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Infestation of pest attacks and its impact on the yield of organic sweet corn in lowland

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Abstract Organic sweet corn still challenges, especially related to pest attacks. Farmers' pest control efforts currently use chemical pesticides that are not environmentally friendly. Integrated pest control techniques are increasingly developing along with increasing awareness of the importance of environmentally friendly sustainable agriculture. One component of integrated pest control is the use of pest-resistant varieties. The results showed that of the 17 sweet corn hybrid varieties evaluated, the variety with the highest level of attack (susceptibility) to *O. furnacalis, H. armigera,* and *S. frugiperda* was Caps15 x Caps22. The highest *O. furnacalis* attack found in Caps15 x Caps22 was 33% and significantly different from the comparison varieties Paragon and Bonanza, and the highest *H. armigera* attack found in the same variety Caps15 x Caps22 was 31%, but not significantly different from the comparison varieties Paragon and Bonanza, as well as the highest scoring *S. frugiperda* attack was found in the same variety. The highest yield was 16.05 tons/ha, the diameter of the cob with husk was 300.93 mm and the weight of the cob with husk was 56.73 g on Caps15 x Caps23 and was not significantly different from the comparison variety Paragon with a yield of 17.87 tons/ha, the diameter of the cob with husk was 335.06 mm and the weight of the cob with husk was 57.3 g.

Keywords: Attack, Hybrid corn, Pests, Resistance, Varieties

Introduction

Sweet corn (*Zea mays* L. *saccharata*) is a highly valued crop worldwide, cultivated for its tender kernels consumed as a vegetable, and it is increasingly recognized for its nutritional value and adaptability to various agro-climatic conditions. Sweet corn has emerged as a valuable crop not only for its economic potential but also for its role in sustainable food systems due to its high consumer demand (Sidahmed *et al.,* 2025, Swapna *et al.,* 2020).

One of the problems in organic sweet corn cultivation is pest attacks. According to Nurmaisah and Purwati (2021), the Asian corn borer *Ostrinia furnacalis* Guenée (Lepidoptera: Crambidae), corn cob borer *Helicoverpa*

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armigera Hübner (Lepidoptera: Noctuidae), armyworm *Spodoptera litura* Fabricius (Lepidoptera: Noctuidae), corn aphid *Rhopalosiphum maidis* Fitch (Hemiptera: Aphididae), shoot fly *Atherigona exigua* Stein (Diptera: Muscidae) and *Spodoptera frugiferda* J.E Smith (Lepidoptera: Noctuidae) (Ginting *et al.,* 2020) are the major pests of corn in Indonesia.

Ostrinia furnacalis is the most destructive corn cob pest in China and Southeast Asia. This pest has caused enormous damage with losses of $ 1.3 billion per year in China (Jie *et al.,* 2019). *H. armigera* attacks the cobs, shoots, and panicles so that male flowers are not formed, which results in reduced crop yields, the decrease in yield due to this pest attack in Gorontalo on the Bisi-2 variety reached 51.92% and Motorokiki 53.48% (Karim *et al.,* 2013). The level of this pest attack in East Java reached 21.54% on the K_2C_3 and 7.03% on the Bisma (Sarwono *et al.,* 2003). Losses due to pest attacks in the United States on sweet corn reached 50% (Kelly and Rick, 2004). *Spodoptera frugiperda* is an important pest of corn crops in America, Africa, India, and Yemen (Georgen *et al.,* 2016). This insect is polyphagous and attacks throughout the crop cycle (Abreu *et al.,* 2019). *S. frugiperda* pests can attack 353 plant species from 76 families, especially from the Poaceae, Asteraceae, and Fabaceae groups (Montezano *et al.,* 2018), currently the pest has spread to various regions in Indonesia.

Farmers' pest control efforts currently use chemical pesticides that are not environmentally friendly. Integrated pest control techniques are increasingly developing along with increasing awareness of the importance of environmentally friendly sustainable agriculture. One component of integrated pest control is the use of pest-resistant varieties. Organic sweet corn cultivation still relies on seeds from varieties developed for conventional cultivation that require synthetic input support from the agrochemical industry to produce high productivity. These varieties, when cultivated organically will experience decreased productivity (Pangaribuan *et al.,* 2018, Libra *et al.,* 2018, Kriswantoro *et al.,* 2016).

A sweet corn breeding program to produce high-yielding hybrid varieties in organic farming systems began at the Faculty of Agriculture, University of Bengkulu, in 2013. The hybridization process of various varieties, followed by a selection program over eight generations, has produced eight elite inbred lines. Of these lines, four inbred lines (Caps 5, Caps 17a, Caps 22, and Caps 23) received Plant Variety Registration Certificates from the Center for Plant Variety Protection and Agricultural Licensing in 2019, while the other four inbred lines (Caps 2, Caps 3, Caps 15, and Caps 17B) are still in preparation for registration.

Preliminary yield testing of hybrids obtained from half-diallel crosses of 8 inbred lines showed that 15 of the 28 hybrids evaluated had superior yield performance under organic conditions (Chozin and Sudjatmiko, 2018). Evaluation of these 15 promising hybrids under various organic environmental conditions is still needed to identify yield stability and quality. The purpose of this study was to assess the infestation of pest attacks and its impact on the yield of organic sweet corn in lowland.

Materials and methods

The research was conducted in August - November 2024 at the research experiment station of Faculty of Agriculture, Bengkulu University, Muara Bangkahulu, at 3 ^{o}45'15.24751"S 102^{o} 16'17.1768"E, 14.4 m asl. The materials used in the study were seeds from 15 experimental hybrids, namely (1) Caps2 x Caps5, (2) Caps2 x Caps22, (3) Caps3 x Caps17A, (4) Caps3 x Caps23, (5) Caps5 x Caps17A, (6) Caps5 x Caps17B, (7) Caps5 x Caps22, (8) Caps15 x Caps17A, (9) Caps15 x Caps22, (10) Caps15 x Caps23, (11) Caps17A x Cap17B, (12) Caps17A x Caps22, (13) Caps17B x Cap22, (14) Caps17B x Cap23, and (15) Caps22 x Cap2, as well as two commercial hybrids (Paragon and Bonanza) as a comparison. The experiment was arranged in a completely randomized block design (RCBD) with three replications to place 17 sweet corn hybrids in experimental units measuring 3 m x 3 m.

Land preparation

The land, cleared of weeds, was tilled with a hoe until ready for planting. It was then divided into three blocks with a 1 m spacing between blocks. Each block was divided into 17 experimental plots measuring 3 m x 3 m, with a spacing of 75 cm between plots. Cow manure, at a rate of 5 tons/ha, was applied to each experimental unit one week before planting.

Planting

Planting was carried out by placing one seed in a hole, arranged in rows 3 m long, with a spacing of 75 cm between rows and 25 cm within rows. Each hybrid occupied four rows, resulting in a population of 48 plants. Granulated organic fertilizer 7.5 g per plant was applied by side-dressing.

Fertilization and irrigation

Follow-up fertilizer was provided in the form of NASA liquid organic fertilizer (POC) applied through the leaves at a concentration of 2% at 2, 4, 6, and 8 weeks after planting. Manual irrigation using a watering can was carried out when groundwater was insufficient to meet the plants' needs.

Pest and disease control

Weeds were controlled manually with a sickle at 2 and 4 weeks after planting. Pests and diseases were controlled using organic pesticides appropriate to the pests and diseases affecting them. Five plants were randomly sampled from each experimental unit, starting one week after planting and continuing until harvest.

Observed variables

The pest attacks observed were *Ostrinia furnacalis, Helicoverpa armigera,* and *S. frugiferda.* The percentage of *O. furnacalis and H. armigera* attacks were carried out by calculating the percentage of attacks using the formula:

$$P = (n / N) \times 100\%,$$

where
P = Percentage of damage (%)
n = Number of corn plants attacked
N = Total corn plants observed

The level of corn resistance to *O. furnacalis* and *H. armigera* attacks was based on the following scores:

1. Score 1: 0–10% = resistant
2. Score 2: 11–20% = moderately resistant
3. Score 3: 21–40% = susceptible
4. Score 4: 41–60% = moderately susceptible
5. Score 5: 61–100% = very susceptible

Leaf damage caused by S. frugiperda

The level of plant resistance is based on leaves damaged by FAW. Leaf damage due to FAW feeding on each corn variety was assessed using a scoring system on a scale of 1-9 (Davis and Williams, 1992).

Cob diameter (mm) and cob weight (g)

Cob diameter (mm) was measured from the base, middle, and tip of the cob produced by the sample plants, measurements were taken at harvest time. Cob weight (g) was measured by weighing the cobs produced by the sample plants, measurements was taken at harvest time using a digital scale.

Harvesting

Harvesting was carried out when the plants meet the harvest criteria: 75-80 days after planting, the cob hairs were brown, the husks dark green, and the cobs fully filled and firm.

Data analysis

The obtained data were analyzed using ANOVA, and if there were significant differences between treatments, they were further tested with DMRT at the 5% level.

Results

Percentage of O. furnacalis attacks on organic sweet corn hybrids

Symptoms of *O. furnacalis* infestation visible on the stems included stem borer holes, male flowers, and the presence of feces in the borer holes. Observations (50-55 days after planting) showed that corn plants showed signs of corn stem borer infestation. The 17 hybrid corn varieties evaluated for *O. furnacalis* attack were resistant (7 varieties), moderately resistant (7 varieties), and susceptible (3 varieties). The highest *O. furnacalis* attack was found on Caps15 x Caps22, at 33%, significantly different from the comparison varieties Paragon and Bonanza (Tabel 1).

Percentage of H. armigera attacks on organic sweet corn hybrids

The attack of pest had begun when the female imago laid eggs on the corn silk, after hatching, the larvae invaded the cob and feed on the developing kernels. Visible symptoms of this pest attack included burrow marks on the tip of the cob and the ingestion of kernels. The 17 hybrid corn varieties evaluated for *H. armigera* attack were moderately resistant (4 varieties) or susceptible (13 varieties). The highest attack rate was found on Caps15 x Caps22, at 31%, and not significantly different from the comparison varieties Paragon and Bonanza (Table 2).

Table 1. Attack of *O. furnacalis* on organic sweet corn hybrids

No	Hybrid Varieties	Attack of *O. furnacalis* (%) ± SD	Respond
1	Caps2 x Caps5	0± 0a	Resistant
2	Caps2 x Caps22	0± 0a	Resistant
3	Caps3 x Caps17A	0± 0a	Resistant
4	Caps3 x Caps23	0± 0a	Resistant
5	Caps5 x Caps17A	13± 11,54b	Moderately resistant
6	Caps5 x Caps17B	0± 0a	Resistant
7	Caps5 x Caps22	0± 0a	Resistant
8	Caps15 x Caps17A	20± 0c	Moderately resistant
9	Caps15 x Caps22	33± 11,54e	Susceptible
10	Caps15 x Caps23	7± 11,54ab	Resistant
11	Caps17A x Caps17B	20± 0ac	Moderately resistant
12	Caps17A x Caps22	26± 11,54d	Susceptible
13	Caps17B x Caps22	13± 11,54b	Moderately resistant
14	Caps17B x Caps23	13± 11,54b	Moderately resistant
15	Caps22 x Caps23	26± 11,54d	Susceptible
16	Paragon	13± 11,54b	Moderately resistant
17	Bonanza	13± 11,54b	Moderately resistant

The numbers followed by the same letter in the same column do not show a significant difference based on the DMRT test at a 5% significance level.

Table 2. Attack of *H. armigera* on organic sweet corn hybrids

No	Hybrid Varieties	Attack of *H. armigera* (%) ± SD	Respond
1	Caps2 x Caps5	21± 9,01a	Susceptible
2	Caps2 x Caps22	16± 5,19a	Moderately resistant
3	Caps3 x Caps17A	22±3,05a	Susceptible
4	Caps3 x Caps23	28± 3,05a	Susceptible
5	Caps5 x Caps17A	27± 6,92a	Susceptible
6	Caps5 x Caps17B	20± 9,71a	Moderately resistant
7	Caps5 x Caps22	23± 9,16a	Susceptible
8	Caps15 x Caps17A	27± 6,92a	Susceptible
9	Caps15 x Caps22	31± 8,08a	Susceptible
10	Caps15 x Caps23	15 ± 9,71a	Moderately resistant
11	Caps17A x Caps17B	26± 8,08a	Susceptible
12	Caps17A x Caps22	29± 2,00a	Susceptible
13	Caps17B x Caps22	23± 8,00a	Susceptible
14	Caps17B x Caps23	15± 12,58a	Moderately resistant
15	Caps22 x Caps23	28± 4,61a	Susceptible
16	Paragon	27± 3,46a	Susceptible
17	Bonanza	28± 5,77a	Susceptible

Leaf damage caused by S. frugiferda

The level of *S. frugiferda* attack organic sweet corn hybrids were found to be resistant (13 varieties), susceptible (3 varieties), and highly susceptible (1 variety) *to S. frugiferda* attack (Table 3).

Table 3. Attack of *S. frugiferda* on organic sweet corn hybrids

No	Hybrid Varieties	Scoring of *S. frugiperda* attacks	Respond
1	Caps2 x Caps5	5	Partially resistant
2	Caps2 x Caps22	5	Partially resistant
3	Caps3 x Caps17A	6	Susceptible
4	Caps3 x Caps23	5	Partially resistant
5	Caps5 x Caps17A	5	Partially resistant
6	Caps5 x Caps17B	5	Partially resistant
7	Caps5 x Caps22	5	Partially resistant
8	Caps15 x Caps17A	5	Partially resistant
9	Caps15 x Caps22	8	Highly susceptible
10	Caps15 x Caps23	5	Partially resistant
11	Caps17A x Caps17B	5	Partially resistant
12	Caps17A x Caps22	5	Partially resistant
13	Caps17B x Caps22	6	Susceptible
14	Caps17B x Caps23	5	Partially resistant
15	Caps22 x Caps23	7	Susceptible
16	Paragon	5	Partially resistant
17	Bonanza	5	Partially resistant

Spodoptera frugiferda had began laying eggs in week 5, with the highest number occurring in week 6 and decreased in weeks 7 and 8. Eggs are laid on the upper surface of leaves. The number of eggs per cluster can vary from 100 to 200 (Table 4).

The highest yield on Caps15 x Caps23 was 16.05 tons/ha, the diameter of the cob with husk was 300.93 mm and the weight of the cob with husk was 56.73 g and was not significantly different from the comparison variety Paragon with a yield of 17.87 tons/ha, the diameter of the cob with husk was 335.06 mm and the weight of the cob with husk was 57.3 g, while the lowest yield was on Caps15 x Caps22 (Table 5).

Table 4. Number of egg groups *S. frugiferda* on organic sweet corn hybrid varieties in the field

No	Hybrid Varieties	Number of egg groups *S. frugiferda* (Weeks)			
		5	6	7	8
1	Caps2 x Caps5	0	1	1	0
2	Caps2 x Caps22	1	2	0	0
3	Caps3 x Caps17A	0	2	0	0
4	Caps3 x Caps23	0	2	1	0
5	Caps5 x Caps17A	0	2	0	0
6	Caps5 x Caps17B	0	1	0	0
7	Caps5 x Caps22	0	2	1	0
8	Caps15 x Caps17A	1	1	1	0
9	Caps15 x Caps22	1	0	2	0
10	Caps15 x Caps23	0	1	0	0
11	Caps17A x Caps17B	0	0	0	1
12	Caps17A x Caps22	0	3	5	0
13	Caps17B x Caps22	0	1	0	0
14	Caps17B x Caps23	0	2	1	0
15	Caps22 x Caps23	0	1	0	0
16	Paragon	0	0	2	0
17	Bonanza	0	0	1	0
	Total	3	21	15	1

Table 5. Yield, cob weight, and cob diameter of organic sweet corn hybrids

No	Hybrid Varieties	Yield (tons/ha)	Weight of corn cobs (g)	Cobs Diameter (mm)
1	Caps2 x Caps5	13,9abc	260,6abc	55,66abc
2	Caps2 x Caps22	10,94a	205,13a	49,16ab
3	Caps3 x Caps17A	12,61ab	236,33bc	53,36abc
4	Caps3 x Caps23	12,36ab	231,8ab	51,23abc
5	Caps5 x Caps17A	15,59bc	292,4bc	52,76abc
6	Caps5 x Caps17B	15,88bc	297,86bc	55,73abc
7	Caps5 x Caps22	13,65abc	256abc	51,36abc
8	Caps15 x Caps17A	14,97abc	280,73abc	56abc
9	Caps15 x Caps22	10,87a	203,93a	48,5a
10	Caps15 x Caps23	16,05bc	300,93bc	56,73bc
11	Caps17A x Caps17B	14,83abc	278,13abc	55,13abc
12	Caps17A x Caps22	15abc	281,26abc	55,13abc
13	Caps17B x Caps22	13,39ab	251,06ab	52,23abc
14	Caps17B x Caps23	12,88ab	241,46ab	52,73abc
15	Caps22 x Caps23	13,82abc	259,2abc	55,76abc
16	Paragon	17,87c	335,06c	57,3c
17	Bonanza	13,26ab	248,73ab	52,2abc

The numbers followed by the same letter in the same column do not show a significant difference based on the DMRT test at a 5% significance level.

Discussion

The most important pests attacking corn in the field were *O. furnacalis, H. armigera,* and *S. frugiperda*. During the study, these three pests attacked corn plants with varying degrees of infestation. The 17 hybrid corn varieties evaluated for *O. furnacalis* attack showed varying levels of resistance (resistant: 7 varieties), moderately resistant (7 varieties), and susceptible (3 varieties). This was suspected to be influenced by biophysical and biochemical factors possessed by these plants. The tissue hardness of a plant greatly affects its tolerance to pest attacks. Strong plants have higher resistance. Varieties with denser vascular bundles were a barrier against attack by borer larvae. The varieties of Harapan and Permadi have more dense vascular bundles than the Genjah Kertas and Kretek, so these varieties were more resistant. In addition, biochemical factors such as Dimboa (2,4–dihydroxy–7– methoxy–(2H)–1,4–benzocaine–3 (4H)–one) which are naturally present in maize can caused high mortality of the first offspring of *Ostrinia nubilalis* larvae in corn (Sodiq, 2009).

The resistance test through the tolerance mechanism was observed from the amount of damage to the hybrid corns from crossbreeding strain and the three commercial hybrid varieties. Each hybrid corn variety had a different attack level. This was thought to be due to differences in leaf tissue. Sodiq (2009) stated that larvae of *O. nubilalis* first live in a group of bulliform cells from leaves and bulliform cells in resistant varieties were smaller than bulliform cells of the susceptible one.

The level of *H. armigera* attack showed that 17 hybrid corn varieties evaluated were somewhat resistant (4 varieties) and susceptible (13 varieties). This pest infestation will reduce the quality and quantity of corn cobs. However, in this study, the cob borer infestation did not cause severe damage (33%). This was evident from the percentage of the attack level, which was still below the economic threshold, more than 50% (Adnan, 2009) because one factor that reduces this pest infestation is the tight covering of the cob husk which inhibits the invasion of larvae into the corn cob.

Symptoms of corn cob borer infestation generally begin to be detected in the field when the plants were observed at 60-65 days after planting (Ginting *et al.*, 2023). Kalshoven (1981) reported that *H. armigera* begins to appear in corn crops when female flowers (cobs) form and silk begin to emerge. Adults lay eggs on the silk. Corn plants typically develop silk at 56 days after planting, and this is when adults typically lay their eggs. Because this pest was cannibalistic, only one *H. armigera* larva was found per cob during observations.

Observations of the intensity of *H. armigera* infestation in corn crops showed symptoms with a high intensity of 31%. Generally, the average intensity of *H. armigera* infestation was categorized as quite low. Karim *et al.* (2013)

stated that the attack of ear borer pests increases with the age of the plant caused by the varying response of the pplant andof course influenced by the appearance of plant resistance properties in the field, namely a decrease in DIMBOA levels which were repellent for ear borers. The low intensity of infestation from *H. armigera* was also possible due to the cannibalistic nature of the larvae which can suppress the population development of *H. armigera.* This was in accordance with the report from Herlinda (2005) that the fertility of *H. armigera* is generally quite high, reaching an average of 76.52%, but the development of pests was lower due to high competition between cannibalistic larvae.

The difference in the level of resistance was influenced by biophysical and biochemical factors which involved in plants interrelationship with insects. Biophysical factors such as morphology, anatomy, and plant color affect the resistance of a variety. Plants become more favored by insects, depending on how big the role of each factor influence resistance of plant or a combination of the three factors above. The morphological and physiological conditions of each plant variety are generally different so they can affect the attack of *H. armigera.*

FAW eggs were typically laid on the upper surface of leaves but sometimes laid on other parts of the host plant. The number of eggs per clutch can vary from 100 to 200 (Prasanna *et al.,* 2018). Eggs hatch in two to four days at temperatures ranging from 21 to 27°C. The final instar larvae cause more than 70% of the damage to corn plants. A single FAW larva can consume approximately 140 cm^2 of corn leaf area during its larval development. Late-instar FAW larvae exhibit cannibalistic behavior on smaller larvae when they coexist. Cannibalism was found to cause approximately 40% of corn plant mortality when two or four fourth instar larvae infested corn plants over a three-day period (Chapman *et al.,* 2000).

Screening for corn variety resistance to FAW infestation was based on the level of plant damage. Resistant varieties were those that experience less damage compared to other varieties under similar environmental conditions. The level of *S. frugiferda* infestation showed that all evaluated hybrid corn genotypes were moderately resistant (10 varieties), susceptible (4 varieties), and highly susceptible (3 varieties) to *S. frugiferda* infestation. This was thought to be influenced by biophysical and biochemical factors, namely morphological and anatomical characteristics, as well as the content of compounds in the plants.

According to Hedin *et al.* (1996), resistant varieties have higher hemicellulose and cellulose content in FAW-resistant corn plants compared to susceptible corn plants. Lipids in the corn leaf cuticle play a role in FAW larval activity. When FAW larvae feed on leaves with cuticular lipids removed, the larvae develop more rapidly than those fed on leaves with cuticular lipids (Yang *et al.,*1993). Another study found that FAW neonate larvae traveled longer distances and moved more quickly on smooth leaves than on leaves with a dense wax crystal structure (Yang *et al.,* 1993).

The characteristics of physical organs or plant tissues and toxic secondary metabolites also influence host selection behavior and part of the direct defense network of plants; for example, trichomes, wax crystal structure, leaf thickness and toughness, and silica content can cause avoidance behavior in insects (Schoonhoven *et al.,* 2005). The process of host plant selection and acceptance by insects involves several insect behaviors (Knolhoff *et al.,* 2014; Schoonhoven *et al.,* 2005). Initially, when the insect touches the plant, the insect evaluates the physical and chemical state of the plant which was used for initial behavioral decisions, either to continue or to reject the plant. In the evaluation phase, the insect limits its movement to a smaller area, the next step, the insect damages the plant with a test-bite, when the sensory information was positively evaluated by its nervous system, the final decision was made, the host plant was accepted. In addition, lipophilic leaf surface constituents (alkenes, esters, and fatty acids) and secondary plant metabolites are also known to influence insect biting and feeding tests.

Since host plant acceptance was determined by the balance between stimulant and inhibitory compounds, a thorough analysis of these compounds in leaf tissue is necessary for host selection and preference. Flavonoid C-glycosides and chlorogenic acid are important for antibiosis activity in maize (Senewe, 2019). Another study has demonstrated the role of leaf toughness in maize resistance to the European corn borer *Ostrinia nubilalis*, finding this trait to be an important defense mechanism in maize across various germplasm groups (Bergvinson *et al.,* 1994).

Evaluating corn plant resistance to FAW infestation in the field was more complex due to the interaction of the plant with several other factors, including location, soil type, plot size, agroecological conditions, weeding frequency, use of hedgerows, intercropping, manure, and nitrogen (Baudron *et al.,* 2019; Ni *et al.,* 2014). Environmental conditions and the abundance of predatory insects also need to be taken into account when assessing corn cultivar resistance to FAW and other insects in the field (Ni *et al.,* 2014). Beetles, earwigs, and spiders were important predators of FAW (Sueldo *et al.,* 2010), however, we did not sample these predatory arthropods in our study.

Further studies are also investigated the role of indirect defenses against FAW in corn. Several studies have shown that certain corn cultivars produce volatile organic compounds (VOCs) that attract insect parasitoids after plant damage (Tamiru *et al.,* 2012), or even that the volatiles themselves are produced by the plant as defense volatiles (Roque-Romero *et al.,* 2020). In corn, VOCs are important not only for attracting parasitoids but also for attracting predatory insects (Merey *et al.,* 2011). *Spodoptera littoralis* Boisduval (Noctuidae) is attracted to nine plant volatiles, demonstrating that plant chemicals play a role in larval behavior in searching for host plants (de Fouchier *et al.,* 2018).

Other defense mechanisms, such as defense genes, are present in corn (Chuang *et al.,* 2014). Differences in plant resistance to damage from *S. frugiferda* in these varieties are also influenced by plant genetics. Transgenic or genetically engineered plants are a strategy to control FAW damage in corn by expressing resistance genes against Lepidoptera. FAW-resistant corn varieties have been developed using insecticide crystal protein genes (cry) isolated from *Bacillus thuringiensis* (Bt). FAW larvae will die after consuming the cry protein. Several cry genes available, including cry1A, cry1Ab, and cry1F, have been developed in Bt corn varieties (Horikoshi *et al.,* 2016). Plant resistance mechanisms against FAW attacks have also been developed in corn plants by increasing plant resistance by creating plants with thicker leaf epidermis (Davis *et al.,* 1995). Viana *et al.* (2013), compared the level of corn resistance to FAW attacks in 32 conventional corn hybrids with three transgenic Bt hybrids expressing the toxin cry1F and cry1A.105 + cry2Ab2 (2B707Hx, AG8088PRO, and DK390PRO). The six best conventional hybrids had scores based on Davis ranging from 2.8 to 4.1, while the three Bt hybrids showed a score of 1; in contrast, the susceptible control hybrid showed a score of 7.

The corn varieties observed in Bengkulu in this study were conventional hybrid corn varieties that were generally partially resistant to FAW attacks. Therefore, it was necessary to develop or plant these varieties. However, this research requires further investigation as measurements of the morphology and chemical compounds in plants that might influence FAW attacks were not conducted. The use of resistant varieties does not cause environmental pollution, and it is easy for farmers to apply in the field. Therefore, plant resistance, especially to pest attacks, plays a crucial role in integrated pest management. The severity of attacks by the three pests on these 17 hybrid corn varieties did not exceed the economic threshold of more than 50%; the highest severity of attack was only 31%. This means that if the pest population or damage has not reached this threshold, pesticide use was still unnecessary. The economic threshold, or control threshold, or economic tolerance threshold was the decision-making process for pesticide use (Dwisatria *et al.,* 2025). Reducing pesticide use will reduce environmental pollution and reduce corn crop maintenance costs.

Growing awareness of the negative impacts of synthetic chemical use has driven the development of organic farming worldwide, and the area devoted to organic crop production has expanded year after year (Willer *et al.,* 2017). This trend of increasing acreage for organic farming is also evident in Indonesia, from a consumer perspective, the growing preference for organic products has driven the development of the organic agricultural market, despite higher prices than conventional agricultural products (Alamsyah, 2016; Aufanada *et al.,* 2018).

Increasing the productivity of organically cultivated sweet corn still faces challenges, particularly related to the availability of seeds that are well-adapted to organic conditions and diverse growing environments and possess desirable traits, including high yield potential, better adaptability to suboptimal environmental conditions, resistance to major pests and diseases, early maturity, and improved nutritional content and quality. Gene sources for these traits need to be identified and found in germplasm collections through characterization and evaluation (Abadassi, 2015). To meet these requirements, sweet corn breeders are challenged to develop varieties with high productivity and yield quality in organic crop production systems.

The 17 sweet corn hybrid varieties evaluated, the variety with the highest level of attack (susceptibility) to *O. furnacalis, H. armigera,* and *S. frugiperda* was Caps15 x Caps22. The highest *O. furnacalis* attack found in Caps15 x Caps22 was 33% and significantly different from the comparison varieties Paragon and Bonanza, and the highest *H. armigera* attack found in the same variety Caps15 x Caps22 was 31%, but not significantly different from the comparison varieties Paragon and Bonanza, as well as the highest scoring *S. frugiperda* attack was found in the same variety. The highest yield was 16.05 tons/ha, the diameter of the cob with husk was 300.93 mm and the weight of the cob with husk was 56.73 g on Caps15 x Caps23 and was not significantly different from the comparison variety Paragon with a yield of 17.87 tons/ha, the diameter of the cob with husk was 335.06 mm and the weight of the cob with husk was 57.3 g.

Observations revealed that the 17 hybrid corn varieties evaluated showed varying responses (resistant, moderately resistant, and susceptible) to pest attacks. The varieties with similar levels of resistance to *O. furnacalis, H. armigera,* and *S. frugiperda* were Caps15 x Caps22, Caps22 x Caps23 (susceptible), and Caps17B x Caps23 (moderately resistant). The severity of these three pests did not exceed the economic threshold, remaining below 50%, with the highest severity reaching only 33%. This means that pest populations or damage caused by these pests have not reached this threshold, so pesticide use is not necessary. Reducing pesticide use will reduce environmental pollution and reduce corn crop maintenance costs.

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Conflicts of interest

I declare no competing interests regarding this publication.

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