ANNUAL REPORT ENTOMOLOGY FOR 2012-13, (UCHANI CENTRE)

Project No. E.4.1: Evaluation of varieties/genotypes for their reaction against major insect pests of sugarcane

A total of 53 entries/genotypes that included IVT Early, IVT Mid Late, AVT Early, plant 1 and plant II, AVT Mid Late, plant I and Plant II and of AICRP and Standard checks were examined for damage occurrences by major moth borers mainly the early shoot borer, top shoot borer and stalk borer of sugarcane. All genotypes showed susceptibility to the three borer species to varying extent. The incidence of both the shoot and the top borer ranged from low to moderate among the test entries. A majority of the genotypes showed low susceptibility to shoot borer, whilst against top borer moderate variability was noticed. The results, in detail, are described as under-

In IVT (Early, Table 1), twelve entries namely Co 09020, CoH 09261, CoH 09262, CoH 09263, CoLk 09201, CoLk 09202, CoLk 09203, CoPb 09181, CoPb 09211, CoPb 09212, CoPb 09213 and CoS 09246 were evaluated against two standards- CoJ 64 and CoP 84211. Shoot borer infestation ranged form a minimum of 5.3 in CoH 09262 to a maximum of 14.8 percent in standard CoP 84211. However, all the entries including the standards were ranked least susceptible to shoot borer, *Chilo infuscatellus*. The standard CoP 84211 also showed the highest infestation (6.7) by stalk borer and root borer (4.2 %) while the second standard CoJ 64 had the highest top borer incidence during the season. The genotype CoPb 09212 contained the lowest top borer incidence (6.8 %). Of all the entries and standards CoLk 09202 with an infestation index of 1.7 showed minimum stalk borer, *Chilo auricilius* damage whilst CoLk 09201 recorded the lowest root borer incidence (0.7 %). All the genotypes and standards showed negligible to low damage by sucking pests like white fly, webbing mite and thrips during 2012 monsoon and post monsoon period.

Table 1: Reaction of sugarcane genotypes in Initial Varietal Trial (Early) to major insect-pests

Sr. No.	Variety/ Genotype	Borers (per cent % infestation)				Sucking pests(number/inch^2)		
		Shoot Borer	Top Borer	Root Borer	Stalk borer*	Whitefly	Webbing mite	Thrips
1	Co 09020	7.3	8.9	1.8	3.6	0	0	0
2	CoH 09261	7.8	7.8	2.7	3.2	0	0	0
3	CoH 09262	5.3	12.1	0.8	2.8	1.2	0.4	1.2
4	CoH 09263	6.9	9.4	1.9	4.7	0	0.8	0.2
5	CoLk09201	9.2	10.6	0.7	2.8	1.5	0.7	1.2
6	CoLk 09202	8.3	9.5	2.3	1.7	0.3	0	0.7
7	CoLk 09203	7.2	11.2	3.1	3.8	0	0	0.6
8	CoPb 09181	6.3	7.2	2.9	2.9	1.1	1.4	0
9	CoPb 09211	5.9	9.2	0.8	3.6	0.9	0	0.7
10	CoPb 09212	9.1	6.8	3.7	4.2	0	0.6	0
11	CoPb 09213	8.4	11.4	2.1	4.8	1.4	0.9	1.3
12	CoS 09246	6.2	10.3	1.6	4.1	0.8	0.4	0
	CoJ 64	8.3	12.7	1.7	4.3	0.9	0	1.2
	CoP84211	14.8	10.2	4.2	6.7	0.9	0.5	1.6

* Infestation index

Under the IVT Mid Late, (Table 2) eight entries Co 09021, Co 09022, CoH 09264, CoLk 09204, CoPb 09214, CoS 09231, CoS 09232 and CoS 09240 were evaluated against the standards CoS 8436, CoS 767 and Co Pant 97222. All the genotypes including the standard were found least susceptible to the shoot borer, its incidence ranging from 4.1 in standard cultivar CoS 767 to 12.4 per cent in standard CoS 8436. The check CoS 8436, in fact, recorded the highest damage by all the major borer species and the check CoS 767, the lowest infestation. In the test entries the shoot borer incidence ranged from 5.4 (CoPb 09214) to 7.8 per cent (Co 09021). The top borer incidence, which was the highest in check cultivar CoS 8463 (18.5 %) and lowest in CoS 767, remained moderate in the test entries. It was recorded less than 10 per cent in all test entries save for CoS 09232 (10.6 %) and CoS 09240 (15.1 %). The stalk borer infestation

index ranged from 2.1 (CoS 767) to 9.3 (CoS 8436), all test entries showing low to moderate borer infestation.

Table 2: Reaction of sugarcane genotypes in Initial Varietal Trial (Mid Late) to major insect-pests

Sr. No.	Variety/ Genotype	Borers (per cent % infestation)				Sucking pests(number/inch^2)		
		Shoot Borer	Top Borer	Root Borer	Stalk borer*	Whitefly	Webbing mite	Thrips
1	Co 09021	7.8	9.2	1.3	4.8	0	1.1	1.2
2	Co 09022	6.5	7.4	0	3.9	0.4	0.6	1.4
3	CoH 09264	7.2	8.2	0.9	3.7	1.2	0	0.8
4	CoLk 09204	5.3	6.4	0.6	5.2	0	0	0.6
5	CoPb 09214	4.9	7.9	0	2.8	0.7	0	0.7
6	CoS 09231	6.1	9.5	0.7	4.3	0.6	0.8	0.6
7	CoS 09232	5.4	10.6	1.1	3.2	0	1.4	1.6
8	CoS 09240	7.6	15.1	1.5	3.7	1.2	0	0
	CoS 8436	12.4	18.5	3.3	9.3	2.1	0.4	5.2
	CoP 97222	7.9	12.9	2.3	4.2	1.1	0	1.4
	CoS 767	4.1	4.2	1.4	2.1	0	0.9	0

* Infestation index

Low incidence of root borer sucking pest insects viz. whitefly, webbing mite and thrips was also observed invariably in the test entries as also the standards. The Standard, CoS 8436 contained the highest thrips population (5.2 per square inch of leaf area). Whitefly and webbing mite infestation remained negligible in both the entries and the standards.

In AVT Early, plant I trial (Table 3), three entries were evaluated against two standards. The shoot borer incidence was recorded less than 10 per cent in all the three test entries. It ranged from 6.2 in (CoS 08233) to 14.8 (CoP 84211) per cent in standard check, albeit, indicating low susceptibility of the all the genotypes to this borer species. The root borer incidence was also quite low reaching a maximum of 2.5 per cent in CoPb 08211 as against 4.2 per recorded in standard check CoS 84211. However, all the entries were recorded low to moderately susceptible to the top shoot borer and the stalk borer.

The top borer incidence ranged from 10.2 in CoS 08233 to 13.1 percent in CoPb 8212 as against 10.2 per cent recorded by standards CoP 84211 and 12.7 per cent by CoJ 64. All the entries, with their infestation index varying between 2.1 (CoPb 08212) to 3.7 (CoS 08233) were found to be low to moderately susceptible to the stalk borer as against the highly susceptible standard, CoP 84211. The webbing mite, whitefly and thrip incidences were negligible in most of the entries and standards.

Table 3: Reaction of sugarcane genotypes in Advanced Varietal Trial (Early, Plant I) to major insect-pests

Sr. No.	Variety/ Genotype	Borers (per cent % infestation)				Sucking pests(number/inch ^{2})		
		Shoot Borer	Top Borer	Root Borer	Stalk borer*	Whitefly	Webbing mite	Thrips
1	CoPb 08211	8.2	10.9	2.5	2.3	0	0.0	0.0
2	CoPb 08212	6.7	13.1	1.1	2.1	0.8	0.0	0.2
3	CoS 08233	6.2	10.2	1.2	3.7	0.6	0.0	1.1
	CoJ 64	8.3	12.7	1.7	4.3	0.9	0	1.2
	C0P 84211	14.8	10.2	4.2	6.7	0.9	0.5	1.6

* Infestation index

In AVT Early, plant II trial (Table 4), five entries were evaluated against two standards. The shoot borer incidence ranged from 5.1 (Co 07025) to 14.8 (CoP 84211) per cent indicating low susceptibility of the all the genotypes to this borer species. The standard check CoP 84211 was also recorded highly susceptible to the root borer and the stalk borer. The root borer incidence was quite low in the test entries reaching a maximum of 1.3 percent in Co 07023. The entry Co 07025 was noticed to contain the lowest incidence of all the four borer species. The remaining entries and the standard checks recorded more than 10 per cent top borer incidence of the top shoot borer. The infestation index for stalk borer varied between 2.9 in Co 07025 to 6.7 in CoP 84211 indicating moderate to high susceptibility to the borer species The webbing mite, whitefly and thrips incidences were almost negligible.

Table 4: Reaction of sugarcane genotypes in Advanced Varietal Trial (Early, Plant II) to major insect-pests

Sr. No.	Variety/ Genotype	Borers (per cent % infestation)				Sucking pests(number/inch ^{2})		
		Shoot Borer	Top Borer	Root Borer	Stalk borer*	Whitefly	Webbing mite	Thrips
1	Co 07023	7.2	12.6	1.3	3.1	0.4	0.6	1.2
2	Co 07025	5.1	8.5	0	2.9	0.9	0.9	0.8
3	Co 06032	6.2	12.5	0.7	4.3	0.0	0.0	1.6
4	CoLk 07201	8.6	14.7	1.2	5.8	0.0	1.4	0.8
5	CoH 07261	8.2	13.8	0	3.7	0.0	0.7	0.6
	CoJ 64	8.3	12.7	1.7	4.3	0.9	0	1.2
	C0P 84211	14.8	10.2	4.2	6.7	0.9	0.5	1.6

- Infestation index

In the AVT Mid- Late plant I (Table 5) six entries were evaluated against standards CoS 8436, CoP 97222 and CoS 767. All the genotypes showed low susceptibility to shoot borer as well as root borer. The shoot borer incidence varied between 3.2 and 6.9 per cent during first fortnight of June (peak activity period. The genotype COS 08235 contained the lowest incidence while, the genotype CoH 08263 possessed the highest incidence. The standard CoS 8436 was more susceptible to shoot borer than the entries. The entries showed low to moderate incidence to the top and the stalk borer while the incidence of root borer in these entries was quite low. The standard check CoS 767 recorded lowest top borer incidence. The incidence of top borer in the genotypes including the remaining standards varied from 7.6 per cent (CoS 08234) to 18.5 (CoS 8436). Most of the genotypes were categorized as moderately susceptible to top borer. All the test entries with infestation index ranging between 2.6 (CoH 08263) to 4.9 (CoS 08234) were low to moderately susceptible to stalk borer. Contrary to the least susceptible CoS 767, the standard CoS 8436, however, was found highly susceptible to this borer species Whitefly, thrips and webbing mite incidence was found negligible in the test genotypes.

Table 5: Reaction of sugarcane genotypes in Advanced Varietal Trial (Mid Late, Plant I) to major insect-pests

Sr. No.	Variety/ Genotype	Borers (per cent % infestation)				Sucking pests(number/inch ^{2})		
		Shoot Borer	Top Borer	Root Borer	Stalk borer*	Whitefly	Webbing mite	Thrips
1	CoH 08262	5.3	9.7	0.0	2.9	0.0	0.7	0.0
2	CoH 08263	6.9	10.3	1.2	2.6	0.0	0.0	0.0
3	CoH 08264	9.3	15.8	0.7	3.6	0.5	0.0	0.0
4	CoPb 08217	5.8	8.4	0.5	3,1	0.8	1.7	0.0
5	CoS 08234	6.1	7.6	1.3	4.9	1.2	0.9	0.3
6	CoS 08235	3.2	8.1	0.4	4.6	0.6	0.0	1.7
	CoS 8436	12.4	18.5	3.3	9.3	2.1	0.4	5.2
	CoP 97222	7.9	12.9	2.3	4.2	1.1	0	1.4
	CoS 767	4.1	4.2	1.4	2.1	0	0.9	0

* Infestation index

In the AVT Mid- Late plant II trial (Table 6) nine entries namely Co 07028, CoH 07263, CoH 07264, CoLk 07202, CoLk 07203, CoPb 07212, CoPb 07213, CoS 07232 and CoS 07234 were evaluated against standards CoS 8436, Co Pant 97222 and CoS 767. All the genotypes showed low susceptibility to shoot borer as well as root borer. The shoot borer incidence varied between 3.7 (CoPb 07213) and 12.4 per cent (CoS 8436) during first week of June (peak activity period). The genotype CoPb 07213 contained the lowest incidence while, the genotype CoS 07234 possessed the highest incidence. The standard CoS 8436 with an incidence level of 12.4 per cent was more susceptible to shoot borer than the entries. The entries showed low to moderate incidence of the top and the stalk borer while the incidence of root borer in these entries was quite low. The lowest incidence of top borer was recorded in standard check CoS 767, while the highest in the standard check 8436 (18.5 %) followed by genotypes CoS 07234 (17.2 %) and CoS 07232 (15.3 %). Most of the genotypes were categorized as moderately susceptible to top borer. All the test entries with infestation index ranging between 1.9 (CoS 07234) to 6.1 (CoPb 07234) showed wide variability in stalk borer damages. The standard CoS 8436,

recording an infestation index of 9.3 was highly susceptible to this borer. The incidences of sucking pests and root borer, however, remained obscure.

Table 6: Reaction of sugarcane genotypes in Advanced Varietal Trial (Mid Late, Plant II) to major insect-pests

Sr. No.	Variety/ Genotype	Borers (per cent % infestation)				Sucking pests(number/inch^2)		
		Shoot Borer	Top Borer	Root Borer	Stalk borer*	Whitefly	Webbing mite	Thrips
1	Co 07028	7.8	9.6	1.7	4.7	0.0	0.0	0.7
2	CoH 07263	9.3	10.6	0.9	3.8	0.0	0.5	1.1
3	CoH 07264	7.1	8.7	1.3	3.5	1.2	0.0	0.8
4	CoLk 07202	5.2	7.9	0.4	3.1	0.4	0.3	0.4
5	CoLk 07203	4.9	9.2	0.8	4.2	0.0	1.0	0.3
6	CoPb 07212	9.1	15.2	1.4	6.1	0.2	0.7	0.0
7	CoPb 07213	3.7	9.2	0	4.3	0	1.3	0.0
8	CoS 07232	7.6	15.3	1.3	3.2	0.5	0.7	2.6
9	CoS 07234	9.5	17.2	2.3	1.9	0.4	0.6	0
	CoS 8436	12.4	18.5	3.3	9.3	2.1	0.4	5.2
	CoP 97222	7.9	12.9	2.3	4.2	1.1	0	1.4
	CoS 767	4.1	4.2	1.4	2.1	0	0.9	0

* Infestation index

Project No. E. 28: Survey and surveillance of sugarcane insect pests

Mills zones of Cooperative sugar factories, Shahbad,Kaithal, Palwal, Panipat, Jind, Rohtak and Karnal were surveyed for insect pests of sugarcane crop. During pre-monsoon period, the shoot borer and black bug incidence was moderate to high in ratoon crop of varieties CoS 8436 and CoH 119 while the incidence of top borer remained quite low. Mild to severe thrips infestation was observed in Co 7717, CoH 119, Co 89003, CoJ 64, CoS 8436 during June-July in mill zones of Karnal, Kaithal, Panipat, Gohana. During monsoon and post monsoon period the incidence of black bug persisted sporadically particularly in varieties CoS 8436, CoH 119, CoH 150 and CoJ 85 in some of the sugar mill zones. The top borer infestation varied from low to moderate (3.4- 11.7 per cent) among the major cultivars grown in the state. A low to moderate incidence of Pyrilla was

also observed on varieties CoH 119, Co 0238, CoJ 85 in sugar mills zone of Kaithal, Asandh, Gohana, Bhadson and Sonipat. White fly and grass hopper incidences were observed sporadically low in almost all the mill zones of Haryana. Low to moderate webbing mite infestation was observed on variety CoH 152, CoH 119 and CoS 8436 in Shahbad and Karnal mill zones.

Project No. E.30: Monitoring of insect pests and bioagents in sugarcane agro-ecosystem

The experiment was planted in end week of February 2012. During the formative phase of crop growth the early shoot borer, *Chilo infuscatellus* and the top shoot borer, *Scirpophaga excerptalis* were recorded as the main pest in spring (February) planted sugarcane variety CoH 152 (Table 7). Shoot borer was the main pest during tillering phase (pre-monsoon period) and its overall incidence was moderate on the select variety. The damage occurrence of shoot borer were observed to begin during the first fortnight of April, its incidence remaining relatively low till April end (4.8 per cent). During first fortnight of May, the borer incidence, however, increased speedily to a maximum of 14.9 per cent, It attained peak during end May (16.9 per cent). The incidence of this borer species was noticed to decline subsequently and was not recorded to increase after mid June. Contrarily, the incidence of top shoot borer remained very low during pre-monsoon period. It was noticed in June. It increased slowly and gradually from July to October but was still quite lower than the economic injury level in end November when the pest reached the fifth brood and the cumulative incidence to 9.3 per cent. Moths of third brood started emerging from second week of August and of 4th brood from last week of September The black bug, *Cavelerius sweeti* infestation in the crop was very mild and first recorded in end June. It increased during June when the crop was found to inhabit a mean of 10.3 nymphs and adults/ shoot. The number was lowered to an average of 4.5 adults and nymphs/shoot during September. It declined further in the subsequent months, but the pest infestation persisted in the crop in small numbers till harvest.

Leaf hopper, *Pyrilla perpusilla* was noticed to make appearance in July end and remained on the crop till November. It was naturally controlled by the egg and nymphal-

adult parasitoids. Whitefly appeared quite late (mid September) but in high proportions in this variety during 2012. Similarly, webbing mite also appeared quite late during end September with moderate incidence (4.2 webbings/inch^2). It had increased slowly to a mean webbing number of 6.2/ inch^2 by October end and subsequently declined gradually to 2.3 webbings/inch^2 by mid December. While the root borer, *Polyocha depressella* incidence remained quite low in the crop, the stalk borer, *Chilo auricilius* was moderately high reaching to about 37.6 per cent at harvest. The intensity of this borer at harvest was measured 19.2 percent. Minor infestation by grasshoppers and thrips was also observed on this variety. The year 2012 was characterized by good monsoon spanning over end June to August which added to luxuriant crop growth. The winter was very severe and foggy and culminated in to frosty in mid January 2013.

Spiders, beetles and earwigs were the major bio-agents recorded during May, however, their population remained very low during pre- monsoon period because of high temperature and low humidity. It was only during September-October that a moderate activity of these could be observed in the experimental field which also recorded high population of the parasitoids of Pyrilla. The infestation of Pyrilla remained under the natural parasitism by its eggs, nymphs and adults parasitoids namely, *Cheilonerus pyrillae* and *Epiricania, melanoleuca*. The population of spiders and coccinellids during monsoon of 2012 was observed to be higher (3-8/ plant) than that recorded in 2011 (1-6/ plant). The earwigs were observed feeding on eggs and young nymphs of black bug during May-June. During formative phase of crop growth, the population densities of spiders and beetles remained low. However, a gradual increment in their number was witnessed from May onwards and peaked during maturity phase (October- November). The lacewing, *Chrysoperla carnea* activity was also moderate (2-3 larvae per whitefly infested leaf) because of adequate monsoon during 2012. A strong natural parasitism of eggs, nymphs and adults of *Pyrilla perpusilla* July through September and October 2012 in varieties CoJ 85, CoH 119 and Co238 was observed that helped contain its population in the region (Table 8). The parasitism build up was first observed during first fortnight of August when the leaf hopper infested field of variety CoH 119 recorded 3.9 per cent parasitism by *Epiricania melanoleuca.* A rapid increase in

Pyrilla parasitism was subsequently recorded August through October. A maximum of total parasitism measuring above 72.0 percent by both egg and nymphal adult parasitoids was recorded during second fortnight of October while during 2011 this peak was attained during third week of September. *Cheiloneurus pyrillae* was the dominant egg parasitoid during monsoon and post monsoon period, attaining a peak parasitic activity to the tune of 42.3 percent in the last week of September. The parasitism of Pyrilla eggs by *Tetrastichus pyrillae* varied from negligible to a maximum of 10.3 percent in the second week of August. Thereafter, consistent and gradual decline in parasitic activity of *T. pyrillae* was observed in the month of September, while it remained obscure during October. A comparison of activity periods of the two egg parasitoids indicated that *Tetrastichus pyrillae* was more abundant during August while, *C. pyrillae* had its peak activity period during September. The nymphal adult parasitoid, *E. melanoleuca* remained active from mid July to mid November.

Table 8. Natural enemy complex of *Pyrilla* at RRS Uchani during 2011

Period of observation	***Cheiloneurus pyrillae***	***Tetrastichus pyrillae***	***Epiricania melanoleuca***	**Total parasitism**
16-31 May, 2010	0	0	0	0
1-15 June	0	0	0	0
16-30 June	0	0	0	0
1-15 July	0	0	3.9	3.9
16-31 July	1.6	4.7	7.3	12.0
1-7 August	0	7.4	12.6	20.0
8-15August	5.3	10.2	21.3	36.8
16-23 August	16.2	8.4	18.3	52.9
24- 31August	32.2	6.2	24.2	62.6
1-7 September	4o.5	4.4	25.2	66.1
8-15 September	42.4	1.3	26.3	69.0
16-23 September	42.3	-	29.6	71.9
24-30 September	33.2	-	39.2	72.4
1-7 October	24.6	-	46.8	71.4

8-15 October	16.6	-	51.2	67.8
16-23 October	11.8	-	44.2	56.0
24-31 October	10.2	-	40.2	50.4
1-15 November	4.7	-	5.9	10.6
16-30 November	-	-	2.4	2.4

A higher parasitism of stalk borer larvae was witnessed during 2012 post monsoon period as compared to that observed during the same period in 2011. The stalk borer larvae showed 15.7 per cent natural parasitism by tachinid fly *Sturmiopsis inferens* and 12.7 per cent by *Beauveria bassiana* and 5.9 per cent by *Cotesia* flavipes (Table 9). Of the top borer larvae collected during November 2012, 7.2 per cent were found naturally infected with *B. bassiana* while the root borer larvae during February, 2013 recorded 11.6 per cent infection bb this fungus. A natural parasitism by *Isotima javensis* of top borer larvae during October was 6.7 per cent and that of *Cotesia* 4.7 per cent.

Table 9. Natural enemy complex of important insect-pests of sugarcane at CCS HAU RRS, Uchani, Karnal

Pest	Stage	Natural enemies	Parasitism (%)
Stalk borer, *Chilo auricilius*	Larva	*Sturmiopsis inferens* *Cotesia flavipes* *Beauveria bassiana* *Nosema sp.*	15.7 5.9 12.7 2.5
Top borer, *Scirpophaga excerptalis*	Larva	*Isotima javensis* *Cotesia flavipes* *Beauveria bassiana*	6.7 4.7 7.2
Root borer, *Polychola* (*Emmalocera*) *depressella*	Larva	*Beauveria bassiana*	11.6

Table 7. Incidence of pest insects during 2012-13 in variety CoH 152 at RRS, Uchani

Period of	Mean % incidence				Mean number/ plant			Mean number/ sq. inch	
Observation	Shoot borer	Top borer	Root borer	Stalk borer	Black bug	Thrips	Pyrilla	Whitefly	Webbing mite
April	4.8	0.3	-	-	-	-	-	-	-
May	16.9	1.1	-	-	4.2	0.0	-	-	-
June	4.6	2.2	0.4	-	10.3	0.0	-	-	-
July	-	4 .2	0.7	1.3	6.2	0.0	2.7	-	-
August	-	6.9	1.1	9.3	4.8	-	5.4	-	-
September	-	8.3	3.2	15.4	4.3	-	8.2	4.3	4.2
October	-	9.3	3.8	24.3	2.6	-	11.4	6.8	6.2
November	-	8.6	1. 3	33.1	1.4	-	3.1	5.9	4.9
December	-	-	0.6	43.2	1.6	-	0.4	2.3	2.3
January	-	-	1.2	38.2	0.4	-	-	-	0.6
February	-	-	0.6	40.2	0.8	-	-	-	-

Project No. E.34: Standardization of simple and cost effective methods for mass multiplication of potential bio-agents of sugarcane insect pests.

Sugar industry wastes/byproducts namely molasses, bagasse, press-mud and cane trash alone as well as supplemented individually with aqueous molasses and yeast (as exogenous sources of carbon and nitrogen, respectively) in different concentrations and combinations were tested for mass production of *M. anisopliae*. It appeared feasible to cultivate the entomopathogenic fungus *M. anisopliae* on molasses, a sugar factory byproduct, on combining it with yeast in different proportions. Of the molasses-yeast liquid cultures, cultivation of *M. anisopliae* on 4.0 per cent molasses combined with 1.5 per cent yeast resulted into highest fungal biomass and conidial density. The size of the conidia here was also the largest of all the substrates. The fungus grown on this medium inflicted the highest mortality against workers of termite, *Microtermes obesi* and young grubs of *Holotrichia consanguinea*.

It also appeared feasible to cultivate *M. anisopliae* on sugar industry wastes like bagasse, press-mud and cane trash as solid substrates. Addition of molasses and yeast in different proportions to these solid substrates was shown to significantly enhance the efficacy of the substrates measured in terms of conidial yield, fungal biomass and time taken to complete by the fungus.Bagasse with addition of molasses and yeast in different proportions as exogenous sources of carbon and nitrogen proved the best solid substrate. Mixed with 3.0 per cent molasses and 1.5 per cent yeast it produced 105 folds more conidia than that harvested from bagasse alone. The fungus produced on this medium showed higher potentiality. The conidia harvested from bagasse based select media were shown to be more potent than those collected from press-mud or cane trash based select media against workers of termite, *M. obesi* (Table 10) and young grubs of *H. consanguinea* (Table 11).

Among the press-mud based media, the fungus produced the highest conidial yields. Press-mud in congest with 3.0 per cent molasses and 1.5 per cent yeast proved to be the next best media in terms of potentiality of fungus. Fungus grown on cane trash based media were found suboptimal in terms of potentiality against the test insects which invariably remained less than 50 per cent irrespective of the influence of the exogenous carbon and nitrogen sources and hence may be eliminated from the list of optimal media.

A two stage cultivation process utilizing sugar industry wastes/byproducts is therefore, possible for the economical and efficacious mass production of *M. anisopliae*. Based on the conidial yield, potentiality, time taken to sporulate and cost of cultivation, bagasse supplemented

with 3.0 per cent molasses and 1.5 per cent yeast may be used as a medium for the mass multiplication of *M. anisopliae*, while 4.0 per cent molasses and 1.5 per cent yeast may be used as an inoculants for the culturing on above described bagasse based medium.

Mass multiplication of *Trichogramma spp.* namely *T. chilonis* and *T. japonicum* was carried out in laboratory on coarsely milled maize grains amended with yeast. The biocontrol laboratory produced and supplied to farmers 2648 Tricho cards for use against sugarcane stalk borer, *Chilo auricilius* and 1760 cards for the top borer, *Scirpophaga excerptalis* management. Egg and nymphal adult parasitoids of Pyrilla were also supplied to farmers for use in more than 1625 acre of sugarcane and sorghum fields

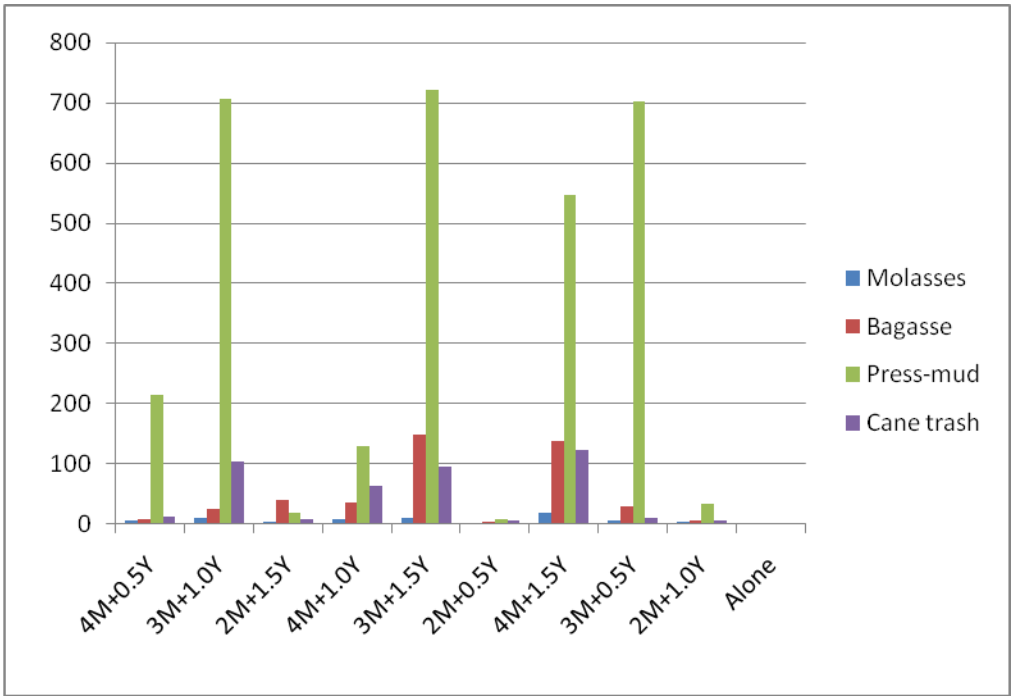

Fig. 1. Sporulation pattern of *M. anisopliae* on media of tested substrates, after 20 days of incubation period

Table 10. Virulence of *M. anisopliae* against workers of termite, *Microtermes obesi.*

Sr. No.	Treatments	Mean per cent mortality*	Time taken to kill (Days)
1	4M+1.5Y	92.59 (74.39)	5.67
2	3M+1.5Y	85.93 (67.95)	6.67
3	3M+1.5Y+bagasse	79.96 (63.40)	6.33

4	4M+1.5Y+bagasse	73.33 (58.91)	7.67
5	3M+1.5Y+press-mud	61.11 (51.41)	8.00
6	3M+1.0Y+press-mud	52.59 (46.47)	8.33
7	4M+1.5Y+cane-trash	47.78 (43.71)	9.33
8	3M+1.0Y+cane-trash	40.00 (39.18)	9.67
9	PDB (Std liquid)	71.48 (57.72)	7.67
10	BRSG (Std solid)	72.22 (58.19)	7.33
	CD (p=0.05)	3.73	0.16
	SE(m)	1.25	0.05

* Mortality corrected using Abbott's formula

Figures in parentheses are arc sin transformed values

PDB= Potato Dextrose Broth, BRSG= Broken Rice and Sorghum Grain

Table 11. Virulence of *M. anisopliae* against young grubs of *Holotrichia consanguinea*

Sr. No.	Treatments	Mean per cent mortality*	Time taken to kill (Days)
1	4M+1.5Y	78.98 (62.74)	7.67
2	3M+1.5Y	69.57 (56.52)	8.00
3	3M+1.5Y+bagasse	69.93 (56.75)	8.00
4	4M+1.5Y+bagasse	64.85 (53.63)	8.33
5	3M+1.5Y+press-mud	42.03 (40.39)	8.67
6	3M+1.0Y+press-mud	38.40 (38.28)	9.00
7	4M+1.5Y+cane-trash	30.43 (33.44)	9.67
8	3M+1.0Y+cane-trash	23.55 (28.99)	9.67
9	PDB (Std liquid)	65.21 (52.98)	8.33
10	BRSG (Std solid)	64.49 (53.41)	8.67
	CD (p=0.05)	3.34	0.13
	SE(m)	1.12	0.04

* Mortality corrected using Abbott's formula

Figures in parentheses are arc sin transformed values

PDB= Potato Dextrose Broth, BRSG= Broken Rice and Sorghum Grain

Project E.36: Management of sugarcane borers through pheromone lures

The experiment was laid out in a half block design choosing borer susceptible CoH 119 as the test cultivar. In the block in which pheromone lures loaded traps were erected for moth capturing, the early shoot borer moth were the first to be trapped during the formative phase of crop growth. It started in third week April when on an average 1.6

moths per trap that increased progressively up to early May (first week) when it reached a maximum of 9.7 moths/trap Hence forth, only stray catches (maximum of 5 moths/trap) were observed and this pattern of moth catching continue till first week of June, when the maximum catches were 2 moths/trap. The shoot borer moths were not trapped thereafter. Top borer moths were trapped from end April onwards. The first top borer moth catches were observed on 28 day of April. The catches during the first week of May increased ranging from an average of 1.5 to 8.7 moths /trap and during the subsequent week of May fluctuated between 2-7 moths /trap (Table 12). Therefore, the peak period of catches for the second brood of top borer during the year 2012 remained between May 5 -May17, followed by a lean period from third week onwards. The moth emergence for third brood was noticed to begin from end week of June and continued up to mid July, 2012 with a maximum catch of 12 moths/ trap recorded on July 7, 2012. The peak activity period for fourth brood was observed mid August when a maximum of 6 moths/trap were recorded on August 16, 2012. On the remaining days it ranged between 1-4 moths/trap followed by a lean period in later period of August. The catches for third and fourth broods were relatively low. However, the catches for fifth brood witnessed a slight spurt over the two earlier broods. It rose to an average catch of 6.3 moths/trap during mid October with a gradual subsequent decline till first week of November after which top borer moths were not trapped. Stalk borer moths were mainly trapped from July mid to October. The mean maximum catches were recorded in July end. The highest moth catch per trap was recorded on September 21, 2012 (11 moths/trap).

The overall incidence of all the broods of the early shoot borer, the top shoot borer and the stalk borer in first half block in which pheromone traps were erected was recorded to be 8.3, 21.2 and 57.7 per cent , respectively, as against 12.4, 29.3 and 71.3 per cent observed in untreated check. In IPM block in which moth trapping through pherone lures was combined with cultural, chemical or biological means, the cumulative incidences of these three borer species was shown to be 4.3, 4.7 and 43.7 per cent, respectively (Table 13).

Table 12. Weekly pheromone traps catches from April to October during 2011

Period of observation		Mean number of moths/trap		
Month	**Week**	**Shoot borer**	**Top borer**	**Stalk borer**
April	First	-	-	-
	Second	-	-	-
	Third	1.6	-	-
	Fourth	3.7	0.7	
May	First	9.7	5.8	0.4
	Second	4.6	4.2	0.2
	Third	2.6	2.3	1.1
	Fourth	1.3	1.1	0.7
June	First	1.6	1.2	1.5
	Second	0.8	3.2	0.6
	Third	0.3	0.8	1.3
	Fourth	-	1.2	1.9
July	First		5.3	2.6
	Second		7.3	3.7
	Third		2.1	4.4
	Fourth		0.3	1.7
August	First		0.2	2.6
	Second		3.7	3.6
	Third		5.1	4.3
	Fourth		2.2	1.5
September	First		1.4	2.3
	Second		0.9	0.1
	Third		3.6	5.2
	Fourth		1.3	4.1
October	First		3.4	3.8
	Second		6.3	4.2
	Third		2.3	0.6
	Fourth		0.8	1.2

Table 13: Effect of moth trapping alone and in conjunct with other IPM practices on incidence of major moth borer

Treatment	**% Incidence of shoot borer in mid June**	**% incidence of top shoot borer in end November**	**% incidence of stalk borer at harvest**
Pheromone block	8.3	21.2	57.7
Untreated block	12.4	29.3	71.3
IPM block (Pheromone+ other IPM practices including chemical control)	4.3	4.7	43.7