Final Report

On Fall Armyworm (FAW) research in Kham, Xieng Khouang and Thatom, Xaisomboun (2020-2021)

Introduction

In 2019 and early 2020, comparative, action research has been undertaken on the control of FAW on maize in farmer fields in Kham district, XiengKouang province. Research has evaluated the application of botanical extracts, Bt and detergent/oil mixtures, the use of insect predators and parasitoids, and predation by chickens and chemicals. Research was conducted in the wet season for maize and the dry season for sweet corn. Trials with sweet corn found that botanical extracts (tobacco and Guduchi) were effective, while the use of insect predators and parasitoids, Bt var. kurstaki and detergent/oil mixtures do not work because of various factors. At the same time, some data on maize yield show different levels of damage for different varieties of maize. PACIFIC 777 was found to be highly damaged during the growing stage but there was no damage to the cobs, while LVN 10 plants were not highly damaged during the growing stage but pods were severely affected.

The purpose of the present research has been to draw on these indications and collaborate with provincial agriculture officers and farmers to identify a method or combination of methods to solve the FAW problem in farmers' maize (corn) fields. The work has focused especially on low-cost, sustainable control options which would be within the meagre, financial resources of typical Lao farmers.

Research team

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Methods/Activities

Research was conducted in Xieng Kouang province during the late wet season to early dry season and in Thatom in the dry season

Xieng Kouang (May – November 2020)

Here, the research activities were performed by farmers in Hainieng and Say villages; six farmers in the two villages joined the research.

- Six farmers in Hainieng and Say villages performed research to compare four treatments: (1) *Tinospora cordifolia* or Guduchi extract (This plant species contains phytoecdysteroids which mimic insect moulting hormones. These compounds are toxic by disrupting insect physiology and thus defend plants against phytophagous insects.); (2) tobacco extract; (3) Guduchi extract + stink bug release; (4) farmer technique (In Say village farmers do not apply pesticide;iIn Hainieng village the farmers learn from experience in the previous season and applied botanical extract, released stink bug, conserved natural enemies and killed caterpillars by hand). Each plot was 1 rai (0.16 ha) and four varieties of corn were grown, LVN 10 (from Vietnam) and CP 535, PACIFIC 777 and PACIFIC 779 (from Thailand). For Treatment 1 and 2, farmers applied treatments two times; for treatment 3, farmers applied botanical once and released 200 stink bugs (the first release time was when maize was 30 days old and the second release was when maize was beginning to flower). Four molasses traps were set up in each plot for FAW moth monitoring but data from these traps was not recorded in these seasons.

- Data collection comprised recording the number of FAW caterpillars on the crop, the extent of damage by FAW and also the number of natural enemies (including ants, spiders, lady beetles, assassin bugs, stink bugs and parasitoids). Each plot was observed before application of treatment, 7 days after treatment and then every 7 days until maize began to flower; in each plot, 50 plants were surveyed, production (i.e. yield) in each plot was also recorded. One hundreds of corn cobs (LVN 10 and PACIFIC 779 varieties) that damaged lost by FAW were counted seeds and determine the number of seeds lost , the weight of 1000 seeds for each variety to calculate - yield lost.

Thatom (December 2020 – February 2021)

Here, research activities were performed by farmers in Pak Yeong and NaXong villages; two farmers in each village joined the research.

- Two farmers in Pak Yeong and NaXong villages performed research to compare two treatments in sweet corn: (1) Guduchi extract + stink bug release plot size 310 m^2; (2) stink bug released only plot size 400 m^2; (3) farmer technique (applied chemical pesticides) plot size 310 m^2,; and , .
- In Pak Yeong farmers cut rice stubble, burn the stubble and then applied seed.
- In NaXong village farmers cut rice stubble, burnt, covered the plot with plastic sheet, and then applied seed. In this village farmers have started to use insecticide to control FAW. Mostly farmers applied insecticide every 7 days.

- Data collection comprised recording the number of FAW caterpillars on the crop, the extent of damage by FAW and also the number of natural enemies (i.e. the same as for research in Xieng Khouang).

Results and discussion

<u>Xieng Kouang:</u>

The data accompanying this report illustrate the inherent challenge in trials of the kind performed in this cooperative research with farmers. The low number of replicates compared to the number of permutations (combinations) of sites, treatments and host plant varieties makes it necessary to interpret results with caution. However, the data do provide some strong signals.

Botanicals (Guduchi and tobacco extracts) had mixed impact on numbers of FAW caterpillars and resulting damage. In Hanieng village, caterpillar numbers were increasing despite the the first treatment (12 to 23 to 42 caterpillars in CP535 maize; 11 to 27 to 37 in LV10 variety) but the second application of botanicals suppressed numbers distinctly (42 to 14 in CP535; 37 to 7 on LV10) (Table 1). On the other hand, this suppression was not observed in Say village (on LV10). Percentage damage remained in the 22 – 48% range in Say. Damage peaked in Hanieng (45 – 56%) at the 14 day mark when caterpillars were most numerous (37 – 42). At the end of the trial, damage levels were comparable in both villages (32 – 40%).

Combining botanicals with release of predatory stink bugs gave more promising results on maize in Say. FAW numbers in the crop remained moderate (10 – 18). In Hainieng damage increased after the first application of botanicals (34 – 44%) but declined steadily after the second application and the release of predatory stink bugs.

Farmer techniques in Say allowed moderate numbers of FAW caterpillars (22 – 27 for the first 21 days of the trial. Numbers of caterpillars declined during the final days of the trial, as did percentage damage (22 – 35%).

Final damage and yield data indicate that in Say village, Guduchi + stink bugs provides the greatest benefit in cash terms to farmers and farmer techniques were the next most financially beneficial. Botanicals alone give clearly poor outcomes for farmers, especially when farmers grow the LV10 variety for which pods are more susceptible to damage by FAW damage. Farmers in Say were growing a variety (PACIFIC 777) in which the pods are less damaged by FAW caterpillars. However, in Hanieng, tobacco extract alone was a clear winning strategy and Guduchi+stink bugs performed least well yield. The yield of tobacco plot ishighest it could be because farmer collected earlier, it is high moisture. This could have been because farmers in Hanieng were both learning from previous experience and were hand killing FAW caterpillars. (Annex 1)

There are low damage there lower damage in general in 2020 when com pare from the wet 2019 season also show damage on leaves up to 100% for PACIFIC 777 and 82% for LVN10 before treatment, possibly because of natural enemies

The data from the counts the number of seeds lost due to FAW, and weight of 1000 seeds in two varieties showed that yield lost for LVN 10 is 2.29 % and for PACIFIC 779 the loss is 0.2 %. Results; corn cobs show low damage for PACIFIC 777 and higher yield according to farmers observations.

Other pests also affect yield lost. These pests include the Asian corn borer (*Ostrinia furnacalis*), the corn earworm (*Helicoverpa armigera*) , a tussock moth (*Euproctis* sp) and especially larvae of Pyralidae. Damage from these occurs when the corn is setting seed but there is also high damage nearer to harvest and post harvesting (most damage is to dry seed in the field and when the corn is in storage) (Annex 3). These insect pests and their damage needs to identified correctly in the field and it will be necessary to find control methods for them in addition to control methods for FAW. Drought also affects production (based on information from farmers who grew maize a few years ago).

<u>Thatom</u>:

A combination of Guduchi extract and predatory stink bugs reduces numbers of FAW caterpillars to very low levels and damage is correspondingly low. The data suggest that a second application of botanicals is essential. Interestingly, predatory stink bug numbers declined sharply 7 days after release. This raises the question: If there are few FAW caterpillars in a crop, do predators leave the crop in search of alternative prey. (Annex 2, Table 1)

A plot only release predatory stink bugs was not record properly by farmer the number of FAW caterpillar are reduced after releasing stink bugs. (Annex 2, Table 2.)

Chemical pesticide applications reduced FAW numbers initially. But by the third application the pesticide application seemed less effective and percentage damage increased after the third application. It is not clear whether this is due to reduction in numbers of beneficial insects or the emergence of pesticide resistance in FAW. Chemical pesticides combined with releases of stink bugs achieved greater suppression of FAW caterpillars and less damage but, damage was greater than in the absence of pesticides. (Annex 2, Table 3.)

Damage of FAW is consistent and clear with each treatment Guduchi+stink bugs deliver the best management for farmers. Guduchi + predatory bugs 4%, release predatory bugs 21 % , Farmer technique (chemical applied) 24%

<u>Natural enemies:</u>

FAW are susceptible to many pathogens, parasitoids and predators, and some of these have been detected in Kham, Xieng Khouang and Thathom, Xaisomboun (Annex 5). Observations in the dry season indicate that not many species of beneficial insects or insect pathogens are present during this period, with the absence of species of fungi, *Beauveria bassiana*, a species of *Nomuraea* and Nuclear Polyhedrosis Virus (NPV) especially noteworthy. Some species of parasitods can not be found in Kham or Thatom but have been found in Vientiane Capital, for example *Telenomus* sp. and *Charops* sp. (Annex 5)

Conclusion

Application of botanicals + predatory bugs is a useful approach and within the means of farmers.

Recommendations

- Studies should be commenced to investigate the possible emergence of pesticide resistance.
- Develop farmer-based rearing techniques for stink bugs.
- Trails should be undertaken to determine the optimal release frequency for stink bugs.
- Develop monitoring protocols for farmers, for example, to determine what numbers of caterpillars should trigger application of botanicals or release of stink bugs.
- PACIFIC 777 and 779 appear to be the bester crop varieties (based only on research in Kham 2 season)
- Investigate pathogens and seed treatments.

References

FAO (2018). Integrated management of the Fall Armyworm on maize. A guide for Farmer Field Schools in Africa.

FAO (2019). Fall armyworm, http://www.fao.org/fall-armyworm/background/en/ [April 8, 2021].

USAID.2019. Global Fall Armyworm Management.

Annex 1. Comparison of number of FAW, percentage of FAW damage, beneficial insect and yield in each treatment in Xieng Kouang.

Table 1. Number of FAW, beneficial insects and percentage damage from 50 plants in Say village.

		Before	After managed				
			7 days	14 days	21 days	28days	32days
Guduchi	FAW	25	18	15	23	9	14
(LVN 10 variety)	% damage	30	36	34	44	22	34
	Beneficial insects	3	1	1	2	4	1
Tobacco	FAW	19	22	17	22	10	13
(LVN 10 variety)	% damage	22	38	32	48	22	32
	Beneficial insects	5	1	0	2	5	1
Guduchi +	FAW	15	18	13	18	14	10
Stink bug	% damage	16	44	34	34	18	14
(PACIFIC 779)	Beneficial insects	1	5	1	1	5	2
Farmer	FAW	27	22	22	22	9	14
technique	% damage	48	42	38	46	22	32
(LVN 10 +PACIFIC 777)	Beneficial insects	0	3	2	0	3	1

Table 2. Number of FAW, beneficial insects and percentage damage from 50 plants in Hainieng village.

		Before	After manage				
			7 days	14 days	21 days	28days	32days
Guduchi	FAW	12	23	42	14	11	15
(CP 535 variety)	% damage	18	28	56	36	30	32
	Beneficial insects	0	1	2	3	1	3
Tobacco	FAW	11	27	37	7	13	21
(LVN 10 variety)	% damage	22	34	48	26	46	40
	Beneficial insects	2	1	2	3	3	6
Guduchi +	FAW	7	22	9	8	6	33
Stink bug	% damage	20	38	24	32	20	48
(LVN 10 variety)	Beneficial insects	0	0	8	13	10	7
Farmer	FAW	12	29	33	16	25	14
technique	% damage	30	40	46	34	56	46
(LVN 10 variety)	Beneficial insects	0	0	7	3	2	2

Table 3. Final damage and yields

	Corn cobs damaged (%)	Yield (kg/ha)	Total balance	Production cost (Kip)	Benefit (Kip)
Say village					
Guduchi(LVN 10)	27.7	4,631	6,020,300	3,600,000	2,420,300
Tobacco (LVN 10)	75.4	4,644	6,037,200	3,374,000	2,663,200
Guduchi + Stink bug (PACIFIC 779)	No record	5,500	7,150,000	3,710,000	3,440,000
Farmer technique (LVN 10+PACIFIC 777)	59.3	5,150	6,695,000	3,334,000	3,361,000
Hainieng village					
Guduchi(CP 535)	Maize dried because of drought when fruiting stage				
Tobacco (LVN 10)	19.3	9,063	11,781,900	3,474,000	8,307,900
Guduchi + Stink bug (LVN 10)	24.6	4,644	6,037,200	3,170,000	2,867,200
Farmer technique(LVN 10)	25.5	6,375	8,287,500	3,494,000	4,793,500

Annex 2. Insect pathogens and beneficial insects

Table 1. Number of FAW, beneficial insects and percentage damage from 50 plants in Guduchi + stink bug plot in NaXong, Thatom.

		Before	**1st applied treatments**	**1st stink bug releases**	**2nd applied treatments**	**2nd stink bug releases**		
			7 days	**7 days**	**7 days**	**7 days**	**14 days**	**21 days**
Guduchi + Stink bug	FAW	46	23	12	14	2	2	2
Sweet corn	% damage	16	6	16	16	4	6	4
(sticky variety)	Beneficial insects	8	2	7	1	0	0	0

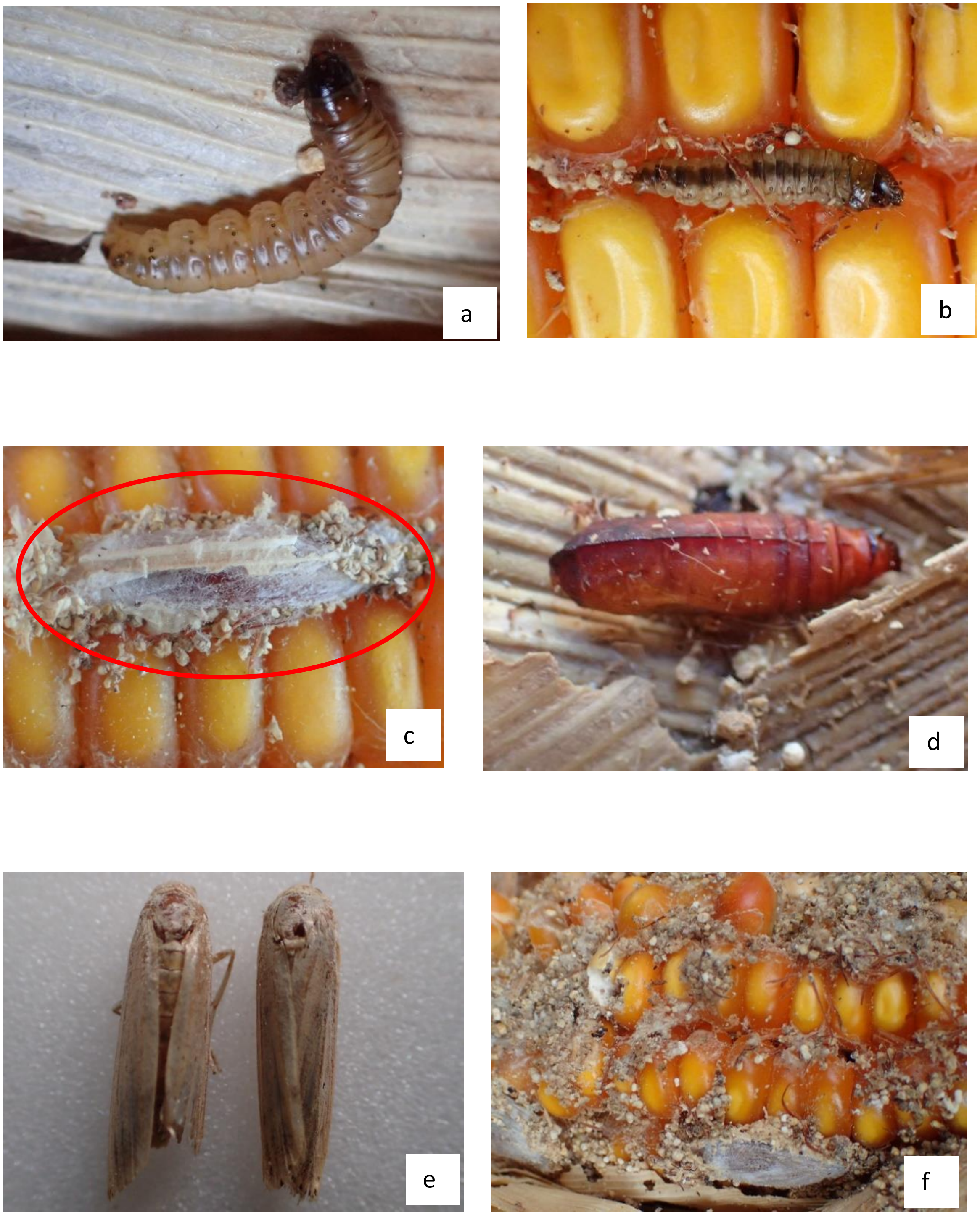
Table 2. Number of FAW, beneficial insects and percentage damage from 50 plants in released stink bug plot in Pak Yeong, Thatom.

		Before	**1st stink bug releases**	
			14 days	**28 days**
Stink bugs released	FAW	21	9	9
(sticky variety)	% damage	22	18	18
	Beneficial insects	7	3	5

Table 3. Number of FAW, beneficial insects and percentage damage from 50 plants in farmer technique plot in NaXong, Thatom.

		Before	**1st applied treatment**	**2nd applied treatment**	**3rd applied treatment**
Chemical pesticide	FAW	33	2	2	14
Sweet corn	% damage	36	16	6	34
(sticky variety)	Beneficial insects	2	0	0	0

Annex 3. Unidentified pest of drying maize: appearance of larvae, adult moth character and damage symptoms.



Figs. (a, b) larvae; (c) pupae in cocoon; (d) pupae; (e) adult; (f) damage symptom.

Annex 5. Insect pathogens and beneficial insects

Insect pathogens and beneficial insects	**Place of record**
Insect pathogens:	
Beauveria bassiana.	Kham
Nomuraea sp.	Kham, Thathom
Nuclear Polyhedrosis Virus (NPV)	Kham
Predators:	
Stink bug (*Eocanthecona furcellata*)	Kham, Thatom, Vientiane
Assassin bug (*Rhynocoris* sp.)	Kham
Assassin bug (*Sycanus collaris*)	Kham, Thatom, Vientiane
Assassin bug	Kham, Thatom
Ants	Kham, Thatom, Vientiane
Earwig	Kham, Thatom, Vientiane
Lady beetle	Kham, Thatom, Vientiane
Spider	Kham, Thatom, Vientiane
Tiger beetle	Kham, Thatom, Vientiane
Parasitoids:	
Charops sp.	Vientiane
Chelonus sp.	Kham,
Cotesia sp	Kham, Vientiane
Microplitis sp.	Kham, Vientiane
Telenomus sp.	Vientiane

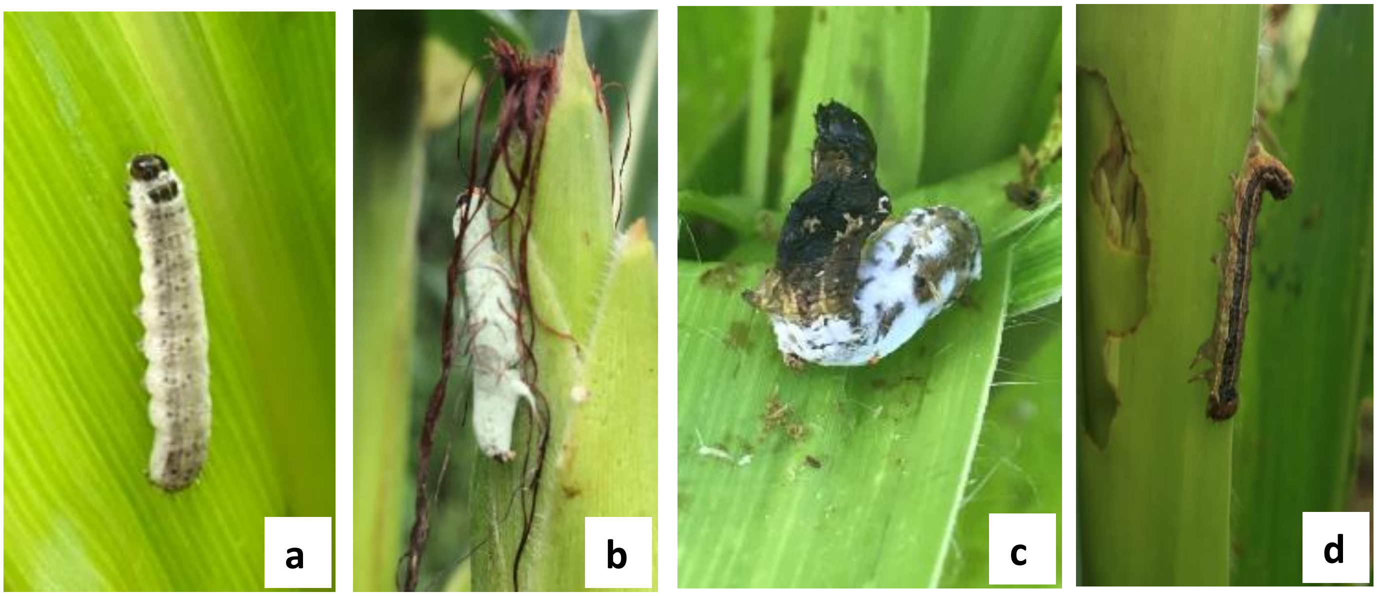


Fig 1. Insect of FAW Larvae: affected by (a b) *Nomuraea* sp, (b) *Beauveria bassiana* and (c) Nuclear Polyhedrosis Virus (NPV)

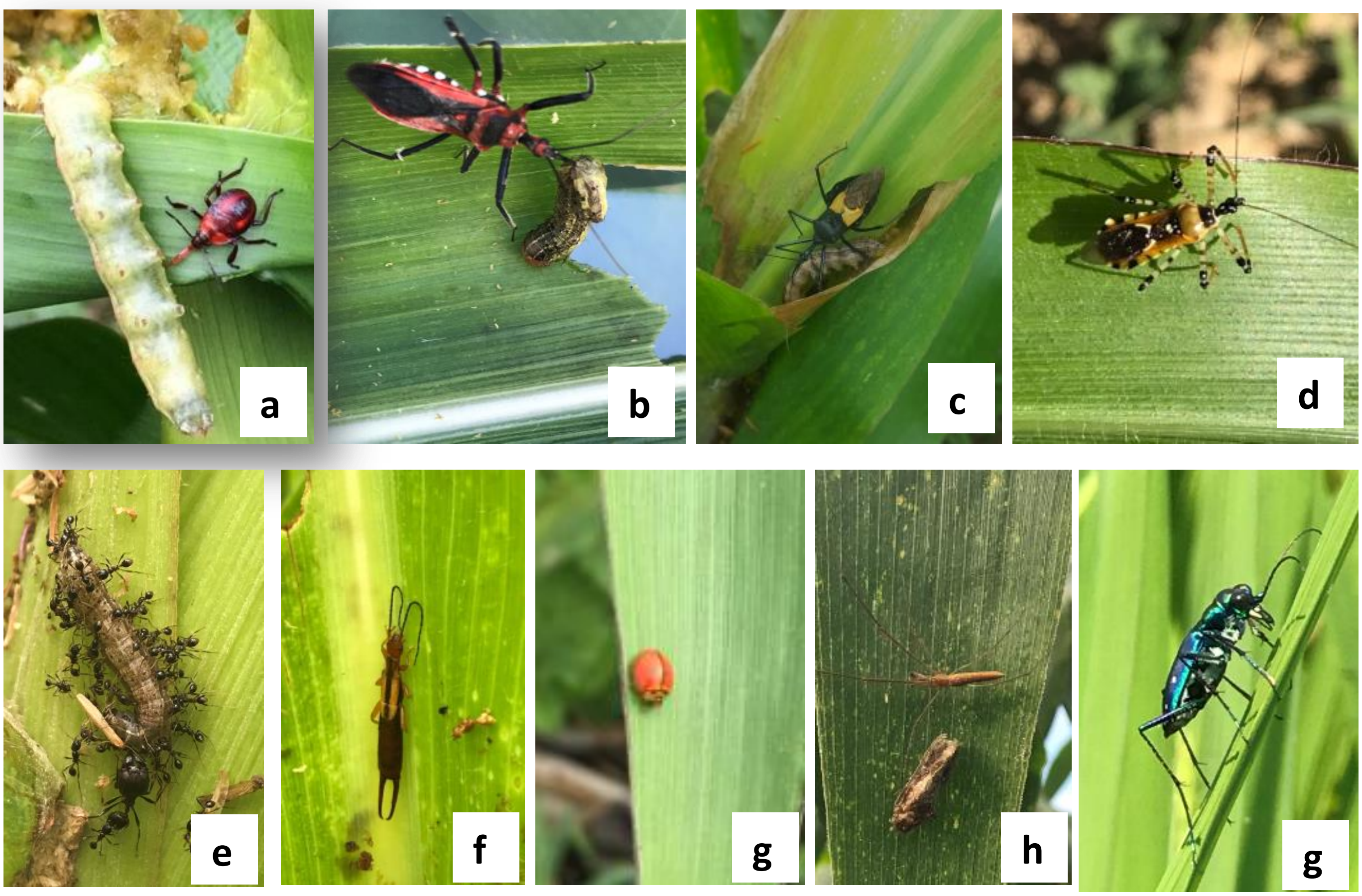


Fig 2. Predators: (a) Stink bug (*Eocanthecona furcellata*), (b) Assassin bug (*Rhynocoris* sp.), (c) Assassin (*Sycanus collaris*), (d) Assassin bug, (e) FAW larva being eaten by ants, (f) earwig, (g) lady beetle, (h) FAW moth eaten by spider, and (i) tiger beetle

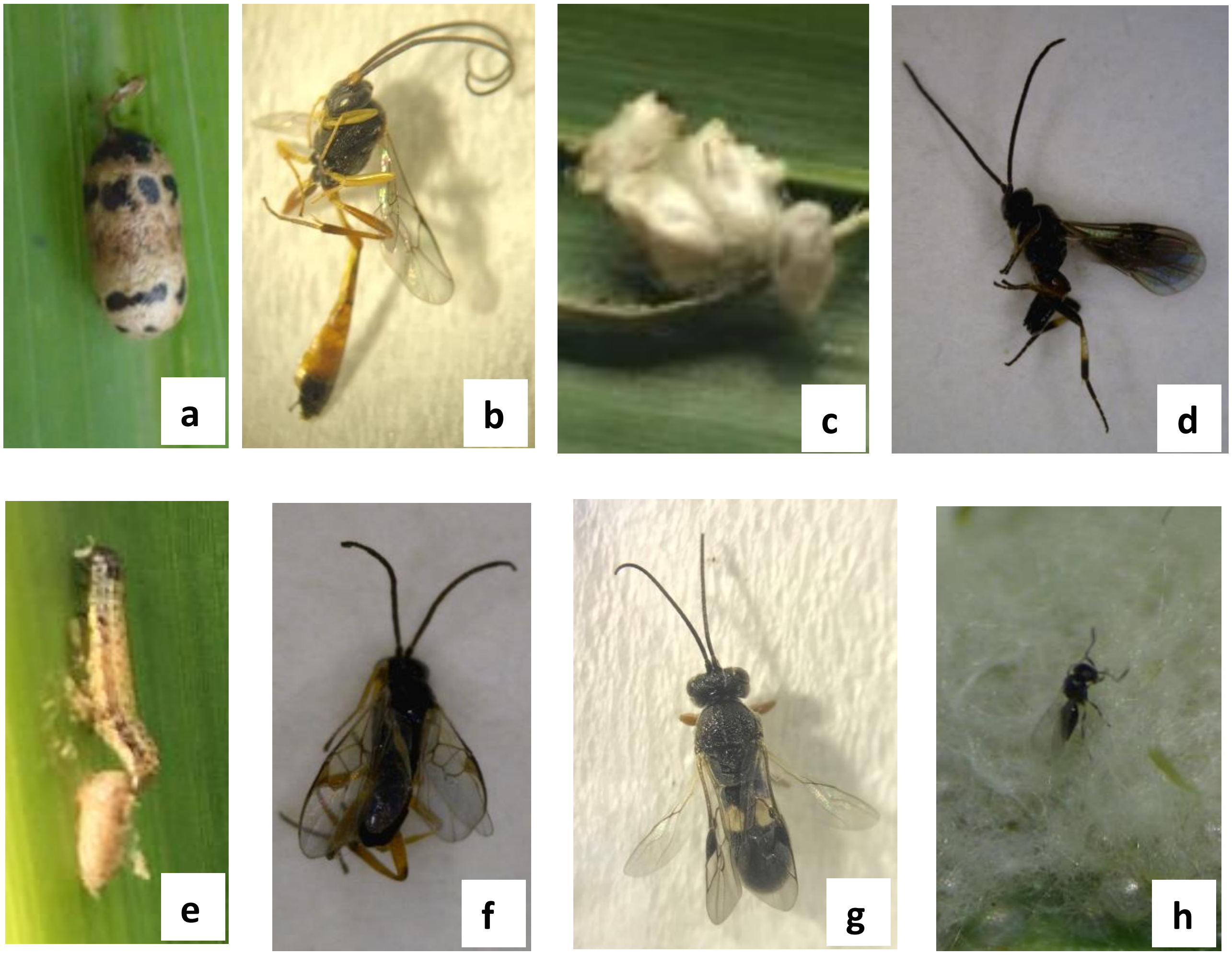


Fig 3. Parasitoids: (a, b) cocoon and adult (*Charops* sp.), (c, d) cocoon and adult (*Cotesia* sp), (e, f) cocoon and adult (*Microplitis* sp), (g) *Chelonus* sp., and (h) *Telenomus* sp.