menimbulkan kerusakan biji.

Kata kunci: insect pest, corn, conservation tillage

INTRODUCTION

As a viable alternative to the existing agricultural practices, the so-called conservation tillage (CT) system deserves special attentions. Better physico-chemical characteristics to the land and better income to farmers have been considered to be some of the advantages of CT system as compared to the conventional full tillage (FT) system (Utomo, 1995; Utomo, 1997). Still, the performance of CT system needs further investigation across field conditions and seasons. As a part of multilocation studies on CT in Indonesia, a field study was conducted during 2000 growing season in Natar, South Lampung to observe the response of three corn varieties to pestiferous insects under CT versus FT system (Susilo & Swibawa, 2001). The potential pests identified during the season were the whorl maggot that attacked seedlings and *Helicoverpa armigera* that attacked ears. The study showed that seedling failure were higher in CT system than that in FT system and the imidacloprid insecticide was unable to prevent the seedling failure in CT system. Other information from the study was that *Helicoverpa* was quite prevalent in cornears but did not injured the seeds. The questions would be (1) are there other insect pests that potentially caused yield loss of corn?; and (2) is the information about the whorl maggot and *Helicoverpa* gained during 2000 growing season consistent over time (growing seasons)? The answers were sought in the 2001 growing season study which was set in the same location as the 2000 growing season. The objectives of the 2001 growing season study were to observe infestations of pestiferous insects associated with three corn varieties (RR, C7, Bisma) grown under CT versus FT system and to compare its information with that gained during 2000 growing season.

METHODS

The study was conducted in an experimental field of the Assessment Station for Agricultural Technology, Natar, South Lampung during the dry season of 2001 (from June to November 2001). An open pollination corn (Bisma) and two hybrid varieties (C7 and RR) were used in this study. The three corn varieties were planted in six plots (each sized 80 m x 50 m; planting distance 25 cm x 75 cm) differing in tillage systems (RR-CT = RR grown under conservation-tillage; C7-CT = C7 grown under conservation-tillage; Bisma-CT = Bisma grown under

[1] Dosen Jurusan Proteksi Tanaman, Fakultas Pertanian, Universitas Lampung

conservation tillage; RR-FT = RR grown under full-tillage; C7-FT = C7 grown under full-tillage; Bisma-FT = Bisma grown under full-tillage). In the FT system, seeds were sowed (July 10: RR and C7, July 13: Bisma) after the field was plowed completely. No plowing and mechanical weeding were done in the CT system. In the CT system, Roundup 75 WSG (74.7% monoammonium glyphosate) was sprayed twice during the growing season. In RR-FT plot, seeds were sowed on June 23 and Roundup was sprayed twice afterwards (without nozzle-protecting cones in-row of the young crops), i.e July 14 (Roundup rate 1.5 kg/ha, spray volume 450 l/ha) and August 4 (Roundup rate 1.0 kg/ha, spray volume 450 l/ha). Meanwhile, C7 and Bisma seeds were sowed in their respective CT plots on July 7 in between two Roundup sprays (first = June 23: Roundup rate 1.5 kg/ha, spray volume 450 l/ha, blanket spray without nozzle-protecting cones; second = August 18: Roundup rate 1.0 kg/ha, spray volume 450 l/ha, between-row spray with nozzle-protecting cones).

A smaller quadrat (5 m x 5 m) was set in the middle of each corn plot. This quadrat was the control area for the whorl maggot attacks. Treated corn seeds were mixed with 70% imidacloprid insecticide (rate 1 g Confidor 70 WS /kg seeds); otherwise, the control seeds were not treated with the pesticide prior to the planting. The control seeds were planted in the control quadrat while the treated seed were planted in the plot outside the control quadrat.

Pestiferous insects that have been found to associate with the corn plants were the whorl maggot (*Atherigona* sp.), *Helicoverpa* (attacking leaves and/or ears), the corn brown planthopper (BPH) and the stemborer (*Ostrinia* sp.) Damage caused by *Atherigona* sp. was observed twice a week cummulatively from 4 days after planting (DAP) of RR-CT to one month after planting of the FTs. Plants attacked by *Helicoverpa* or BPH were observed weekly (from July 30 to the harvest time). Plant samples for the whorl maggot attacks, i.e. six five-meter-rows (FMR), were taken along the diagonal transect of the field. Three of the samples were taken from the control plant rows (no seed treatment) while the other three samples were taken from the treated plant rows (with seed treatment). The sample points and sample size for observing *Helicoverpa*, BPH, and stemborer attacks were the same as those for the whorl maggot while the sample units were FMR for *Helicoverpa*, three-meter-row (TMR) for BPH and FMR for stemborers, respectively. F-test and the Least Significant Difference (LSD) test at 0.05 level (Lentner & Bishop; 1986; Little & Hills, 1978) were used to analyze the whorl maggot attacks and *Helicoverpa* attacks across corn varieties and tillage systems.

The position of stemborer gallery opening in the corn stem was observed using the base of the ears as the reference point. Thus, the openings can be located beneath, at, or above the base of the ears. The position was defined as the distance between the base of the corn ears to the gallery opening and was taken to be the number of nodes within that distance.

RESULTS AND DISCUSSION

The whorl maggot attacks

Three pieces of information can be depicted from Table 1. First, in any tested corn variety and under either tillage system, the whorl maggot attacks on seedlings with seed treatment did not differ from those without seed treatment. That alone might indicate overall inability of imidacloprid insecticide to protect the seedlings from the attacks.

Table 1. The whorl maggot attacks (%) on treated versus untreated corn seedlings

Corn varieties and tillage systems	Seed treatment	
	No	Yes
Conservation Tillage		
RR	0.1 c	0.1 c
C7	0.1 c	1.1 c
Bisma	0.1 c	1.1 c
Full Tillage		
RR	8.9 ab	6.4 abc
C7	10.9 ab	4.6 bc
Bisma	11.6 a	7.3 abc
LSD 0.05	*6.5*	

Values in the cell followed by the same letter indicated no siginificant difference (protected LSD, α=0.05); percentage of attack = the number of hills with whorl maggot symptom was multiplied by 100 and divided by the number of sowed hills in five-meter row.

Second, no seed treatment for CT plots did not result in any seedling damage in CT plots but caused 9—12% of seedling damage in FT plot. That might indicate effectivity of CT (i.e. mulching as the pre-requisite of CT, Prof. M. Utomo, Personal communication) in reducing the whorl maggot attacks on corn seedling. CT system seemed to have reduced seedling damage to such a low level (<< 1%) that other means (including seed treatment) was ineffective to contribute to any further damage reduction in the system.

Third, seedling damage in CT plots without seed treatment did not differ from that in FT plots with seed treatment. Did that indicate no difference in effectivity between CT and seed treatment? Comparison between seedling damage in either plots and that in FT plots without seed treatment should clearly show that, if at all effective, the seed treatment appeared to be far less effective than CT (mulching) for the whorl maggot control.

Compared with its absence in FT plots, abundant organic mulch (weed refuses, stubbles and plant debris) in CT plots might be related to the lower attacks of the whorl maggot in CT plots. The seedlings could have become less apparent (either chemically or physically) to the whorl maggot. In contrast, practically barer soil surface in the FT plot exposed the young plants to the whorl maggot that made them easier to find and be attacked by the insect. The whorl maggot attacks were fatal and thus reduced the plant ability to provide normal yield. That way, the level of attacks indicates the loss of potential yield in the plots (4—12% in FT plots). When combined with the loss due to the downy mildew disease (Prasetyo, published elsewhere) it added up to 12—43% plant loss from the FT system.

Helicoverpa attacks

Helicoverpa larvae were found to attack corn leaves and ears, in that sequence. Attacks of *Helicoverpa* on leaves started at 7 week after planting (WAP) where RR plants in CT plot were apparently attacked more by the pest than plants in the other five plots regardless of their tillage systems or plant varieties (Figure 1). In general, however the attacks in all plots tended to decline afterward. The attacks in all but RR-CT plot were so declined that they have become practically non-existent since 12 WAP. But attacks in RR-CT plot was only slightly declined that it could still be detected at 16 WAP, i.e. at the period when ears have already been abundant in all plots for the pest's next choice of attacks.

Attacks of *Helicoverpa* on ears started at 10 WAP in RR-CT plot (Figure 2). At that time no attacks could be detected in the other plots where ears were still rare, especially in the FT plots. However, at

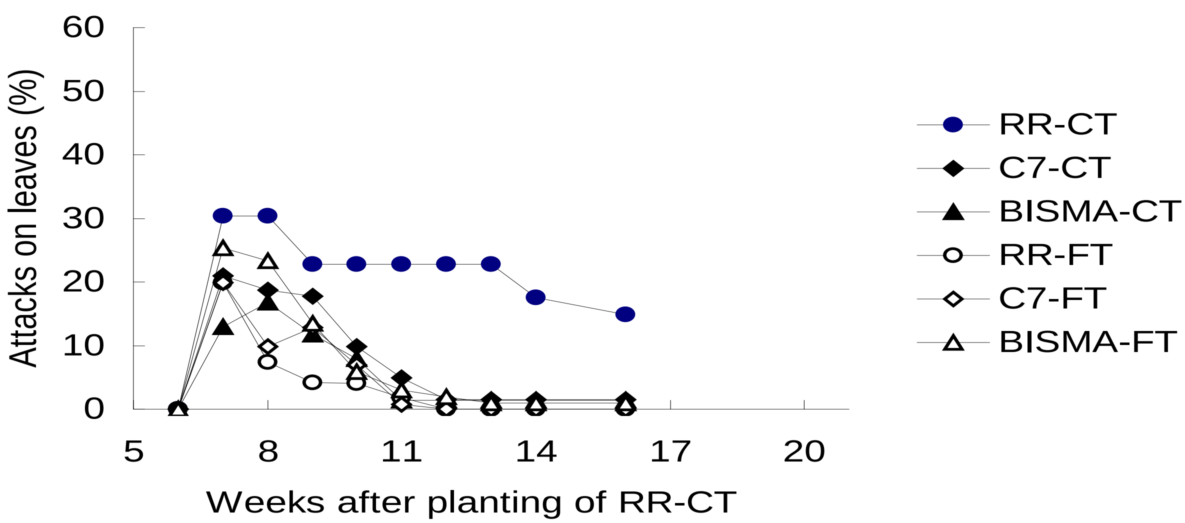

Figure 1. *Helicoverpa* attacks on leaves of three varieties of corn plants managed under conservation tillage (CT) or full tillage (FT). (RR = Roundup Ready, hybrid variety), C7 = hybrid variety and Bisma = open pollination variety)

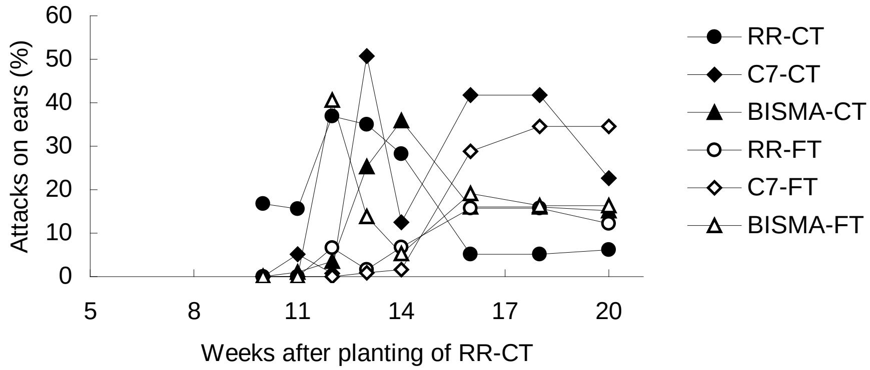

Figure 2. *Helicoverpa* attacks on ears of three corn plants varieties managed under conservation tillage (CT) or full tillage (FT). (RR = Roundup Ready, hybrid variety), C7 = hybrid variety and Bisma = open pollination variety)

Table 2. Attacks of *Helicoverpa* on leaves and ears of three corn varieties grown under conservation versus full tilllage systems, 2001 growing season

Tillage systems and corn varieties	Average attacks on leaves (%)	Final attacks on harvested ears (%)
Conservation Tillage		
RR	23.0 a	6.2 c
C7	8.7 b	22.7 ab
Bisma	6.3 b	15.2 bc
Full Tillage		
RR	4.1 b	12.2 bc
C7	5.6 b	34.6 a
Bisma	8.5 b	16.3 bc
LSD 0.05	*6.34*	*12.46*

Values in the same column followed by the same letter indicated no siginificant difference (protected LSD, α=0.05); percentage of attack = the number of plants with *Helicoverpa armigera* symptoms (skeletonized leaves or bored ears) was multiplied by 100 and divided by the total number of plants in five-meter row.

that time no ear attacks could be detected in either C7-CT or Bisma-CT plots in spite of higher availability of ears in both plots. However, unlike the declining pattern of *Helicoverpa* attacks on leaves (Figure 1), the attacks on ears fluctuated without any clear pattern. In addition, unlike no detectable seed injury in the 2000 growing season (Susilo & Swibawa, 2001), ear attacks of 2001 growing season resulted in some seed injury. Average attacks on leaves and final attacks on ears (where seeds were injured) were depicted in Table 2**.**

It is showed in Table 2 that *Helicoverpa* attacks on leaves were not parallel to the attacks on ears (seeds). In the case of RR-CT plants, excessive leaf attacks were followed by moderate ear attacks. The opposite result were recorded on C7 plants where lower leaf attacks were followed by higher ear attacks, especially on plants managed under FT system. In general, however, the ear attacks seemed to vary more across varieties than across tillage system with RR tending to be the most and C7 the least resistant to the attacks. The fact that ear attacks injured seeds (i.e. 20 – 30% of the harvested C7 ears were injured by *Helicoverpa*) informed warning that *Helicoverpa* might not be as harmless as it was understood from the 2000 season data (Susilo & Swibawa, 2001).

The corn stemborer attacks were depicted in Figure 3. The attacks were more apparent in RR-CT plot than in any other plot regardless of variety or tillage system. Nonetheless, at this time the stemborer attack could not be considered as important based on three reasons as follow. First, the number of plants they attacked did not exceed 3 plants per 5-m row (FMR); which was equivalent to 10% attack or less. Second, the attacks occurred after most plants have already produced ears. Third, and most importantly, the attacks were mostly above the ear where only small portion, if any, of photosynthetically-active leaves were located so that they practically would not hinder the transport of the bulk of assimilate to the ear. Figure 4 shows that ca. 90% of the stemborer gallery openings (which indicate the breadth of boring activities in the stem) were located above the base of the ears of the attacked plants. On average, the openings were located 3.5 nodes above the base of the ear.

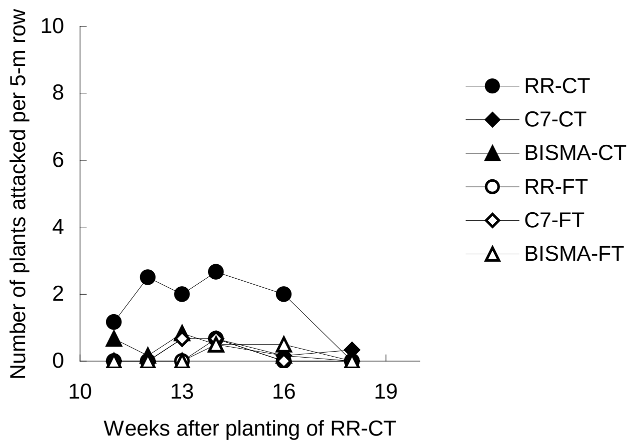

Figure 3. *Ostrinia* sp. attacks on stems of three varieties of corn plants anaged under conservation tillage (CT) or full tillage (FT). (RR = Roundup Ready, hybrid variety), C7 = hybrid variety and Bisma = open pollination variety).

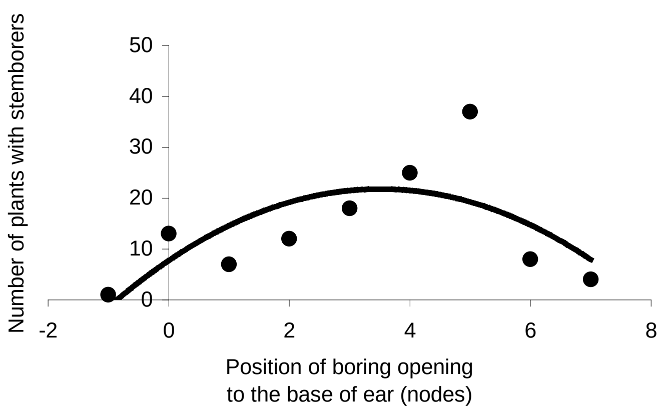

Figure 4. Position of *Ostrinia* sp. boring opening to the base of corn ears of three varieties of corn plants managed under conservation tillage (CT) or full tillage (FT). (RR = Roundup Ready, hybrid variety), C7 = hybrid variety and Bisma = open pollination variety). Zero point = the stem node where the base of ear is located. Dots = the actual number; line = predicted trend of second order (quadratic).

At first glance, with their purplish appearance, the stemborer larvae looked like the purple stemborer *Sesamia inferens,* a noctuid group that may attack rice or other gramineous plants including corn. However, placing the insects in the noctuid group (and naming them as *Sesamia*) cannot be justified. Instead, the insects should be placed in the pyralid group based on the following morphological reasons (Peterson, 1984). Their crochets are typical of the Family Pyralidae, i.e. arranged in full circles in all but the last abdominal prolegs and the arrangement in the last abdominal prolegs is more perpendicular than parallel to the mesal body axis. Further examination on the spesimen should place them in the genus *Ostrinia* (*Pyrausta*) based on the fact that (Peterson, 1984) (1) all setae on their abdominal segments 1—8 are arised from disk-like pigmented pinacula and (2) the length of their coronal suture is less than one third of the mesal length of their frons.

Meanwhile, the study confirmed that corn plants were also attacked by a brown planthopper (BPH). Prior to the study, Supriyono (personal communication) of the Laboratorium Proteksi Tanaman, Trimurjo, Lampung has collected similar corn BPH specimens from various corn fields in Central Lampung and sent them to us (FXS). The corn BPH morphology is very similar to the rice BPH morphology as described in Kalshoven (1981). The corn BPH are of typical delphacids with prominent spurs on their hind tibiae (Borror *et al.* 1981). Beside brown in color, the corn BPH share common morphological structures characteristic of the rice BPH (*Nilaparvata lugens* Stal, Homoptera: Delphacidae), i.e. three longitudinal stripes on their pronotum (Kalshoven, 1981). But, since the corn BPH were found and could reproduce easily and naturally on corn plants (i.e. as indicated by their consistent presence and high number as observed in the field) whereas the rice BPH feed and reproduce practically exclusively on rice plants (Oka, 1979 & Mochida *et al.* 1979 *cit.* Kalshoven, 1981), it would not be proper at this time to directly designate the corn PH as *Nilaparvata lugens*. Instead, naming the corn BPH as *Nilaparvata* sp. should suffice its provisional identity before a full taxonomic description is available (Susilo, published elsewhere).

The corn BPH attacks were depicted in Figure 5. The attacks began to appear at 7 WAP of RR-CT. In RR-CT plants, BPH population continued to increase afterwards and peaked at 13 WAP (> 50 individuals per plant, IPP). In its highs, the number of BPH fluctuated in the range of 30 IPP in Bisma-CT plot and 20 IPP in C7-CT plot. The temporal distribution of BPH population took dissimilar pattern in the FT plots. BPH population increase or fluctuation as such in CT plots did not occur in FT plots. The number of BPH in FT plots was quite low. With the exception of 7 IPP in RR-FT at 12 WAP and

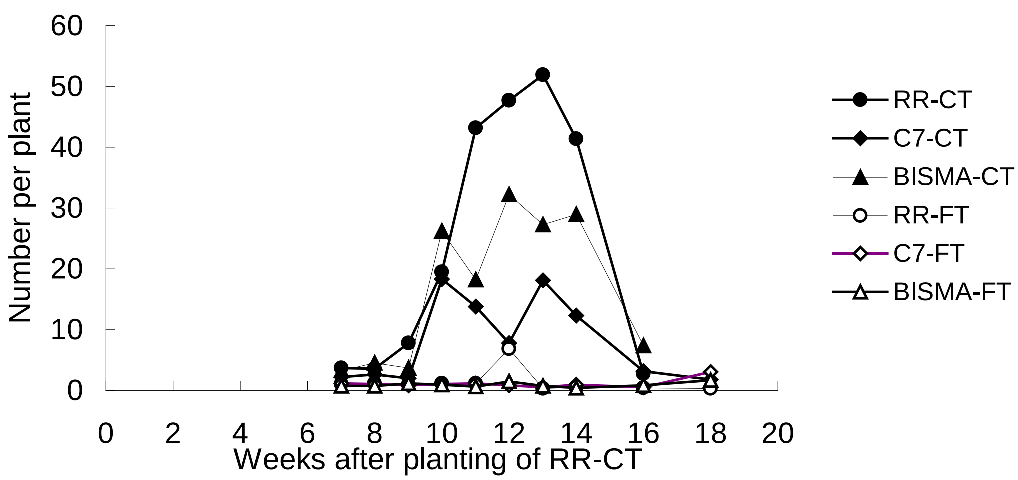

Figure 5. The corn brown planthopper attacks on three varieties of corn plants managed under conservation tillage (CT) or full tillage (FT). (RR = Roundup Ready, hybrid variety), C7 = hybrid variety and Bisma = open pollination variety)

3 IPP in C7-FT at 18 WAP, in all cases the number of BPH in FT plots was < 2 IPP. Overall, FT corn system was dwelled by much less BPH than CT corn system.

More humid micro-environment in CT plots might be the major factor that induced higher attacks of BPH on corn plants. This situation seemed to be parallel with the known behavior of the rice BPH. Constant humidity and shade are prefered by the rice BPH (Oka, 1979 *cit.* Kalshoven, 1981). In our case, the corn CT systems provided more humidity and more shade than the FT systems. That was partly contributed by more surviving plant population in CT systems (23.9 plants per FMR in CT system versus 15.9 plants per FMR in FT system; t-calculated significant at $\alpha = 0.05$ level). Furthermore, plant growth in CT system was better and more vigorous than that in FT system. In other words, more food and shelter in CT plots were associated with more BPH attacks on them. But more surviving plants was also a logical consequence of less lost plants in the CT system. Less plant losses in CT plots were due to less previous attacks of the downy mildew disease or the whorl maggot. It is explanatory that in relation to CT versus FT system, the BPH attacks were in contrast with the downy mildew or whorl maggot attacks. The combined attacks of the whorl maggot and the downy mildew in FT plots reduced the plant population as such that the remaining plants (lower density) could not provide ample shading and humidity for optimum growth of the corn BPH.

CONCLUSIONS

Based on the information at hand, the following conclusions were drawn from the 2001 corn growing season. Seedlings were attacked by the whorl maggot (*Atherigona* sp.) The whorl maggot attacks contributed to $\leq$ 1% and 4—12% loss of productive plants in CT and FT system, respectively. Other insects that have been found to attack the corn plants were the corn BPH (*Nilaparvata* sp.), the stemborer (*Ostrinia* sp.), and the corn earworm (*Helicoverpa*; that not only attacked ears but also attacked leaves).

ACKNOWLEDGEMENTS

Our thank goes to Prof. Dr. Muhajir Utomo for allowing us doing this study and publish the results. During the study we were helped by Mr. Dad R. Sembodo, Mr. Hanung Ismono, Dr. Kukuh Setiawan, Mr. Rahmat Pranoto, Mr. Paryadi, Mr. Suhaimi, and Mr. Iwan. We also grateful to Mr. Edwin Saragih (PT Monagro Kimia/Monsanto Company) for financial assistance.

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