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Project E. 4.1: Evaluation of zonal varieties/genotypes for their reaction against major insect-pests

A total of forty-three entries/genotypes of sugarcane were screened at RRS, Uchani, Karnal against major moth borers (shoot borer, top borer, stalk borer and root borer) and sucking pests (Pyrilla, whitefly, black bug and webbing mite) that included entries in six trials viz. ten under IVT (Early), four under AVT (Early)-I Plant, three under AVT (Early)-II Plant, fifteen under IVT- Midlate, six under AVT (Midlate)-I Plant and five under AVT (Midlate)-II Plant with 2 standards for early and 3 for midlate (Tables 1.1-1.6). All the evaluated genotypes showed susceptibility to the major borer species and sucking pests to varying extent.

Table 1.1a: Reaction of sugarcane genotypes in Initial Varietal Trial (Early) against major borers

Sr No.	Variety/Genotype	Borer (% infestation)				Grade of infestation			
		Shoot Borer	Top Borer	Stalk borer*	Root borer	Shoot Borer	Top Borer	Stalk borer*	Root borer
1	Co12026	23.8	4.9	2.2	8.0	MS	LS	MS	LS
2	Co 12027	14.0	4.8	2.7	28.4	LS	LS	MS	MS
3	CoH 12261	14.0	6.1	1.3	20.2	LS	LS	LS	MS
4	CoLk 12201	20.9	4.8	1.2	14.4	MS	LS	LS	LS
5	CoLk12202	16.2	5.8	1.1	25.2	MS	LS	LS	MS
6	CoLk 12203	10.1	6.2	1.5	22.2	LS	LS	LS	MS
7	CoLk 12204	21.1	10.2	1.4	24.0	MS	MS	LS	MS
8	CoPant 12221	4.3	11.2	2.1	17.4	LS	MS	MS	MS
9	CoPant 12222	15.6	3.6	1.7	28.3	MS	LS	LS	MS
10	CoS 12231	20.5	2.6	1.8	32.0	MS	LS	LS	HS
CK	CoJ 64	13.3	4.7	1.9	36.0	LS	LS	LS	HS
	Co 0238	6.3	5.2	1.6	11.3	LS	LS	LS	LS

*Infestation Index

In IVT- early, (Table 1.1a) ten genotypes were evaluated against two standards CoJ 64 and Co 0238. Shoot borer, *Chilo infuscatellus* incidence ranged from 4.3 to 23.8 per

cent in different genotypes and genotypes (Co 12027, CoH 12261, CoLk 12203, CoPant 12221, CoJ 64 and Co 0238) were categorised under least susceptible. Incidence of top borer, *Scirpophaga excerptalis* ranged from 2.6 to 11.2 per cent in tested genotypes. Genotypes CoLk 12204 and CoPant 12221 showed a reaction of moderately susceptible against top borer. All other genotypes including standard checks (CoJ 64 & Co 0238) were categorised under least susceptible category. In case of stalk borer, *Chilo auricilius* infestation index ranged from 1.1 to 2.7 in all genotypes. Out of which, three genotypes (Co 12026, Co 12027 and CoPant12221) were categorised under moderately susceptible and rest were least susceptible. Root borer, *Emalocera depressella* incidence ranged from 8.0 to 36.0 per cent. The highest infestation(36.0%) was recorded in CoJ 64(check). Genotype Co 12026, CoLk 12201 and Co 0238 (check) were found least susceptible.

Table 1.1b: Reaction of sugarcane genotypes in Initial Varietal Trial (Early) against major sucking pests

Sr No	Variety/Genotype	Sucking pests infestation				Grade of infestation			
		Pyrilla	White fly	Black bug	Webbing mite	Pyrilla	White fly	Black bug	Webbing mite
1	Co12026	4.2	3.3	4.0	5.5	LS	MS	LS	LS
2	Co 12027	4.0	11.5	4.8	7.8	LS	HS	LS	LS
3	CoH 12261	4.5	2.3	3.8	4.2	LS	MS	LS	LS
4	CoLk 12201	4.0	2.9	4.0	9.0	LS	MS	LS	LS
5	CoLk12202	4.0	0.6	3.2	8.3	LS	LS	LS	LS
6	CoLk 12203	4.4	2.1	4.3	9.2	LS	MS	LS	LS
7	CoLk 12204	4.8	0.5	2.7	2.7	LS	LS	LS	LS
8	CoPant 12221	4.5	1.9	5.0	4.0	LS	LS	LS	LS
9	CoPant 12222	6.7	6.2	4.0	8.3	MS	HS	LS	LS
10	CoS 12231	4.7	12.7	2.5	4.7	LS	HS	LS	LS
CK	CoJ 64	4.7	0.5	8.4	5.6	LS	LS	LS	LS
	Co 0238	4.2	2.2	4.7	3.6	LS	MS	LS	LS

Pyrilla population(nymph & adult)/leaf;Whitefly population (nymph & puparia)/2.5q.cm; Black bug population/leaf; Webbing mite(% leaf incidence)

All the tested genotypes (Table 1.1b) against *Pyrilla* were categorised in least susceptible group except CoPant 12222 which showed moderately susceptible reaction. All

genotypes exhibited least to highly susceptible reaction against whitefly and infestation ranged from 0.5 to 12.7 nymphs & puparia/2.5 sq.cm. Genotypes CoLk 12202, CoLk 12204, CoPant 12221 and CoJ 64 (standard check) were found least susceptible against whitefly. In the tested entries, the reaction against black bug varied from 2.5 to 5.0 black bug/leaf and all tested entries were graded as least susceptible. The incidence of webbing mite was also found at lower side in all the tested genotypes.

Table 1.2a: Reaction of sugarcane genotypes in Advance Varietal Trial (Early)- I Plant against major borers

Sr No.	Variety/Genotype	Borer (% infestation)				Grade of infestation			
		Shoot Borer	Top Borer	Stalk borer*	Root borer	Shoot Borer	Top Borer	Stalk borer*	Root borer
1	CoH 11262	24.2	2.9	1.2	11.4	MS	LS	LS	LS
2	CoLk 11201	14.5	3.6	0.8	19.5	LS	LS	LS	MS
3	CoLk 11202	12.8	11.7	2.4	12.0	LS	MS	MS	LS
4	CoLk 11203	10.4	8.8	1.8	28.3	LS	LS	LS	MS
CK	CoJ 64	13.3	4.7	1.9	36.0	LS	LS	LS	HS
	Co 0238	6.3	5.2	1.6	11.3	LS	LS	LS	LS

*Infestation Index

Shoot borer infestation in AVT (Early) –I Plant tested genotypes ranged from 6.3 to 24.2 per cent and all entries were categorised under least susceptible except CoH 11262 (Table1.2a). The top borer incidence was found to be lowest (2.9 %) in CoH 11262 and all genotypes showed least susceptible reaction except CoLk 11202 (Table 1.2a). The incidence of stalk borer was registered as low as 0.8 Infestation index in CoLk 11201 and all screened genotypes exhibited least susceptible reaction except CoLk 11202 which showed moderate susceptible reaction. All tested genotypes exhibited least to moderately susceptible reaction against root borer and check (CoJ 64) remained high susceptible against this pest.

Table 1.2b: Reaction of sugarcane genotypes in Advance Varietal Trial (Early)- I Plant against major sucking pests

Sr No.	Variety/Genotype	Sucking pests infestation				Grade of infestation			
		Pyrilla	Whitefly	Black bug	Webbing mite	Pyrilla	Whitefly	Black bug	Webbing mite
1	CoH 11262	4.0	1.8	3.7	3.0	LS	LS	LS	LS
2	CoLk 11201	9.4	1.9	5.2	9.0	MS	LS	LS	LS
3	CoLk 11202	4.2	3.5	5.0	8.2	LS	MS	LS	LS
4	CoLk 11203	3.8	1.5	5.0	6.5	LS	LS	LS	LS
C K	CoJ 64	4.7	0.5	8.4	5.6	LS	LS	LS	LS
	Co 0238	4.2	2.2	4.7	3.6	LS	MS	LS	LS

Pyrilla population(nymph & adult)/leaf; Whitefly population (nymph & puparia) / 2.5 sq.cm; Black bug population/leaf; Webbing mite(% leaf incidence)

Among all the evaluated genotypes (Table 1.2b), five genotypes exhibited least susceptible reaction (CoH 11262, CoLk 11202, CoLk 11203, check CoJ 64 & Co 0238) and one genotype (CoLk 11201) moderately susceptible reaction against *Pyrilla* incidence, whereas, all genotypes showed least susceptible to whitefly except Co 0238(check) and CoLk 11202 which were reported moderately susceptible. The infestation of black bug in this category varied from 3.7 to 8.4 and all tested genotypes including standard check (CoJ 64 & Co 0238) were reported as least susceptible. All tested genotypes were found least susceptible against webbing mite.

Table 1.3a: Reaction of sugarcane genotypes in Advance Varietal Trial (Early) - II Plant against major borers

Sr No.	Variety/Genotype	Borer (% infestation)				Grade of infestation			
		Shoot Borer	Top Borer	Stalk borer*	Root borer	Shoot Borer	Top Borer	Stalk borer*	Root borer
1	Co 10035	9.4	4.6	1.6	24.2	LS	LS	LS	MS
2	CoH 10261	9.6	3.4	2.5	20.0	LS	LS	MS	MS
3	CoS 10231	5.6	3.2	1.2	12.5	LS	LS	LS	LS
CK	CoJ 64	13.3	4.7	1.9	36.0	LS	LS	LS	HS
	Co 0238	6.3	5.2	1.6	11.3	LS	LS	LS	LS

*Infestation Index

All the tested genotypes in AVT (Early)- II Plant were categorised under least susceptible against shoot and top borer infestation. All the screened genotypes(Table 1. 3a) against

stalk borer showed a range of infestation from 1.2 to 2.5 infestation index and were observed as least susceptible including standard checks(CoJ 64 & Co 0238) except CoH 10261. Genotypes CoS 10231 and Co 0238 were recorded least susceptible reaction against root borer. Two genotypes Co 10035 and CoH 10261 were categorised moderately susceptible against this pest. However, CoJ 64 was reported highly susceptible where infestation was observed 36.0 per cent.

Table 1.3b: Reaction of sugarcane genotypes in Advance Varietal Trial (Early)- II Plant against major sucking pests

Sr No.	Variety/Genotype	Sucking pests infestation				Grade of infestation			
		Pyrilla	White fly	Black bug	Webbing mite	Pyrilla	Whitefly	Black bug	Webbing mite
1	Co 10035	4.7	1.6	3.5	4.0	LS	LS	LS	LS
2	CoH 10261	4.0	1.9	4.7	2.8	LS	LS	LS	LS
3	CoS 10231	4.0	17.2	4.7	6.0	LS	HS	LS	LS
CK	CoJ 64	4.7	0.5	8.4	5.6	LS	LS	LS	LS
	Co 0238	4.2	2.2	4.7	3.6	LS	MS	LS	LS

Pyrilla population(nymph & adult)/leaf; Whitefly population (nymph & puparia) / 2.5 sq.cm; Black bug population/leaf; Webbing mite(% leaf incidence)

The three evaluated entries Co 10035, CoH 10261 and CoS 10231 exhibited least susceptible reaction along with check CoJ 64 and Co 0238 against *Pyrilla* while, CoS 10231 showed highly susceptible against whitefly and other two genotypes (Co10035 & CoH 10261) were found least susceptible. CoJ 64 (standard check) was reported least susceptible against whitefly while Co 0238 (standard check) was observed to be moderately susceptible against this pest(Table 1.3b). All the tested entries found least susceptible against webbing mite. All tested genotypes were found least susceptible against black bug including standard checks.

Table 1.4a: Reaction of sugarcane genotypes in Initial Varietal Trial - Midlate against major borers

Sr No.	Variety/Genotype	Borer (% infestation)				Grade of infestation			
		Shoot Borer	Top Borer	Stalk borer*	Root borer	Shoot Borer	Top Borer	Stalk borer*	Root borer
1	Co 12028	20.4	3.2	1.3	21.2	MS	LS	LS	MS
2	Co 12029	16.9	4.2	3.3	15.6	MS	LS	MS	MS
3	CoH 12262	14.0	3.3	2.3	24.0	LS	LS	MS	MS
4	CoH 12263	10.1	2.6	1.2	26.4	LS	LS	LS	MS
5	CoLk 12205	11.7	3.8	0.7	12.5	LS	LS	LS	LS
6	CoLk 12206	7.9	1.5	2.6	23.6	LS	LS	MS	MS
7	CoPant 12223	19.1	2.6	0.8	22.8	MS	LS	LS	MS
8	CoPant 12224	14.2	11.9	2.1	32.0	LS	MS	MS	HS
9	CoPant 12225	11.8	3.2	0.4	14.0	LS	LS	LS	LS
10	CoPant 12226	18.3	4.2	1.9	21.2	MS	LS	LS	MS
11	CoPb 12181	8.6	3.8	6.8	27.6	LS	LS	HS	MS
12	CoPb 12182	9.3	4.0	1.3	20.0	LS	LS	LS	MS
13	CoPb 12211	15.1	3.7	0.8	26.8	MS	LS	LS	MS
14	CoPb 12212	8.3	2.8	1.4	18.4	LS	LS	LS	MS
15	CoS 12232	8.0	1.8	0.4	16.0	LS	LS	LS	MS
CK	CoS 767	11.2	1.6	0.2	16.0	LS	LS	LS	MS
	CoS 8436	14.5	2.6	0.4	25.4	LS	LS	LS	MS
	CoPant 97222	12.6	1.9	0.7	18.0	LS	LS	LS	MS

*Infestation Index

In the IVT Midlate trial (Table 1.4a) fifteen entries were evaluated against three standards(CoS 767, CoS 8436 & CoPant 97222). The shoot borer incidence varied between 7.9 and 20.4 per cent. The genotype CoLk 12206 contained the lowest incidence while, the genotype Co 12028 possessed the highest incidence. All tested genotypes including standard checks (CoS 767, CoS 8436 and Co 97222) except Co 12028, Co 12029, CoPant 12223, CoPant 12226 and CoPb 12211 were found in least susceptible category against shoot borer. All the entries showed least susceptible reaction against top borer except CoPant 12224. All the entries showed low to high incidence of stalk borer. Lowest infestation index (0.2) was reported in CoS 767 (check) and highest (6.8) in CoPb 12181. While the incidence of root borer in all entries was quite high. Genotypes CoLk 12205 and CoPant 12225 were reported in least susceptible category while all other were categorized in moderately to highly susceptible category.

Table 1.4b: Reaction of sugarcane genotypes in Initial Varietal Trial - Midlate against major sucking pests

Sr No	Variety/Genotype	Sucking pests infestation				Grade of infestation			
		Pyrilla	White fly	Black bug	Webbing mite	Pyrilla	Whitefly	Black bug	Webbing mite
1	Co 12028	4.5	6.6	3.3	3.5	LS	HS	LS	LS
2	Co 12029	8.0	1.3	4.8	8.0	MS	LS	LS	LS
3	CoH 12262	4.3	1.0	4.2	4.0	LS	LS	LS	LS
4	CoH 12263	4.0	3.3	4.3	7.0	LS	MS	LS	LS
5	CoLk 12205	3.7	2.1	4.3	8.7	LS	MS	LS	LS
6	CoLk 12206	4.2	5.7	3.8	8.3	LS	HS	LS	LS
7	CoPant 12223	3.2	1.3	6.3	4.2	LS	LS	LS	LS
8	CoPant 12224	10.8	0.9	4.2	4.5	MS	LS	LS	LS
9	CoPant 12225	4.3	2.8	3.3	2.3	LS	MS	LS	LS
10	CoPant 12226	4.7	0.7	2.8	2.7	LS	LS	LS	LS
11	CoPb 12181	4.8	0.9	3.8	7.8	LS	LS	LS	LS
12	CoPb 12182	3.7	1.5	4.0	7.7	LS	LS	LS	LS
13	CoPb 12211	4.7	11.1	3.8	4.3	LS	HS	LS	LS
14	CoPb 12212	3.3	3.3	3.2	9.5	LS	MS	LS	LS
15	CoS 12232	4.2	3.1	4.3	8.5	LS	MS	LS	LS
C K	CoS 767	4.3	3.9	4.0	9.7	LS	MS	LS	LS
	CoS 8436	3.2	1.9	2.7	5.0	LS	LS	LS	LS
	CoPant 97222	4.2	3.5	4.8	9.4	LS	MS	LS	LS

Pyrilla population(nymph & adult)/leaf; Whitefly population (nymph & puparia) / 2.5 sq.cm; Black bug population/leaf; Webbing mite(% leaf incidence)

Fifteen entries were evaluated under IVT midlate (Table 1.4b) against sucking pests. All genotypes were found least susceptible except Co 12029 and CoPant 12224 against *Pyrilla*. Lowest whitefly infestation (0.7 nymphs & puparia / 2.5 sq.cm). was observed in CoPant 12226 and highest in CoPb 12211(11.1 nymphs & puparia/2.5 sq.cm). CoS 8436(check) was also observed in least susceptible category. The infestation of black bug in this class ranged from 2.7 (CoS 8436) to 6.3 (CoPant 12223) black bug/ leaf and all genotypes were categorised as least including standard check. In case of webbing mite invasion, all genotypes were classed as least susceptible including standard checks.

Table 1.5a: Reaction of sugarcane genotypes in Advanced Varietal Trial (Midlate) -I Plant against major borers

Sr No.	Variety/Genotype	Borer (% infestation)				Grade of infestation			
		Shoot Borer	Top Borer	Stalk borer*	Root borer	Shoot Borer	Top Borer	Stalk borer*	Root borer
1	Co 11027	8.4	3.5	1.2	20.5	LS	LS	LS	MS
2	CoH 11263	6.6	1.2	0.8	16.2	LS	LS	LS	MS
3	CoLk 11204	9.2	1.0	0.6	9.2	LS	LS	LS	LS
4	CoLk 11206	9.6	4.2	1.8	12.5	LS	LS	LS	LS
5	CoPb 11214	10.2	2.8	1.7	32.4	LS	LS	LS	HS
6	CoS 11232	8.8	1.6	4.0	28.6	LS	LS	MS	MS
CK	CoS 767	11.2	1.6	0.2	16.0	LS	LS	LS	MS
	CoS 8436	14.5	2.6	0.4	25.4	LS	LS	LS	MS
	CoPant 97222	12.6	1.9	0.7	18.0	LS	LS	LS	MS

*Infestation Index

In AVT (Midlate)- I Plant (Table 1.5a), six entries were evaluated against three standards. The shoot borer incidence ranged from 6.6 (CoH 11263) to 14.5 per cent (CoS 8436, standard check) indicating low susceptibility of the all the genotypes to this borer species. The top borer incidence was also quite low reaching a maximum of 4.2 per cent in CoLk 11206. However, all the tested entries including standard checks were categorized in least susceptible against top borer. All the entries, with their infestation index varying between 0.2 (CoS 767, standard check) to 4.0 (CoS 11232) were found to be low to moderately susceptible against stalk borer. Genotypes CoLk 12204 and CoLk 12206 were found least susceptible against root borer. Highest infestation (32.4%) was observed in CoPb 11214.

Table 1.5b: Reaction of sugarcane genotypes in Advanced Varietal Trial (Midlate) – I Plant against major sucking pests

Sr No.	Variety/Genotype	Sucking pests infestation				Grade of infestation			
		Pyrilla	Whitefly	Black bug	Webbing mite	Pyrilla	Whitefly	Black bug	Webbing mite
1	Co 11027	2.6	1.8	5.4	12.5	LS	LS	LS	MS
2	CoH 11263	4.6	1.9	3.4	5.4	LS	LS	LS	LS
3	CoLk 11204	3.3	8.5	3.2	6.0	LS	HS	LS	LS
4	CoLk 11206	2.8	2.1	1.8	3.8	LS	MS	LS	LS
5	CoPb 11214	4.8	6.4	3.8	6.8	LS	HS	LS	LS
6	CoS 11232	9.6	13.5	3.5	3.0	MS	HS	LS	LS
CK	CoS 767	4.3	3.9	4.0	9.7	LS	MS	LS	LS
	CoS 8436	3.2	1.9	2.7	5.0	LS	LS	LS	LS
	CoPant 97222	4.2	3.5	4.8	9.4	LS	MS	LS	LS

Pyrilla population(nymph & adult)/leaf; Whitefly population (nymph & puparia) / 2.5 sq.cm; Black bug population/leaf; Webbing mite(% leaf incidence)

Entries tested against sucking pests *i.e.*, *Pyrilla*, whitefly, black bug and webbing mites were categorised under least to moderately susceptible including checks (Table 1.5b) in AVT(Midlate)- I Plant. All tested entries except CoS 11232 were recorded in least susceptible category against *Pyrilla*. Minimum infestation of whitefly (1.8 nymphs & puparia/2.5 sq.cm) was observed in genotype Co 11027 and maximum(13.5 nymphs & puparia/2.5 sq.cm) in CoS 11232. Three genotypes Co 11027, CoH 11263 and CoS 8436(check) were found least susceptible against whitefly. All tested genotypes including standard checks were categorised in least susceptible category against black bug. All genotypes except Co 11027 were also observed as least susceptible against webbing mite.

Table 1.6a: Reaction of sugarcane genotypes in Advanced Varietal Trial (Midlate) - II Plant against major borers

Sr No.	Variety/Genotype	Borer (% infestation)				Grade of infestation			
		Shoot Borer	Top Borer	Stalk borer*	Root borer	Shoot Borer	Top Borer	Stalk borer*	Root borer
1	Co 10036	7.4	0.8	0.8	26.5	LS	LS	LS	MS
2	CoH 10262	7.2	0.6	1.3	18.5	LS	LS	LS	MS
3	CoPant 10221	8.2	3.8	3.1	22.4	LS	LS	MS	MS
4	CoPb 10181	8.1	2.4	0.3	23.8	LS	LS	LS	MS
5	CoPb 10182	18.1	2.9	1.2	20.0	MS	LS	LS	MS
CK	CoS 767	11.2	1.6	0.2	16.0	LS	LS	LS	MS
	CoS 8436	14.5	2.6	0.4	25.4	LS	LS	LS	MS
	CoPant 97222	12.6	1.9	0.7	18.0	LS	LS	LS	MS

*Infestation Index

All genotypes evaluated in AVT midlate –II Plant (Table 1.6a) against shoot borer were found least susceptible except CoPb 10182 and infestation ranged from 7.2 to 18.1 per cent including standard checks. Lowest incidence (7.2%) was observed in CoH 10262 and highest (18.1%) in CoPb 10182. All entries tested against top borer infestation showed least susceptible reaction including standard checks. In case of stalk borer, infestation ranged from 0.2 to 3.1 infestation index and all the genotypes were categorised as least susceptible except CoPant 10221(3.1 infestation index). Root borer infestation ranged from 16.0 to 26.5 per cent including standard checks in tested entries and were categorised moderately susceptible.

Table 1.6b: Reaction of sugarcane genotypes in Advanced Varietal Trial (Midlate 11Plant) against major sucking pests

Sr No.	Variety/ Genotype	Sucking pests (% infestation)				Grade of infestation			
		Pyrilla	Whitefly	Black bug	Webbing mite	Pyrilla	Whitefly	Webbing mite	Black bug
1	Co 10036	4.2	2.3	3.2	3.3	LS	MS	LS	LS
2	CoH 10262	3.2	1.2	3.2	3.3	LS	LS	LS	LS
3	CoPant 10221	3.8	4.4	4.3	3.5	LS	MS	LS	LS
4	CoPb 10181	4.2	3.3	3.5	5.5	LS	MS	LS	LS
5	CoPb 10182	3.5	1.6	4.3	5.5	LS	LS	LS	LS
CK	CoS 767	4.3	3.9	4.0	9.7	LS	MS	LS	LS
	CoS 8436	3.2	1.9	2.7	5.0	LS	LS	LS	LS
	CoPant 97222	4.2	3.5	4.8	9.4	LS	MS	LS	LS

Pyrilla population(nymph & adult)/leaf; Whitefly population (nymph & puparia) / 2.5 sq.cm; Black bug population/leaf; Webbing mite(% leaf incidence)

All genotypes tested against *Pyrilla* were found least susceptible. Lowest infestation of whitefly was observed in genotype CoH 10262(1.2 nymphs & puparia / 2.5 sq.cm) and highest(4.4 nymphs & puparia / 2.5 sq.cm) in CoPant 10221. Genotypes CoH 10262, CoPb 10182 and CoS 8436 (standard check) were categorised in least susceptible category and rest other genotypes were categorised as moderately susceptible. All tested genotypes were observed least susceptible against black bug and webbing mite.

Project E.28: Survey and surveillance of sugarcane insect- pests

A roving survey of Mills zones of Cooperative sugar factories, Karnal, Shahabad, Rohtak, Meham, Assandh, Palwal, Panipat, Jind, Sonipat and Gohana was carried out for insect-pests of sugarcane crop. Survey of insect-pests during pre-monsoon season revealed that in Sugar Mill Zone Karnal, during second fortnight of May, a low to moderate incidence of early shoot borer in both plant and ratoon crops of varieties Co 89003, Co 0238, Co 0118, CoS 8436 and CoH 160 and a moderate incidence of black bug was observed in ratoon crop of varieties, CoS 8436, CoJ 85, Co 0238, Co 05011 and Co 89003. During June in Karnal mill zone thrips was sporadically severe in villages Nasirpur, Kunjpura and Newal in varieties Co 0238 and CoS 8436. Black bug was also severe in Co 89003 and CoS 8436

in ratoon crop in these villages. Top borer and early shoot borer incidence was observed low to moderate in Co 0238, Co 89003 and CoH 160 varieties of sugarcane in plant crop in villages Kheri Mann Singh, Nagla Roran and Muradgarh of Karnal mill zone. However, incidence of black bug was reported severe in ratoon crop of Co 0238 and CoS 8436 in Kheri Mann Singh of Karnal mill zone. Severe incidence of termite was observed in Co 05011 and CoS 8436 varieties at Muradgarh village of Karnal mill zone. Low incidence of top borer and low to moderate incidence of shoot borer was observed in Malikpur, Barota, Jamalpur, Sadarpur, Manglora, Andhera villages of Karnal sugar mill in varieties CoP 84212, Co 0118, Co 0238, Co 89003, CoS 8436, CoJ 88, Co 05011 and CoH 119. Incidence of termite was also observed low to moderate in Co 05011, Co 89003 and CoS 8436 in Sadarpur village. Moderate incidence of black bug was also observed in ratoon crop of CoS 8436 in Andhera village of Karnal mill zone.

Survey of sugarcane in Shahabad mill zone during pre-monsoon season revealed that low to moderate incidence of early shoot borer and top borer was observed in varieties Co 0238, CoS 8436, Co 05011 and Co 89003. During monsoon season (August), a low to moderate incidence of whitefly, *Pyrilla* and webbing mite was also reported in Co 0238 and CoS 8436 in plant as well as ratoon crop in Shahabad mill zone in villages Khanpur Kohilon, Sharifgarh, Dhantori, Jhirbari, Masana, Kanipla and Umri. Survey of sugarcane crop in Rohtak and Meham sugar mill zones during monsoon season revealed that a few fields of CoH 119, Co 89003 and Co 0238 recorded high incidence of whitefly and webbing mite in villages Titoli, Samargopalpur, Nidana, Madina, Girwad, Bahu Akbarpur and Gaddi Khara in water logged areas. Incidence of top borer was low to moderate in CoH 119, CoH 160, Co 0238, Co 0118 and CoJ 85 in villages, Balli, Dhob, Lahali and Baniani of Rohtak sugar mill zone. However, incidence of sucking pests (whitefly, webbing mite, red mite and *Pyrilla*) was low to moderate in these villages of Rohtak sugar mill zone. Severe black bug incidence in villages Madina and Nindana in ratoon crop of varieties Co 0238 and CoH 119 was observed. A low to moderate incidence of whitefly was also observed in Co 0118, Co 0238, CoS 8436, Co 89003 and CoJ 85 in villages Bhramanwas, Gilod and Jasia of Rohtak sugar mill zone. Survey of

sugar mill zone Assandh during monsoon season revealed that incidence of top borer and webbing mite was observed low to moderate in Ballah, Salwan, Fafrana, Dupedi villages in varieties CoS 8436, CoS 88230, Co 0238 and Co 89003.

During post monsoon season, incidence of white grub (1-2 grub/sq. mt.), top borer and stalk borer was reported low to moderate in sugar mill zone of Palwal in varieties CoJ 85, CoJ 64 and Co 119. However, population of *Pyrilla* was also recorded moderate but its nymphal-adult parasitoid(4-7 cocoons/leaf) was also present in field which kept *Pyrilla* population below economic threshold. Survey of Assandh sugar mill zone revealed that population of *Pyrilla* and whitefly was moderate to high in sugarcane varieties Co 0238, CoS 8436 and Co 89003 in post monsoon season in villages Salwan, Dupedi and Kurar. Parasitization of *Pyrilla* was reported to be very less and only 0.5-1.0 cocoons/leaf of *Epiricania melanoleuca* (nymphal-adult parasitoid) were found. This may be due to factor that farmers might have adopted unjudicious use of insecticides for control of this pest. Stalk borer incidence was also reported low to moderate in this zone. Moderate incidence of top borer, moderate to high incidence of *Pyrilla* and whitefly was observed at Katwal and Kandela villages of Sugar mill Jind in varieties CoH 160, CoS 8436 and Co 05011. Similarly parasitisation of *Pyrilla* was also reported to be very less(0.5-1.0 cocoon/leaf). Root borer and whitefly population was reported severe in varieties CoH 119 and Co 89003(ratoon) in village Rajpura Bain of sugar mill zone Jind. Incidence of top borer and stalk borer was least to moderate in villages Ramrai of Jind sugar mill zone in varieties CoH 160, CoH 119,CoJ 64 and CoS 8436. Incidence of whitefly was reported severe in Nidana, Bamla, Bahu Akbarpur, Mokhra and Madina villages of Sugar mill Meham in varieties CoS 8436, CoH 119, Co 89003, Co 05011, CoJ 85 and Co 0118.

Survey of insect pests during post monsoon season in Panipat sugar mill zone revealed that stalk borer incidence was observed to be moderate to high in varieties Co 89003, CoS 8436 Co 0238 and Co 05011. Incidence of *Pyrilla* was also reported severe but nymphal-adult parasitoid was also present(4-5 cocoons/ leaf). Survey of Gohana and Sonipat sugar mill zones indicated that stalk borer incidence was moderate in varieties

CoS 8436, Co 89003, Co 0238, Co 0118 and CoH 119. Stalk borer infestation was reported to be least to moderate in varieties CoS 8436, CoJ 85, CoJ 64, Co 89003 and Co 0238 in sugar mill zone of Assandh and Jind. Stray incidences of grasshoppers were recorded in mill zones of Rohtak, Palwal, Sonipat and Gohana during monsoon and post-monsoon period.

Table 2: Incidence of sugarcane insect pests in mill zones of Haryana during 2015-16

Sugar Mills Zone	Season	Varieties	Insect-pests	Per cent incidence (%)	Remarks
Karnal	Pre-monsoon	Co 89003, Co 0238, Co 0118, CoS 8436 & CoH 160	Shoot borer	4-13	-
		CoS 8436, CoJ 85, Co 0238, Co 05011, & Co 89003	Black bug	10-34	Infestation in ratoon crop.
		Co 0238 & CoS 8436	Thrips	12-18	Infestation under drought conditions
		Co 05011, Co 89003 & CoS 8436	Termite	1.5 -15	Termite damage more in sandy soils
		Co 0238, Co 89003, CoP 84212, Co 0118, CoS 8436, CoJ 88, Co 05011, CoH 119 & CoH 160	Shoot borer Top borer	5-18 2-9	-
Shahbad	Pre-monsoon	Co 0238, Co 89003, CoS 8436 & Co 05011	Shoot borer	2-9	-
			Top borer	2-7	-
	Monsoon	Co 0238 & CoS 8436	Whitefly Pyrilla Webbing mite	1-6 2-5 8-10	In water logged fields
Rohtak & Meham	Monsoon	CoH 119, Co 89003, Co 0118, CoJ 85, CoH 160, Co 8436 & Co 0238	Whitefly Webbing mite Red mite Top borer	2-16 14-36 2-4 3-8	In water logged fields
		Co 0238 & CoH 119	Black bug	15-36	Ratoon crop
Assandh	Monsoon	CoS 8436, CoS 88230, Co 0238 & Co 89003	Top borer	2-4	-
			Webbing mite	4-10	-

	Post monsoon	Co 0238, CoJ 85, CoJ 64, CoS 8436 & Co 89003	White fly Pyrilla <i>Epiricania melanoleuca</i> Stalk borer	2-11 4-14 0.5-1.0 1.8-3.8	In water logged fields
Palwal	Post-monsoon	CoJ 85, CoJ 64, & CoH 119	White grub Pyrilla <i>Epiricania melanoleuca</i> Top borer Stalk borer	1-2 grub/sq. mt. 2-5 4-7 2-7 1.5-4.2	Damage in sandy soils -
Jind	Post monsoon	CoH 160, CoJ 64, CoH 119, CoS 8436, Co 89003 & Co 05011	Top borer Whitefly Pyrilla <i>Epiricania melanoleuca</i> Root borer Stalk borer	3-6 2-10 5-16 0.5-1.0 16-34 1.5-4.2	-
Meham	Post monsoon	CoS 8436, CoH 119, Co 89003, Co 05011, CoJ 85 and Co 0118	Whitefly	4.5-15.7	Severe incidence in water logged areas
Panipat	Post monsoon	Co 89003, CoS 8436, Co 0238, and Co 05011	Stalk borer Pyrilla <i>Epiricania melanoleuca</i>	2.8-6.8 6-14 4-5	-
Gohana & Sonipat	Post monsoon	Cos 8436, Co 89003, Co 0238, Co 0118 and CoH 119	Stalk borer	2.1-3.2	-

Black bug : Nymph&adult/tiller; Thrips : infested leaves(%); Whitefly : Nymph & adult/2.5 sq. cm.; Pyrilla : Nymphs & adults/leaf; Stalk borer: infestation index; *Epiricania melanoleuca* : cocoons/leaf.

Project E. 30: Monitoring of insect pests and bio-agents in sugarcane agro-ecosystems

During the initial stage of crop establishment (formative phase), early shoot borer, *Chilo infuscatellus* was the major pest in March planted sugarcane variety Co 0238 during pre-monsoon period (Table 2.1). The damage occurrence of shoot borer was started in first fortnight of April, its incidence being relatively low in end April (1.8 per cent).

Table 2.1: Incidence of insect-pests during 2015-16 in variety Co 0238 at RRS, Uchani

Period of observation	Mean incidence (%)				Mean number		Mean leaf incidence (%)		Mean number/ 2.5 sq.cm
	Shoot borer	Top borer	Stalk* borer	Root borer	Black bug/ central whorl	Pyrilla / leaf	Webbing mite	Thrips	Whitefly
April, 2015	1.8	-	-	-	-	-	-	-	-
May, 2015	4.6	-	-	-	3.8	-	-	2.3	-
June, 2015	6.8	3.6	-	-	6.4	-	-	2.2	-
July, 2015	2.4	4.9	-	3.2	6.5	4.7	1.8	2.8	0.6
August, 2015	0.4	5.2	0.3	5.4	3.3	4.2	3.7	0.6	1.2
September, 2015	-	5.6	0.6	10.8	3.4	4.4	4.6	0.6	3.2
October, 2015	-	5.8	1.1	11.6	1.3	2.6	4.3	-	2.4
November, 2015	-	-	1.6	12.4	0.6	2.5	0.8	-	1.2
December, 2015	-	-	1.8	12.8	0.2	1.3	-	-	-
January, 2016	-	-	1.9	13.2	-	-	-	-	-

*Infestation Index

During month of May, shoot borer incidence increased to a maximum of 4.6 per cent. During month of June shoot borer incidence reached to a maximum of 6.8 per cent. The incidence of this borer species was noticed to decline subsequently and was recorded 2.4 per cent during month of July and 0.4 per cent during month of August. There after incidence of this pest was not recorded. Top borer infestation was observed to begin in mid June with an infestation level reaching 3.6 per cent in end June. The infestation was shown to rise with the build up of second brood raising the population density to 4.9 per cent in end July. It increased (5.2%) by end August (third brood) and 5.6 per cent in last week of September (fourth brood). The infestation of this borer species in variety Co 0238 was 5.8 per cent during September when the pest reached the fifth brood. The damage of stalk borer started during month of August, its incidence being relatively low in end August (0.3 infestation index). During month of September, stalk borer incidence started increasing and reached to a maximum of 1.9 infestation index during month of

January. The incidence of root borer was noticed during month of July (3.2%). During August its population reached 5.4 per cent and there after population of root borer increased gradually and reached to a maximum of 13.2 per cent during month of January.

The black bug, *Cavelerius sweeti* infestation in the crop was first recorded during May(3.8 nymph/adults per shoot). It increased during June when the crop were found to inhabit a mean of 6.4 nymphs and adults/ shoot and 6.5 nymphs and adults/ shoot during month of July. The number was lowered to a mean of 3.3/ shoot in the month of August. It declined further in the subsequent months, but the pest infestation persisted in the crop till end December. Leaf hopper, *Pyrilla perpusilla* was noticed to begin in July because of drought during June-July and remained in the crop till December. It was naturally controlled by the egg and nymphal- adult parasitoids. Whitefly appeared in end July and its population was recorded 0.6 nymphs and puparia/ 2.5 sq. cm. Similarly, webbing mite also appeared during end July with incidence (1.8 % infested leaves). It increased slowly to a mean per cent webbing leaves of 4.6 during month of September and subsequently declined to 0.8 per cent webbing leaves by end November. Maximum infestation of whitefly (3.2 nymphs and puparia/2.5 sq. cm) was recorded during month of September and there after its population decreased and remained up to end November. Minor infestation by grasshoppers and thrips was also observed on this variety. The year 2015 was characterized by poor to a moderately monsoon rainfall.

Table 2.2: Natural enemy complex of *Pyrilla perpusilla* at RRS Uchani during 2015

Period of observation	<i>Cheiloneurus pyrillae</i>	<i>Tetrastichus pyrillae</i>	<i>Epiricania melanoleuca</i>	Total parasitism
16-31 May, 2015	0	0	0	0
1-15 June	0	0	0	0
16-30 June	0	0	0	0
1-15 July	0	4.2	0	4.2
16-31 July	0	12.8	4.6	17.4
1-7 August	3.4	15.4	9.5	28.3
8-15 August	8.4	14.8	12.8	36.0
16-23 August	18.5	18.2	18.7	55.4
24- 31 August	22.4	20.4	21.5	64.3
1-7 September	24.8	22.3	22.6	69.7

8-15 September	16.2	14.6	36.8	67.6
16-23 September	20.3	10.6	39.4	70.3
24-30 September	11.4	10.5	53.4	75.3
1-7 October	8.6	6.2	51.8	66.6
8-15 Oct	6.4	3.6	52.8	62.8
16-23 Oct	4.5	0.5	54.6	59.6
24-31 Oct	1.8	-	59.4	61.2
1-7 November	-	-	44.6	44.6
8-15 November	-	-	28.3	28.3
16-23 November	-	-	16.2	16.2
24 November-01 December	-	-	-	-

In pre-monsoon (May and June) duration of 2015, spiders, beetles and earwigs were the main natural enemies recorded in the experimental fields. The population of spiders and coccinellids during 2015 was observed to be 1-4/ plant. The earwigs were observed feeding on eggs and young nymphs of black bug during May-June. A natural parasitism (1.8-3.2 %) of whitefly was also recorded by *Encarsia* sp. A strong natural parasitism of eggs, nymphs and adults of *Pyrilla perpusilla* from first fortnight of July to third week of November in variety Co 0238 was observed that helped contain its population in the region. The parasitism build up was first observed during first fortnight of July when the leaf hopper infested field of variety Co 0238 recorded 4.2 per cent parasitism by *Epiricania melanoleuca*. The nymphal adult parasitoid, *E. melanoleuca* remained active from mid July to third week of November, with a maximum parasitism of 59.4 percent recorded during last week of October. A rapid increase in *Pyrilla* parasitism was subsequently recorded during August- October. A maximum of total parasitism measuring 75.3 percent by both egg and nymphal adult parasitoids was recorded during second fortnight of September. *Cheiloneurus pyrillae* and *Tetrastichus pyrillae* were the dominant egg parasitoids during monsoon and post monsoon period, attaining a peak parasitic activity to the tune of 24.8 and 22.3 percent, respectively during the first week of September. Thereafter, consistent and gradual decline in parasitic activity of *C. pyrillae* and *T.pyrillae* was observed, while these remained up to second fortnight of October.

Table 2.3: Natural enemy complex of sugarcane borers at RRS Uchani during 2015

Insect-pest	Stage	Natural enemies	Parasitism (%)
Top borer, <i>Scirpophaga excerptalis</i>	Larva	<i>Isotima javensis</i>	6.4
		<i>Cotesia flavipes</i>	4.9
		<i>Beauveria bassiana</i>	8.2
Stalk borer, <i>Chilo auricilius</i>	Larva	<i>Sturmiopsis inferens</i>	8.7
		<i>Cotesia flavipes</i>	4.3
		<i>Beauveria bassiana</i>	5.5
Root borer, <i>Polychola (Emmilocera) depressella</i>	Larva	<i>Beauveria bassiana</i>	7.2

A natural parasitism by *Isotima javensis*, *Cotesia flavipes* and *Beauveria bassiana* of top borer larvae was 6.4, 4.9 and 8.2 per cent, respectively (Table 2.3). In case of stalk borer, parasitism by *Sturmiopsis inferens*, *Cotesia flavipes* and *Beauveria bassiana* was 8.7, 4.3 and 5.5 per cent, respectively during post monsoon season. The larvae of root borer collected from field showed parasitism to the extent of 7.2 per cent by *Beauveria bassiana* during month of September.

Project E.34: Standardization of simple and cost effective techniques for mass multiplication of sugarcane bio-agents.

***Encarsia* sp. on sugarcane whitefly**

Whiteflies are tiny, sap-sucking insects that may become abundant especially during warm weather. Natural enemies may provide adequate control of whiteflies. Whiteflies have many natural enemies and outbreaks frequently occur when these natural enemies have been disturbed or destroyed by pesticides. Avoiding the use of insecticides that kill natural enemies is a very important aspect of whitefly management. *Encarsia* spp. is an important nymphal parasitoid of whitefly.

An experiment on rearing of *Encarsia* sp. on sugarcane whitefly nymphs was conducted. *Encarsia* sp. was reared in modified release cages (versatile insect rearing

cage Ac. 202-05, complete nylon, 25x30 cm. Plate a & b). Highly infested leaves by whitefly were brought to laboratory. Whitefly nymphs parasitized by *Encarsia* sp. were observed. Parasitized nymphs were dark in colour. Leaves with parasitized nymphs were cut in small pieces and placed in cages of nymphs of whitefly on test plants i.e. tomato and bringal (Plate a). Parasitized nymphs were also placed in cages on sugarcane leaves infested with whitefly nymphs. Parasitisation of sugarcane whitefly by *Encarsia* sp. ranged from 2.3-4.6 per cent when released in field.



Plate: a



Plate: b

Project E.36: Management of borer complex of sugarcane through lures

To evaluate the management of borer complex of sugarcane (shoot, top and stalk borer) through pheromone trap, a field experiment was conducted in 0.4 ha. of sugarcane field of variety CoH 160. Crop was planted on March 18, 2015 and completed germination by mid April. Six pheromone traps for each pest (shoot, top and stalk borer) were installed in 0.4 ha. on 20th of April, 2015 and another 0.4 ha. field was taken as control plot without traps. Moths trapped were recorded at weekly interval. Pheromone lures were changed at monthly intervals. The present investigations revealed that first shoot borer, *C. infuscatellus* moth capture was recorded during last week of April when an average of 2.4 moths were trapped (Table 3.1). The number of captures increased speedily up to second week of June reaching 10.4 moths/ trap. Thereafter, moth capture decreased gradually during the next four weeks and no moths of shoot borer were trapped after second week of July, 2015. Infestation by shoot borer ranged from 0.2 to 5.4 per cent in trap installed field as compared to 0.2 to 5.6 per cent in without trap installed field (Table 3.2).

Top borer, *S. excerptalis* moths were trapped from second week of June, 2015 onwards. The first top borer moth catches were observed during second week of June where an average of 1.8 moths/trap were trapped (Table 3.1). Thereafter, captures increased gradually and reached to a maximum of 7.4 moths/trap during first week of August, 2015. Thereafter, a gradual decrease was observed up to third week of September where moth trapping was observed 2.1 moths/trap. However, second peak of moth trapping was also observed in top borer where an average trapping of 5.6 moths/ trap were observed in last week of September and further a gradual decrease was observed up to second week of October when average trapping was 1.6 adults/ trap. After second week of October no top borer adult moth was trapped. Infestation by top borer ranged from 2.9 to 4.3 per cent in trap installed field as compared to 3.2 to 4.5 per cent in without trap installed field (Table 3.2).

Table 3.1. Weekly pheromone traps catches from April to December during 2015

Period of observation		Mean number of moths/trap		
Month	Week	Shoot borer	Top borer	Stalk borer
April	Third	-	-	-
	Fourth	2.4	-	-
May	First	3.2	-	-
	Second	3.0	-	-
	Third	3.4	-	-
	Fourth	5.8	-	-
June	First	7.2	-	-
	Second	10.4	1.8	-
	Third	6.8	5.6	-
	Fourth	4.2	6.2	-
July	First	2.4	6.0	-
	Second	1.2	6.4	-
	Third	-	6.2	-
	Fourth	-	6.8	-
August	First	-	7.4	-
	Second	-	6.0	-
	Third	-	5.4	-
	Fourth	-	4.2	2.2
September	First	-	4.4	5.4
	Second	-	3.8	6.2
	Third	-	2.1	4.4
	Fourth	-	5.6	2.6
October	First	-	2.8	6.8
	Second	-	1.6	5.4
	Third	-	-	3.8
	Fourth	-	-	3.2
November	First	-	-	4.6
	Second	-	-	6.4
	Third	-	-	5.2
	Fourth	-	-	4.8
December	First	-	-	3.4
	Second	-	-	2.8
	Third	-	-	1.6
	Fourth	-	-	-

Table 3.2. Observations on borers infestation from pheromone trap and control plot during 2015-16

Period of observation	Shoot borer		Top borer		Stalk borer	
	% infestation		% infestation		infestation index	
	With pheromone trap	Without pheromone trap	With pheromone trap	Without pheromone trap	With pheromone trap	Without pheromone trap
April, 2015	2.1	2.3	-	-	-	-
May, 2015	3.8	4.1	-	-	-	-
June, 2015	5.4	5.6	2.9	3.2	-	-
July, 2015	2.3	2.8	3.2	3.3	-	-
August, 2015	0.2	0.2	3.8	4.0	0.3	0.4
September, 2015	-	-	4.2	4.4	0.6	0.8
October, 2015	-	-	4.3	4.5	0.9	1.0
November, 2015	-	-	-	-	1.2	1.3
December, 2015	-	-	-	-	1.2	1.2
January, 2016	-	-	-	-	1.4	1.5

The activity of stalk borer, *C. auricilius* fluctuated widely between end August to third week of December. First trapping of stalk borer was observed during last week of August with an average trapping of 2.2 moths/trap (Table 3.1). In case of stalk borer, three peaks were observed. First peak was observed during second week of September where average trapping was 6.2 adults/trap, second during first week of October (average trapping 6.8 moths/trap) and third peak during second week of November (6.4 moths/trap). Thereafter, a gradual decrease was observed and none of stalk borer moth trapped after third week of December. Infestation by stalk borer ranged from 0.3 to 1.4 infestation index in pheromone trap installed field as compared to 0.4 to 1.5 infestation index in without trap field (Table 3.2)

